Biohegemony, interrupted: The limits to GMO agriculture in a neoliberal era

by

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Abstract

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This thesis argues from a contrarian point of departure that the successes of GMO agriculture have thus far been limited or underwhelming. It thus asks what accounts for the limitedness of the GMO food economy. From this overarching question, the research is divided into three further questions that consider the roles of law, the structural requirements of the capitalist system, and the use of discourses of nature amongst activists respectively as factors influencing the underdevelopment of GMO agriculture. These questions form the basis for three chapters that comprise the thesis. Chapter one draws on the work of Antonio Gramsci and Karl Polanyi in evaluating the consequences of legal regimes that regulate GMOs. Against the tide of neoliberalism, I discuss how a binding, precautionary agreement over international trade in GMOs emerged through the Cartagena Protocol on Biosafety. I argue that this Protocol is an example of what Polanyi termed the "self-protection of society," the second phase of his double movement. Chapter two uses Marxist theories of agrarian capitalism to understand both the early successes and later setbacks of GMOs as a capital accumulation strategy. I argue that the successes and failures of GMO agriculture are partly circumscribed by the structural requirements of the capitalist system, as well as by the materiality of GMO crops themselves. The chapter builds on the work of Gabriela Pechlaner and David Goodman to show how processes of appropriationism, expropriationism and the logic of capital more generally can explain not only why some innovations have succeeded but also why so many others have been unsuccessful. Innovations that are geared at consumers rather than farmers have largely failed due to their status as value-added products (whose value is subjective and market-driven) rather than capital goods. Chapter three considers the role played by nature narratives in structuring the cultural politics of GMO agriculture. It argues that natural purity discourses have been central to the success of GMO activism as they have mobilized widely resonant nature-culture dualisms that separate the natural world from the human world. However, though strategically effective, these discourses hold dubious political implications, as they entrench or naturalize unequal power relations in the social world and deflect attention away from the problematic political economic consequences of GMOs under neoliberalism. The chapter argues that activist campaigns that directly target the political economic, neocolonial, and class implications of GMOs within the context of neoliberalism have also had successes without resorting to appeals to the purity of nature, an approach that I argue ought to frame opposition struggles against GMOs going forward. The thesis uses a mixed methods approach that includes document analysis, historical analysis, discourse analysis and literature review. It incorporates a wide lens approach, drawing on a range of case studies from multiple scales to animate the conceptual arguments being analyzed. By problematizing how GMO agriculture has evolved as a capital accumulation strategy for large transnational corporations, this thesis seeks to critically evaluate the practical social justice implications of anti-GMO resistance efforts for those opposed to neoliberal globalization.

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Introduction: GMO, OMG?

Ever since Stanford University scientists Stanley Cohen and Herbert Boyer created the first transgenic *E. coli* bacteria in 1973, genetically modified organisms (GMOs) have garnered significant popular attention, both positive and negative (Bud 1993). Jeremy Rifkin, one of the most outspoken opponents of GMOs, argued in 1977 that they "…raise[ ] the most significant ethical, political, and social dilemmas a society has ever had to face," and warned that genetic engineering threatened humanity with "a form of annihilation every bit as deadly as nuclear holocaust, and even more profound" (Howard and Rifkin 1997: 13, 9-10). In contrast to Rifkin's catastrophism, the genetic engineers of the age expressed a profound optimism. One of the early innovators in plant biotechnology, Mary-Dell Chilton was quoted in 1984 as predicting that "[i]n three years, we'll be able to do anything that our imaginations will get us to" (Charles 2000: 31). Positively or negatively, it seemed given that GMO technology would significantly reshape humanity's relationship with the rest of nature in the twenty-first century and beyond.

In the ensuing decades, and in the wake of GMO agriculture's commercial development, much has been written and said about GMO agriculture, whether in the oppositional manifestos of environmental activists, the public relations campaigns of the biotechnology industry, or the critical analyses of academic scholarship. Yet accounts of the actual efficacy of GMO agriculture have been few and far between. While some research (Andree 2007; Eaton 2013; Schurman and Munro 2010) has examined the success of particular activist campaigns within the anti-GMO opposition movement, many studies have begun with the assumption that GMO agriculture has generally succeeded as a capitalist accumulation strategy and instead sought to evaluate its positive and negative social and environmental consequences (Barben 1998; McAfee 2003, 2004; Newell 2009; Pechlaner 2010, 2012). This thesis takes a different approach. Rather than

assuming that GMO agriculture has been successful and proceeding to explain its impacts, this thesis seeks to account for both the successes and limitations of the GMO food economy and explore what can be learned from such limitations. Against the grain of neoliberalism, GMO agriculture has been successfully resisted by civil societies in many parts of the world. A perspective that emphasizes its limitations is especially well positioned to locate both chinks in the armor of neoliberal capitalism[1] and potential paths of successful resistance to the further encroachment of corporate power in the agricultural economy and beyond.

How then might we evaluate the impact of GMO crops on global agriculture? Certainly, there have been successes. Four crops in particular – cotton, soy, maize and canola – have been immensely successful, especially in North America. Moreover, only two particular innovations have been used for each of these four crops respectively: herbicide tolerance and insect resistance. Overall, there have been more than 170 million hectares of GMO crops planted in 28 countries (James 2012). At the same time, GMO agriculture has been resisted. Numerous other crops, including herbicide-resistant wheat, pest resistant potatoes, slow-ripening tomatoes and beta-keratin-enhanced rice have proven to be commercially unviable due to regulatory constraints, a lack of consumer demand or public resistance, all of which ultimately contribute to a perceived lack of profitability on the part of capital. Moreover, there have been bans, moratoria and mandatory labelling laws in at least 64 countries and many more subnational regions, especially in Europe but also in Asia and Africa (CFFS 2013). With few exceptions, almost no GMO food is grown outside of the Americas. Thus GMO agriculture's development has been spatially variegated and contradictory and often the same institutional structures and dynamics that were central to its proliferation have simultaneously worked against it.

[1] As I explain below, GMO agriculture has developed as a neoliberal project.

Though it borrows theoretically from a wide range of sources, this thesis charges that GMO agriculture has developed as a neoliberal project (see Bakker 2003, 2005, 2010; Bumpus and Liverman 2008; Castree 2003, 2008a, 2008b; Collard 2014; Mansfield 2007; McAfee 2004, 2008; McCarthy 2005, 2006; Peck and Tickell 2000; Prudham 2005; Robertson 2004, 2006; Sharp 2000). Neoliberalism refers to both a concrete set of political practices and an ideology that often (though not always) informs those practices and grants them normative legitimacy. In concrete policy terms, neoliberalism has meant a reorientation of the state's role in relation to the economy, as governments seek to provide corporations with optimal conditions for investment and profit-making through policies of deregulation, privatization, tax cuts, and the entrenchment of private property laws, pursuing policies that promote economic growth and market freedom over those that promote economic equality through progressive taxation and social programs. In ideological terms, proponents of neoliberalism have sought to advance a rationalist, individualist worldview that sees the unfettered market as the freest and fairest mechanism for distributing wealth and ensuring progress and economic growth (see Castree 2008a, 2008b, 2003; Harvey 2005; Mann 2012; Peck and Tickell 2002).

How has GMO agriculture come to be part of this process of neoliberalization? GMO agriculture has come to be a very profitable accumulation strategy for a small number of large transnational corporations, but in order to do so it has relied on neoliberal policies every step of the way. It was the American government's deregulation and privatization of seed breeding that enabled hybrid seed breeding – the predecessor to GMO seed breeding – to develop as an area of potential profit for capital (Kloppenburg 2004).[2] It was the development of a multiscalar

[2] It is important to remember that the state has played an important role in subsidizing biotechnological innovation, through public university research and other public subsidies to corporations (Cooper 2008; Kloppenburg 2004).

neoliberal legal regime – ranging from patent rights on transgenic life forms granted in 1979 to the global constitutionalization of neoliberal trading and patent rights under the WTO agreements of 1994 to the private technology use agreements between corporations and farmers – that empowered biotech corporations to enclose the genetic commons, ensuring control over the profits from their "inventions" (Andree 2007; Pechlaner 2012). The GMO food economy that we have today could only have emerged in the context of neoliberalism; it is inexorably tied to neoliberalizing regimes. At the same time, it was never inevitable that the GMO food economy would come to be imbricated within processes of neoliberalism, nor is it inevitable that GMO agriculture will continue to develop as part and parcel to the overall project of neoliberalization in the future. By this I mean that the potential has always existed for a different GMO food economy geared toward social justice rather than private profit and structured around social relations that empower publics rather than corporations.

By situating this research within critical geography and political economy, I assume an explicit normative stance in relation to neoliberalism. As Harvey (2007) has shown, neoliberalism has operated since the 1970s as a project for the restoration of capitalist profitability and for the re-entrenchment of capitalist class power. Neoliberal policies have brought forth an era of greater material and social inequality globally whilst undermining workers' rights and exacerbating environmental destruction, as environments and societies are increasingly abandoned by waning regulatory safeguards and left vulnerable to the effects of the free market. For this reason, the thesis makes normative evaluations of the limitedness of the GMO food economy, interrogating what positive and negative lessons can be learned from its uneven development by those struggling against processes of neoliberalization and for a more socially and ecologically just world. Such lessons include the potential role of law as a vehicle

for slowing or challenging the expansion of corporate power; the need to see technological trajectories as circumscribed by political economic relations; and both the ethical problems and strategic benefits for activists of mobilizing nature-essentialist discourses.

The overall argument in this thesis is that the GMO food economy has failed to live up to early expectations. Its success has been underwhelming at best and contradictory at worst. Juridico-political, political economic and cultural-semiotic dynamics[3] that were initially central (and remain central) to its success as a neoliberalizing project have ultimately been mobilized by activist resistance efforts, or have otherwise proven to be barriers to the further development of the industry. Legally, while international legal institutions have formed the basis for a constitutionalized neoliberal order (Gill 2008), the law and juridico-political institutions have been mobilized by opposition efforts to resist the constitutionalization of a free trade, intellectual property rights (IPR)-based global trading regime for GMOs at multiple scales. Political-economically, material and ecological dynamics that render GMOs profitable have enabled the success of some innovations as accumulation strategies for capital. Yet the logic of capital[4] has simultaneously frustrated the success of many other innovations, as capital has been dissuaded from pursuing all but the most lucrative innovations. Cultural-semiotically, while the ontological framing of GMOs as human inventions and distinct from the rest of nature has enabled the patentability of GMOs, this same framing of GMOs as distinct from the rest of nature has

[3] Juridico-politics refers to the way legal institutions are manifest as sites of political contestation and struggle. Political economic refers to the way power relations are reproduced and challenged through economic institutions and interactions. Cultural-semiotic refers to the way discourse is always inscribed by deeper cultural meaning, while cultures themselves are dynamically reproduced through discourse.

[4] The logic of capital can be understood as entailing two key conditions: the profit motive and the pressure of competition. Under capitalism, all firms and other profit-seeking actors (including farmers) are compelled to maximize profits or lose out as rival firms outcompete them. Firms are obliged to make business decisions that will provide maximum profits to them. This basic logic structures how all profit-seeking actors behave in a market system. Biotechnology firms are required to pursue innovations that will bring them more revenue rather than those that might fill a wider social need without the promise of profits. Similarly, farmers are compelled to adopt new technologies that will increase their revenue streams and enable them to stay competitive with rival farmers.

prompted fears among consumers and inspired substantial resistance efforts among a wide range of actors including environmental NGOs, the media, and various political parties that have been immensely successful in limiting the success of GMOs.

Three chapters comprise what follows, examining in turn the juridico-political, political economic and cultural-semiotic dimensions of GMO agriculture's contradictory development. Chapter one draws on the work of Antonio Gramsci (1992) and Karl Polanyi (1944) in evaluating the consequences of the juridico-political regimes that regulate genetically modified foods. Against the tide of neoliberal (de)regulation, I discuss how a binding, precautionary agreement over international trade in GMOs has emerged through the Cartagena Protocol on Biosafety. I argue that this Protocol is an example of what Polanyi termed the "self-protection of society," the second phase of his double movement. The final form the Protocol took was a product of European governments' immediate responses to public concerns over the potential environmental and health impacts of GMOs in an unregulated global economy. With Polanyi we can see how such concerns are part of a wider pattern of spontaneous backlashes to the potentially adverse consequences of treating nature like a commodity.[5] This "self-protective" turn has been manifest at regional and national scales, including in Australia, through the country's mandatory labelling policy and state-based moratoria that existed in the early 2000s. Drawing on Gramsci, I argue that this unlikely turn emerged in the context of shifting public opinion and effective anti-GMO activism, through an alternative discursive framing of GMOs as distinctly risky rather than substantially equivalent to non-modified foods. It took hold with

[5] It is important to note that this line of analysis hold particularly true in Europe. In the Global South, due the historical legacy of colonialism and ongoing unequal North-South power relations, anti-GMO actors were more concerned with the potential for Southern countries to become testing grounds for new technologies, bearing an undue burden of the risk associated with their development.

European publics and subsequently European governments, generating the relations of force, or assemblage of discursive, institutional and material power needed to become the new hegemonic framing of GMOs in the international arena.

However, the turn to this biosafety framing of GMOs – and the subsequent self-protective countermeasures – has not called into question the underlying structural basis for GMO agriculture as a strategy for capital accumulation. Rather, the demands of anti-GMO activists and Southern governments for a more comprehensive protocol have been carefully co-opted into an ideological framework that accepts a discourse of precaution but otherwise fails to challenge the basic premises of neoliberal rationality. Unlike the Convention on Biodiversity (from which the Protocol emerged), the Protocol largely rejects restrictions based on socio-economic considerations, mandates sound science-based decision-making, and obligates members to adhere to basic WTO principles of free trade and free markets when making restrictions as much as possible (Andree 2007). Thus while on one level demonstrating the potential of regulatory counter-movements in a neoliberal era, the regulatory backlash to GMO agriculture's rapid expansion has failed to challenge the legitimacy of power relations that make GMO agriculture a site of profitable accumulation for corporations at the expense of farmers.

Chapter two explores how Marxist theories of agrarian capitalism can be animated through the study of GMO agriculture, and explains both its early successes as an accumulation strategy and later setbacks. I argue that the successes and failures of GMO agriculture are partly circumscribed by the structural requirements of the capitalist system, as well as by the materiality of GMO crops themselves. Successful innovations have been able to mitigate the material barriers to accumulation found in agricultural production, and thus appeal directly to farmers as comparatively profitable capital inputs. In this way, they cohere with David

Goodman's (1987) notion of appropriationism, where manufactured capital inputs (such as pesticides, machinery and fertilizers) replace "natural" inputs (such as manure or draft animals), reducing labour time and biological contingency, and thus creating a competitive advantage for those farmers who adopt the new technology (at least temporarily). However, unlike earlier appropriationist innovations such as farm machinery or chemical inputs, the main source of value is not a material commodity but (biological) information. Moreover, the liveliness of transgenic seeds means that their reproduction and proliferation cannot be biophysically regulated.[6] Therefore, profits cannot be accumulated across generations, and a special set of legal mechanisms is required to ensure that profits accrue with patent holders, what Pechlaner (2012) has termed "expropriationism."

However, my analysis goes beyond Pechlaner and Goodman *et al* to show how appropriationism, expropriationism and the logic of capital more generally can explain not only why some innovations have succeeded but also why so many others have been unsuccessful. Innovations that are geared at consumers rather than farmers have largely failed due to their status as value-added products (whose value is subjective and market-driven) rather than capital goods. Without providing the structural competitive advantage to ensure uptake by farmers, their only means of being profitable is to appeal to consumers as superior to non-GMO foods. This has not happened, and as a result, all other GMO innovations have failed to interest capital and have thus been ignored, abandoned, or remain in regulatory limbo. Overall, the chapter demonstrates how the logic of capital and the biophysicality of specific GMO crops intersect to determine which types of innovations are likely to be successful and which are not. The

[6] Genetic Use Restriction Technologies (GURTs) hold one potential solution to this problem for capital as a genetic innovation that renders seeds sterile, but, as Chapter Three will show, this technology has met staunch resistance from civil society and subsequently been banned at a global level.

biophysicality of GMO crops provides both barriers and opportunities to capital, and the logic of capital conditions what sort of material interventions are pursued. The analysis in this chapter thus demonstrates that under capitalism, successful technological innovations will be limited only to those that bring profits to corporations, and not necessarily those with wider social benefits.

Chapter three considers the role played by nature narratives in structuring the cultural politics of GMO agriculture. It argues that natural purity discourses have been central to the success of GMO activism as they have mobilized widely resonant nature-culture dualisms that separate the natural world from the human world. However, though strategically effective, these discourses hold dubious political implications. In valorizing the natural as a pre-discursive essence of truth, natural purity discourses do little to deconstruct the way naturalizations have been used to legitimize sexist, racist, heterosexist and colonial systems of injustice and oppression. Rather, they revitalize the discursive purchase of appeals to nature as a justification for the way things are, and thus indirectly serve to reinforce existing power relations. Moreover, these discourses fail to challenge the critical though contingent reality of GMOs' location within the wider framework of neoliberal social relations. To this end, they not only leave unchecked the political economic and class consequences of GMOs, but also preclude any role for biotechnology in a socially just future. However, though they have dominated anti-GMO activism, appeals to natural purity have not been the only effective strategy for opposing GMOs. Though in the minority, activist campaigns that have directly targeted the political economic, neocolonial, and class-based implications of GMOs *within the particular context of neoliberalism* have also had successes without resorting to appeals to the purity of nature. The successes of these campaigns suggest that while nature-culture dualisms remain politically

effective normative groundings, concerns over equity, farmers' rights, accountability and democracy retain potential as terrains of ideological struggle. As a spatially variegated and multifarious component of the wider struggle against neoliberalism and the new enclosures, GMO activism can, and must, seize this normative terrain going forward.

Important differences and points of comparison exist between the three chapters. While the first chapter engages more deeply with questions of law, politics and political economy, the second chapter places greater emphasis on the importance of nature's biophysicality. Heavily indebted to both Gramsci and Polanyi, chapter one engages in more cultural-political debates over the making and contesting of hegemony and the way GMOs' juridico-politics might be demonstrative of a renewed double movement in the neoliberal era. Conversely, chapter two places greater emphasis on the way GMOs' materiality presents new opportunities and barriers to capital. However, the two chapters reinforce each other. The materiality of GMO agriculture has constitutive impacts on the sort of legal regimes that emerge to regulate it. The fact that intellectual property rights are not simply helpful but necessary for GMOs to be successful under capitalism has been central to the configuration of the existing legal order. At the same time, the legal regime that has emerged to regulate GMOs, both through the overarching biosafety rubric of the Cartagena Protocol and through the myriad of regional, national and subnational efforts around the world, has profoundly impacted the material configuration of GMOs, including which innovations are pursued and which are deemed too risky and unlikely to garner profitable returns. In this way, juridico-political institutions, GMOs' materiality and the logic of capitalism interact in complex ways.

A further side of the GMO story is the cultural-political or cultural-semiotic, as discussed in chapter three. Cultural political factors, including the unusual level of public ambivalence and

often hostility towards GMOs, particularly in Europe, have played a significant role both in constitutionalizing a relatively rigorous though inchoate and geographically varied web of restrictions on GMOs globally and in precluding the success of GMOs that target consumer preferences rather than productive efficiencies. Most people have been unwilling to accept a framing of GMO foods as "new and improved," and have thus stymied all efforts to make GMOs that target nutrition or taste an economic reality. The cultural-political sphere has thus interacted significantly with the political economic and juridico-political spheres. Moreover, this engagement has not only been unidirectional. While the commodification of life signified through intellectual property rights has been integral to the commercial success of GMOs, this juridico-political process has generated a staunch backlash from civil society groups, leading to widespread concern for the unaccountable power held by corporations like Monsanto and the potentially adverse economic impacts GMOs would bring to farmers of the global South. In this way, just as the cultural-political has influenced the legal realm, legal decisions have sparked new and critical cultural-political framings of GMOs. At the same time, the sticky materiality of GMOs – their "messiness" as technologies that are lively and uncooperative, with reproductive capacities and complex ecological consequences has also influenced cultural politics and encouraged resistance. Their uncontrollability renders them novel risks which have prompted concern among publics, ultimately leading to the precautionary Cartagena Protocol. Just as the cultural politics behind GMOs has influenced how they have come to be manifest materially, the materiality of GMOs has been central to the sorts of questions that generate public ambivalence about the technology.

An important question is that of methods. The thesis primarily relies on methods of historical analysis, document analysis, literature review and critical discourse analysis. It takes a

wide lens approach to exploring dynamics in GMO agriculture whilst mobilizing various case studies to illustrate conceptual arguments. On one hand, such a broad approach might be seen as a methodological weakness of the study, as it has prevented much deep analysis of particular cases. On the other hand, it strengthens the research by showing connections across space and between scales. Empirically, the thesis draws on a range of case studies. I have tried to draw on empirical cases that exemplify the theoretical concepts that I explain while still remaining representative of general dynamics. Therefore, although I selected cases that could most effectively demonstrate the arguments being made, I did so after carefully considering the overall picture, in all of its variegation and contradictions. To that end, chapter one uses a case study of Australia to demonstrate how Polanyi's double movement has been manifest on national levels. The Australian case captures the bivalent and contradictory dynamics of the double movement better than other states, and might be seen as exceptional in that regard. Yet precisely because of this, the Australian case shares commonalities with other countries, including those that are both pro- and anti-GMO. Thus, while the double movement may be generally manifest globally, whether it tends to be more expansionist or protectionist varies, with Australia only providing a midpoint on the global scale, and not necessarily demonstrative of dynamics in every country.

Chapter two uses a case study of herbicide tolerant Roundup Ready soybeans to demonstrate the effectiveness of expropriationism and appropriationism. It contrasts the success of this innovation with the failures of slow-ripening Flavr Savr tomatoes and vitamin A-enhanced Golden Rice. Roundup Ready soybeans were chosen as a case study because they illustrate how GMOs function as capital accumulation strategies under optimal conditions: when dynamics conducive with appropriationism and expropriationism are present. In contrast, Golden Rice and Flavr Savr tomatoes demonstrate what happens under conditions that are not conducive

with appropriationism and expropriationism. In other words, although these cases are exceptional examples of these logics, by examining them together we can understand the contradictory effects of appropriationism and expropriationism for GMO agriculture in practice. Similarly, chapter three uses cases that are individually exceptional but collectively representative of the overall picture. While certain groups who adopt a more nature-essentialist framing in their critique of GMOs do so sensationally, such as the Austrian Freedom Party and New Zealand's Mothers Against Genetic Engineering in Food and the Environment, these cases are contrasted with those who assume a more political economic framing of their critique, such as the campaign against Genetic Use Restriction Technologies (GURTs) or that against Roundup Ready wheat in Saskatchewan. Overall, in each of the chapters, cases were chosen individually to optimally illustrate the theoretical concepts being employed and collectively to represent the variegated and contradictory empirical picture. Therefore, we must remember that although individually the cases chosen should not be seen as representative of overall dynamics, when taken together they aptly characterize the general dynamics being explored.

While the three chapters stress the complex, contradictory and dynamic ways through which institutional, material and discursive conditions have conditioned the development of the GMO food economy, they are centrally concerned with how and why these factors of GMO agriculture have been so impactful on the successes and limits of the industry. I avoid questions of whether GMOs are good or bad in and of themselves, because my entry point is to understand how their manifestation is conditioned by the logic of capital and the political context of neoliberalism. The influence of the logic of capital and the need for intellectual property rights have been so constitutive to the industry in and of itself that we simply cannot disaggregate GMO agriculture as we know it from neoliberalism. Thus while the pages in this thesis hopefully

lend themselves toward a deeper critique of neoliberalism and its adverse social, political and ecological implications for people around the world, they are not intended as a critique (nor an appraisal) of GMO agriculture in general.

Following Noel Castree's (2003) call to consider the multifarious ways in which neoliberalisms are manifest and the differential effects that scalar, spatial and biophysical properties will have on actually existing neoliberalisms, I want to emphasize that the story I tell in the chapters that follow is specific to GMOs. Indeed, it advances Castree's point: the way GMOs have come to be manifest, and the sort of actually existing neoliberalism they are imbricated within, could only have emerged in the context of a specific and overlapping set of cultural, biophysical, social, semiotic, institutional, economic and political conditions.

At the same time, we must also look for connections. A purely myopic, case-by-case approach to understanding neoliberalisms that does not seek to explore any overarching patterns is equally problematic as one that is ill attuned to the reality of variegation (Bakker 2010). These chapters thus seek to explore how the political economy and juridico-politics of GMO agriculture can be demonstrative of larger processes, and how it can provide lessons for the future. The relative success of legal restrictions against GMOs can only be understood in their context but they simultaneously resonate with historical processes of societal self-protection, as Polanyi would see, or *trasformismo* (co-optation), as Gramsci would point out. Despite all of the contextual contingencies, we can still see the workings of a double movement, or of a nascent counter-hegemony that is often co-opted by the neoliberal historic bloc. Similarly, we can see how the logics of appropriationism and expropriationism remain central to agriculture; GMOs may be unique, but they also play an historical role in the long and uneven process of agriculture's piecemeal commodification (Goodman et al 1987).

Thus, in resonance with Pechlaner (2012), Kloppenburg (2004), Haraway (1997) and Andree (2004), the point of this thesis is not to oppose or support GMO agriculture, but to better understand it and its impact on cultural, political, economic and social processes. GMO agriculture is significant because of its pervasive contradictions. Its commodification has been deeply contested and stymied, though for reasons that are often inchoate and incoherent. The relative success of resistance efforts is demonstrative of the potential efficacy of wider social resistance to processes of neoliberalization. However, though a minority of movements such as the campaign against Roundup Ready wheat in Canada and the global campaign against terminator technology, have been conscious of how neoliberal social relations have structured or threaten to structure GMO political economies in ways that are at odds with social and ecological justice, part of what has been central to that very success of the anti-GMO movement has been an unwillingness to engage seriously with the fundamental political economic factors behind GMO agriculture's development. Drawing from the lessons of these few hopeful examples, the question of how an oppositional political force such as that that inspired the Cartagena Protocol and the multifarious restrictions on GMOs throughout the world can be mobilized around a more coherent and critical vision of the problems inherent to neoliberalism, but not to GMOs necessarily, remains the task for those concerned with building a better world.

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Chapter 1: The new agrarian double movement

Two decades ago the first commercial GMO crops were planted in the United States. Since 1994, the success of the GM food economy has been mixed. Although certain countries, including Canada, the United States, Argentina and Brazil, have largely embraced GMO agriculture, as of 2012, 92 percent of all land used to grow GMO crops was located in just six countries, and 99 percent was located in only twelve countries (James 2012; see Appendix 1). Moreover, the number of crops that have enjoyed commercial success is equally limited. While GMOs accounted for 77 percent of soybeans, 49 percent of cotton, 26 percent of maize and 21 percent of canola globally as of 2009 (Halford 2012), GMOs are largely absent from the rest of agriculture. Furthermore, GM versions of all of these crops have been commercially available since the late 1990s, meaning that it has been more than fifteen years since the industry has come up with a new modified crop that holds much commercial potential. Even in a relatively pro-biotechnology country like Australia, which is discussed below as a case study, the success of GMOs has been mixed, with GMO canola accounting for just 3.5 percent of total canola production as of 2009 (AusBiotech n.d.). Overall, the success of GMO agriculture has been partial at best. While several factors account for the limitations of the GM food economy, the juridico-political regime through which it has evolved has been fundamentally important to both its initial commercial success and subsequent setbacks.

The GMO food economy cannot be disaggregated from the overarching political economic context within which it has emerged: neoliberalism and the era of new enclosures. As others have shown (Barben 1998; Newell 2009; Prudham 2007, McAfee 2008, 2004, 2003a, 2003b), GMOs are exemplary of the contemporary process of enclosure under neoliberalism, as their very genetic codes are rendered patentable and ownable by large corporations who are

empowered to extract rents or super-profits from dependent farmers through technology use agreements and other means (Andree 2007; Prudham 2007; Pechlaner 2012, 2010). Given the extent to which GMO agriculture has developed as a capital accumulation strategy, and given the important role of law in enabling and securing capital accumulation in general, we must ask what role law has played in the development of the GMO food economy, and how the juridico-politics of GMOs can be understood, in light of GMO agriculture's limited development.

Several critical accounts of commercial biotechnology have emphasized the role played by law, and the state more generally, in promoting the development of biotechnology, either through subsidized research or pro-market legal regimes (Cooper 2008; Kloppenburg 2004; Pechlaner 2012, 2010; Prudham 2007). Indeed, the state has played an indispensable role in the development of GMO agriculture. However, I argue that while earlier legal institutions were central to the development and expansion of the GMO food economy, recent laws since the turn of the century have worked to slow the development of the GMO food economy, against the tide of neoliberalism. This has resulted in an overall dynamic akin to Karl Polanyi's "double movement." Yet, these laws have not challenged the underlying neoliberal normative basis of the GMO food economy. They have thus done little to alter the unequal power dynamics that make GMO agriculture profitable for corporations but disempowering for farmers, particularly in the global South. It is therefore worth considering not only how and why these laws were successful, but also why the more radical concerns of civil society organizations were coopted into legal agreements that ultimately did little to challenge neoliberal ideology. In addressing this question, the chapter synthesizes theoretical contributions of Polanyi and Antonio Gramsci to explain both why this regulatory backlash occurred when it did and why it was ultimately unable to push towards a deeper restructuring of GMO agriculture. While Polanyi's notion of the double

movement is useful in explaining why this regulatory response was successful in slowing the nascent GMO food economy, Gramsci's notion of the relations of force is helpful in understanding why these regulations developed in a way that ultimately failed to challenge neoliberal orthodoxy.

The analysis takes a multiscalar approach, looking at both the global scale and the national and regional through a case study of Australia, a country that shares similarities with both pro-GMO countries in the Americas (it opposed the Cartagena Protocol) and with anti-GMO countries in Asia and Europe (it instituted a mandatory labelling policy and subnational moratoria). In this way, Australia aptly reflects the bifurcated global context of GMOs' juridico-politics. Though they differ in certain respects, similar dynamics have been at play both in Australia and globally, and therefore comparison between scales reveals both important similarities and differences in the general trend of regulatory countermeasures that emerged in response to concerns over the potentially adverse effects of an unregulated GMO food economy.

This chapter begins by considering Gramscian and Polanyian insights relevant to the argument outlined above. It then explores juridico-political dynamics of market expansion and regulatory countermovement through a history of the juridico-politics of GMO agriculture, both globally and more specifically in the case of Australia. It first explores the global picture, considering the juridical expansion of the GMO economy through IPR laws and the subsequent self-protective backlash expressed through biosafety laws. It then considers the picture in Australia, first examining Australia's pro-biotechnology and free trade policies in the 1990s, and then looking at Australia's own regulatory countermeasures: a mandatory labelling policy and five state-wide moratoria, all of which emerged between 2001 and 2004.

Hegemony and spontaneity

To what extent have previous studies in critical political economy engaged the theoretical insights of Polanyi and Gramsci? While Burawoy (2003), Gill (1995), Birchfield (1999) and Parry (2009) prove notable exceptions, syntheses of these two thinkers have been few and far between, despite widespread engagement with each of them individually.[7] While such a lacuna may be understandable – there are significant theoretical divergences between the thinkers – there is much to be gained from a dialogical engagement with their respective works.

Karl Polanyi's (1944) concept of the "double movement" has been one of the most widely used approaches to studying the political economy of neoliberal capitalism (see Bakker 2010; Guthman 2007; Mansfield 2004; McCarthy and Prudham 2004; Mutersbaugh 2002; Barham 1997, 2002). Polanyi's double movement characterizes the history of capitalism's development in England through a dialectical political economic pattern of market expansion and resistance and has been liberally appropriated to explain contemporary processes of economic globalization. Polanyi argued that capitalism is unique in history as an economic system governed by sheer market logic – the profit motive and competition – rather than other social institutions.[8] Polanyi saw that for capitalism to function, the market had to treat all productive inputs as if they were commodities: bought and sold in the market and governed by the price mechanism. However, not everything can function as a commodity without incurring deleterious impacts. In particular, Polanyi characterized land, labour and capital as "fictitious commodities" because they are not designed to be bought and sold on the market. Neither the human being who

[7] For an engagement with Gramsci within political ecology and geography see volume 40, issue 3 of *Geoforum*.

[8] Or at least this was the utopian ideal upon which the liberal ideology rested. Polanyi saw that in actuality, even under free market capitalism, social institutions were always necessary, though their role was reduced and generally subordinated to the laws of the market.

engages in commodified human labour nor the natural environment within which commodified land is embedded can simply be subjected to market laws of supply and demand without being affected, and likely harmed. For this reason, Polanyi saw that a self-regulating market system would inevitably drive itself to the point of collapse, as its key ingredients – land, labour and capital – would be overexploited. He thus observed that in response to the expansion of markets, a countermovement which he termed the "self-protection of society" would often (though not inevitably) occur. This involved spontaneous popular efforts to re-embed markets within social institutions so as to protect societies from the adverse social and environmental consequences of the free market.

Polanyi was also adamant that markets require the state and particular juridico-political configurations to emerge and to function. The double movement, as an abstract formulation rather than a definite historical process, can thus be represented as a juridico-political process: its expansionary side involves those legal measures that extend market rights and promote commodification and capital accumulation. Its protective side involves legal measures to regulate and minimize the harmful environmental and social effects of unregulated markets.

Polanyi's notion of the double movement enables us to see how GMO regulations that emerged at the turn of the century cohere with a broader framework of backlash against the expansion of markets, and the unknown and potentially adverse health and environmental consequences of treating nature – in this case GMOs and the environments with which they interface – as a commodity. However, while Polanyi's notion of the double movement remains useful in theorizing the neoliberal moment, there are limits to Polanyi's thinking. For one thing, his theory does not account for the *political* nature of self-protection. What sort of self-protection emerges will be a result of political struggle, and not universal common sense, as his theory

suggests. Moreover, his theory misses how even self-protective countermeasures that may appear to be spontaneous are contingent on existing configurations of power. Therefore, we can only understand why spontaneous countermeasures take the form they take if we examine how the normative justification for those measures is continually being struggled for within civil society.

In light of these shortcomings in Polanyi's analysis, I seek to overcome these limitations by engaging with the critical insights of another early twentieth century thinker, Antonio Gramsci. Drawing on the work of Gramsci (1992), several studies have considered how neoliberal hegemony is extended (and contested) in the arena of international law (Cutler 1999a, 1999b, 2010; Mieville 2004, 2005; Gill 2008). Gramsci understands hegemony as reliant upon both coercion and consent. His theory thus demonstrates how the neoliberal historical bloc is constituted through both a pervasive (though not wholly coherent) ideology rooted in individual responsibility, free markets and the rule of law to which most of us consent and a coercive set of institutions, from international legal institutions like the WTO agreements down to micro-level biopolitical projects such as workfare that discipline subjects to comply with neoliberal hegemony. While Gramsci's concept of hegemony is useful to our understanding of the neoliberal juridico-political order and how it is maintained and extended through both coercive and consensual measures, another Gramscian concept, the relations of force, can help us overcome the limitations in Polanyi's analysis and aid in our understanding of the juridico-politics of GMO agriculture.

Gramsci's conception of the relations of force refers to the convergence of material, institutional and discursive power actors hold in relation to each other (Andree 2007). It allows us to see how hegemony is resisted and reasserted in accordance with shifting power dynamics within civil society. It also shows how Polanyi's claim that self-protective measures benefit

society as a whole fails to take into account how self-protective measures are necessarily enabled and constrained by particular configurations of material, discursive and institutional power that condition what sort of regulatory context emerges, and who benefits from it. Moreover, the relations of force direct us to another shortcoming in Polanyi's thinking. Polanyi argues that self-protective measures are often spontaneous reactions to the problems of a self-regulating market and that they reflect the interests of "society." Gramsci shows us that "society" is an inherently contradictory assemblage of class interests, and the interests of "society" really amount to the interests of the group of actors whose relations of force enable them to be hegemonic. This means that the specific form that self-protective measures take are more likely to secure the power of the ruling class than fundamentally undermine it.

However, while the relations of force is useful for explaining the power dynamics that are central to processes of political and social change, there are limits to an approach that relies solely on Gramsci. While Gramsci can help us understand the content of what transpired at Cartagena and in Australia, he is less useful in helping us understand the context behind what occurred. Gramsci's theory emphasizes gradual change through processes of intellectual and moral reform, but it is less able to account for the spontaneity and contingency of political transformation. Polanyi's notion of the double movement can locate the turn-of-the-century regulatory backlash against GMOs within the context of a more enduring dynamic of spontaneous, self-protective countermeasures to the unintended and unsustainable effects of treating nature like a commodity in an unregulated market economy. A Polanyian perspective can therefore provide critical insights into the circumstances under which capitalism's contradictions may inspire spontaneous resistance and the ushering in of a new normative framing, a moment that can – though by no means inevitably will – inspire systemic transformation. Taking the step

from spontaneous self-protective measures that 'save capitalism from itself' to a deeper subversion of capitalist hegemony is the critical, though as this thesis shows, yet elusive next step for those concerned with the creation of a socially just future. The rest of this chapter explores how these key dynamics – the double movement and the relations of force – have characterized the juridico-politics of GMO agriculture over the past thirty-five years, first exploring the global picture before turning to Australia.

Global juridico-politics of GMOs

In general, two sorts of legal mechanisms have either enabled or hindered the development of the GMO economy globally. On one hand, there are laws that have facilitated the commercialization of GMOs through the protection of intellectual property regimes, beginning in 1980 in the US and expanding globally in the 1990s. On the other hand, there have been a number of legal regimes instituted to restrict the commercialization and trade of GMO crops and foods, at regional, national and international levels. These laws are diverse, and range from outright bans on GMO products to requirements for "farm-to-fork" GMO labeling (Schurman and Munro 2009). At the global level, the most important example of this is the 2000 Cartagena Protocol on Biosafety.

GMO patent laws

The first law allowing ownership of new plant varieties was the 1961 Plant Breeders' Rights, created at the International Convention for the Protection of New Varieties of Plants in Geneva. According to Halford (2012), "Plant Breeders' Rights enable the holder of the rights to prevent anyone from producing, reproducing, offering for sale or otherwise marketing, exporting,

importing, conditioning for propagation or stocking a new variety without a license from the holder" (152). However, Plant Breeders' Rights were limited because although they gave breeders exclusive ownership and market rights to their line of seeds, they did not prevent other farmers from harvesting the next generation of seeds nor from breeding their own variety of those seeds for sale (Andree 2007). Consequently, there was little commercial incentive for the producers of GM seeds, who would only profit from the first generation of their seeds. This changed with the *Diamond vs. Chakrabarty* case of 1980, where the US Supreme Court ruled that GMOs could be patented because they were novel life forms that did not exist in nature (Andree 2007). *Chakrabarty* granted proprietary ownership not only to the physical seeds of a GM breed, but to the idea of the genetic basis for those seeds, and all others that shared their transgenes. Such an intellectual property rights (IPR) regime prevents farmers from saving seeds and therefore ensures that GM seed breeders can profit from the royalties earned off of each seed. From a Polanyian perspective, *Chakrabarty* represents a landmark step in the expansion of markets, as human-engineered genetic materials come to be seen as patentable, ownable, and sellable commodities. Through constitutionalizing the commodification of novel life forms, it sets into motion the field of biotechnology as an industry of great potential profit.

Patent laws were further extended to the international arena with the TRIPS Agreement of the Uruguay Round of WTO negotiations that concluded in 1994. According to Strauss (2009), ensuring the creation of a global IPR regime governing GMOs was a major goal for the US government in the early 1990s. The relations of force that enabled the global constitutionalization of TRIPS were centered on the growing economic and institutional power of a group of industries, among them biotechnology, pharmaceuticals and information technology. These groups lobbied behind the notion that TRIPS was the vehicle through which

the United States' neoliberalizing economy could secure unencumbered access to world markets, reasserting American hegemony against the threats posed by East Asian post-Fordist economies (Cooper 2008).[9] Prior to TRIPS, the 1883 Paris Convention had mandated that states give national treatment to the patents of other states, but left each state to decide for itself what "national treatment" would entail. Under TRIPS, all WTO members are legally mandated to accept a uniform regime of IPR that enables the patenting of "any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an innovative step and are capable of industrial production" (Strauss 2009: 306). Two restrictions to this overarching law grant states the ability to impose exceptions in the case of patents that would have serious negative impacts on health or the environment and in the patenting of animals, plants, and microorganisms. While these restrictions are permitted for non-modified organisms, they may not be extended to the actual transgenic "parts" of GMOs. In practice, then, it has been difficult to use TRIPS's allowable restrictions on plant and microorganism patents to restrict GMO patents (Strauss 2009).

The TRIPS Agreement further entrenches the commodification of altered genetic material at the global level, locking states into a strictly codified regime of IPR. In this way, it represents the coercive arm of neoliberal hegemony. Moreover, the WTO agreement holds further provisions that restrict states' capacities to set up protective barriers against trade in GMO foods. In both senses, the Uruguay Round agreements represent significant legal steps in the expansion of markets. State sovereignty itself is compromised to the laws of free trade and market

[9] While the need for a global IPR regime had previously been absent from international discussions, through the work of a small number of dedicated lobbyists in the US, it came to be seen as integral to the reassertion of American geopolitical hegemony. At Uruguay Round negotiations the US fought hard, often resorting to coercive measures, to ensure that the TRIPS Agreement would come to fruition. In Gramscian terms, TRIPS thus represents a more coercive measure in the entrenchment of both American and neoliberal hegemony.

autonomy. It is here that we see what neo-Gramscian political economist Stephen Gill (2008) has termed "new constitutionalism" thoroughly at play, as law operates as a coercive tool of hegemony, becoming a mechanism to both restrict the state's ability to protect itself and to lock in market freedoms, ensuring all firms have equal, unencumbered access to markets. With regard to GMOs, this trend is no better evinced than with the WTO's 2008 decision on the EU's *de facto* moratorium, where it ruled that the EU's practice of never approving GMO crops for commercial release was unjustified and illegal (WTO 2014). However, as we shall see, this expansion of markets into uncharted waters of free trade, intellectual property rights, and the commodification of modified life has not gained universal acceptance. The hegemony of market ideology has been contested, with some success, through biosafety laws. In Polanyian terms, these constitute the self-protection of society.

GMO biosafety laws

If IPR has enabled the development of a commercial GMO industry, international biosafety legislation has played a role in constraining it. While biosafety emerged as a discourse at the Rio Summit of 1992 (Andree 2007), the first global biosafety framework that dealt with GMOs emerged as part of the 1994 Uruguay Round of WTO negotiations in the Sanitary and Phytosanitary Agreement (SPS). The SPS is based on the doctrine of "substantial equivalence," implying that GMOs are categorically indistinct from other organisms, and allows restrictions to GMO imports only if the importing country can provide scientific evidence for their restrictions, thus disallowing precautionary restrictions. The SPS was designed to be as unobtrusive as possible to the smooth functioning of markets. However, many states perceived the SPS Agreement to be weak and ultimately toothless. Consequently, in the mid-1990s, parties to the

Convention on Biodiversity (CBD) met in Cartagena, Colombia to negotiate a new, more rigorous biosafety protocol.

The most robust and extensive international legal regime for regulating biotechnology, the Cartagena Protocol "seeks to regulate the safe transfer, handling, and use of 'living modified organisms' [GMOs] in order to limit any negative impact on biodiversity" (Strauss 2009: 310). Under the Protocol countries may demand information regarding whether their food imports contain GMOs and may restrict imports of GMO foods insofar as they deem them to be unmanageable or severe risks, or if they perceive existing scientific knowledge to be insufficient to make a satisfactory risk assessment (Andree 2007). Unlike earlier health and safety regulations, such as the SPS, Cartagena does not mandate countries to show scientific evidence for the risks that they fear; nor must they limit their restrictions on GMOs to a certain time period (Oberthur and Gehring 2006). In these ways, it provides countries with a wide degree of agency in limiting the proliferation of GMOs within their food systems. The Cartagena Protocol came into effect in 2003 and has been ratified by 166 countries (CBD 2013).

During the negotiation process, leading countries like the US, Canada and Australia resisted inclusion of special biotechnology provisions in the Cartagena Protocol. They wanted the industry to be commercially successful, and hence eschewed special restrictions on biotechnology that would hinder its development. In contrast, seeking to protect small-scale farming and biodiversity, Asian and African developing nations argued for a rigorous protocol, with European countries staking out a position in the middle. That it was partly the position of Southern countries that ultimately took the force of binding international law is significant, and not incidental to the work done by anti-GMO activist groups. Over the course of the late 1990s, and through the commercial struggles of GMO foods and the work of activists and Southern

governments, the notion that GMOs were distinct from other organisms came to be seen as cause for a special, precautionary approach to their regulation (Andree 2007).

Thus, what is unique about Cartagena is its use of the precautionary principle. While other legal regimes seek to regulate problems after they appear, Cartagena enables countries to protect themselves from unknown or potential risks. It is through Cartagena's use of the precautionary principle – as borrowed from the Rio Declaration – that "where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (Strauss 2009: 311), that European and other states have been able to set restrictions on GMO imports despite the rules of the WTO. This discourse of biosafety precaution has thus been a serious roadblock to the expansion of the neoliberal GM food economy: as Andree (2007) shows, the uptake of GMOs slowed markedly in the wake of Cartagena, and has never subsequently returned to its previously high rate of growth.

How can we account for the successful creation of a biosafety protocol rooted in a discourse of precaution that is somewhat at odds with neoliberal orthodoxy? As Andree argues, Cartagena's commitment to the precautionary principle emerged gradually over the course of the 1990s. A small number of Southern countries, including Ethiopia and Malaysia, touted the idea of a comprehensive protocol: one that was binding, precautionary, and allowed restrictions based on socioeconomic as well as environmental and health grounds (Andree 2007; CBD 1997).[10]

[10] For example, the African position at the 1997 Biosafety Working Group expressed concern for the "anticipated social and economic costs due to loss of genetic diversity, employment, market opportunities and, in general, means of livelihood of the communities likely to be affected by the introduction of the living modified organisms or products thereof" as well as "possible effects which are contrary to the social, cultural, ethical and religious values of communities arising from the use or release of the living modified organism or the product thereof" (CBD 1997: 84-85). Moreover, they emphasized that the Protocol "[take] into account the limited capabilities of many countries, particularly developing countries, to cope with the nature and scale of known and potential risks associated with

Gradually, their position – that countries in the South would face an undue burden of risk in an under-regulated GMO food economy – was accepted by other Southern countries. Through their relative unity, the Southern countries – named the "Like-minded Group" at negotiations – were able to strengthen their position by convincing Northern governments that GMOs were distinct from traditional biotechnologies such as beer, wine and cheese; that they were categorically distinct from other organisms; that a protocol ought to be binding; and finally that it ought to be precautionary. With each step, the Miami Group, which included the pro-GMO economies of Canada, the US, Australia, Argentina, Uruguay and Chile found their position of substantial equivalence more and more indefensible and was forced to make concessions in hopes of preserving some of its power to bargain for a limited protocol. However, a moment of transformation came 1996, as news of the BSE scandal shook Europe just as Roundup Ready soy was approved for commercial release (Andree 2007). As public concern mounted over the safety of GMO foods and the ability of state regulators to assess that safety accurately, anti-GMO opposition spiked, particularly in Europe (Andree 2007). By 1997, the EU had a mandatory labelling policy, and by 1999 a *de facto* moratorium on all GMOs. It was at this point that the EU's position at Cartagena became almost identical to the Like-minded Group: almost, because the EU resisted Like-minded efforts to include socio-economic considerations in the Protocol. Nonetheless, even without those considerations, achievement of this agreement was a major coup for the Like-minded Group.

Gramsci's analysis of the relations of force that undergird any successful historical bloc is integral to our understanding of what went on with Cartagena. The institutional power of a *united* Global South ensured that its concerns could remain on the agenda. Discursively, the

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living modified organisms resulting from biotechnology" (3), thus expressing concern over how the expansion of GMO agriculture might interface with existing unequal global power dynamics between the North and South.

work of a number of key organic intellectuals,[11] among them Ethiopian scientist Tewolde Egziabher, was integral to persuading European and even North American scientists of the validity of the Like-minded Group's precautionary position (Andree 2007). However, it was events in Europe that enabled a precautionary protocol to be realized. Internationally, the EU's unity over foreign policy matters has enabled it to become a second global force: a check on American hegemony. In this case, a culmination of events and conditions in Europe – the BSE scare, the introduction of GM soy, Europe's food culture, Europe's identity as a GMO-importer, and the successful and visible tactics of anti-GMO activists – produced a position that was different from that of the US. Moreover, the EU's material and institutional power in international fora enabled it to ensure that the final text of the Protocol was largely its own position: a mandatory, precautionary protocol that otherwise respected international trade law, rejected socio-economic considerations and generally did little to challenge the overarching neoliberal ideology of the WTO.[12] [13] The fact that Cartagena came to reflect the bioskeptical views of European consumers and farmers and not the socio-economic concerns of activists and Southern governments complicates Polanyi's notion that self-protective measures benefit society as a whole. It shows that it is not the interests of society that are advanced, but those of the leading ensemble of power relations: in this case chiefly the EU governments. A different, more comprehensive and equity-oriented protocol might have emerged – one that might have benefited

[11] Gramsci (1992) contrasts organic intellectuals with traditional intellectuals. While traditional intellectuals represent the ruling class and seek to reproduce their interests (hegemony), organic intellectuals develop a critical understanding of the problems with an existing hegemonic order and thus seek to challenge its ideological basis.

[12] The Cartagena Protocol preserves the WTO's commitments to most-favored nation status and national treatment, and requires all restrictions to be science-based and as limited as possible. The overarching ideology is that GMOs ought to be part of a global free trade regime to the greatest extent that is safely possible (Andree 2007).

[13] Moreover, Cartagena explicitly excludes pharmaceuticals made from GMOs from its scope (Andree 2007). This omission further indicates the extent to which the Protocol reflects European economic interests: unlike agricultural biotechnology, the European pharmaceutical industry is enormous and extremely powerful.

Southern farmers while challenging the way power and the burden of risk are configured in global agriculture – but for the relations of force and the power held by the EU in negotiations.

A Polanyian analysis of what transpired at Cartagena, however, still remains fruitful. While a Gramscian perspective might emphasize the slow, careful construction of consent through a period of intellectual and moral reform that results in the replacement of "common sense" with "good sense" as central to the construction of a new historical bloc (Gramsci 1992), the story told here involves much more contingency and spontaneity. The EU's shift of position was not the result of a deep-seated commitment to a radical new world; it emerged as a relatively sudden reaction to a new, unforeseen set of dynamics. It occurred very much in the vein of Polanyian self-protection, as governments reacted to immediate public concerns over the environmental and public safety consequences of treating nature – in this case GMO crops – as a mere commodity without regulatory safeguards. Polanyi's analysis is thus helpful in demonstrating how effective resistance measures need not be rooted in an ideological opposition to capitalism; they can more easily be inspired by immediate problems resulting from capitalism's contradictions, without a deeper analysis of those contradictions. It was not the successful construction of a counter-hegemonic historical bloc on the part of the Like-minded Group but rather the EU's self-protective efforts to contain an unfamiliar risk that tipped the balance. Public concerns over the proliferation of transgenic commodities culminated in a backlash against the expansion of markets, as European publics sought to restrict the proliferation of GMOs through self-protective barriers, whether labelling laws, moratoria, or the precautionary Protocol. However, equally important here is the fact that these self-protective measures were not really spontaneous, as the Polanyian framework would suggest: they only emerged because of the dedicated work of activists – North and South – who challenged the

discourse of GMOs as substantially equivalent and made an alternative narrative intelligible to publics and governments alike.

Overall, as a rigorous, mandatory and precaution-oriented legal regime, Cartagena sits uncomfortably with neoliberal orthodoxy of free markets and free trade. And yet, it fails to challenge neoliberal ideology in any fundamental sense, eschewing Southern requests for a comprehensive protocol that would have given legal grounding and normative legitimacy to the idea that societies have a right to protect themselves from the potentially harmful socio-economic impacts of free trade. Nonetheless, it gives global legitimacy to the discourse of precaution, an international legal moment that could have major implications in the global struggle to curtail the effects of climate change, though as of yet this impact has not been realized. With specific regards to GMOs, it has had a pronounced material impact: global adoption of GMOs nearly halted completely in the aftermath of Cartagena, and has been modest ever since, particularly in contrast to GMOs' rapid rise in production in the late 1990s. Moreover, the precautionary parameters of Cartagena were readily adopted into national and regional regulatory policies: The 2001 EU Directive 2001/18/EC is explicit in its use of the precautionary principle as a basis for more stringent regulations (Myhr 2010). Similarly, in the wake of Cartagena, a number of African countries such as Zambia and Ethiopia promulgated strict regulations, restricting or outright banning GMOs (Morris 2008). While I do not want to make the argument that Cartagena itself specifically caused this halting, the overarching context within which Cartagena emerged – the new discursive framing of GMOs that its negotiation engendered and the legal anchor it provides bioskeptic governments – have altered the developmental trajectory of GMO agriculture globally (Andree 2007).

The juridico-politics of GMO in Australia

The global picture of GMO regulation is thus uneven: on one hand, efforts to constitutionalize an IPR regime around GMOs at the global level through the TRIPS Agreement have been successful. At the same time, the Cartagena Protocol has had some success as a regulatory institution that allows restrictions to trade based on the precautionary principle. Contrary to expectations, it has not simply buckled under the weight of the WTO, though its regulatory teeth have proven to be less than razor-sharp, and blanket bans have generally not been upheld.[14] This global picture is also geographically differentiated. European governments have used the Protocol as the basis for a stringent set of restrictions to imports of GMO foods, protecting European consumers and farmers alike. African and other developing nations, concerned with both the potential health risks to their own populations and the risks of losing access to valuable European markets, have similarly sought to restrict GMOs, with Zambia going so far as to categorically reject GMO food aid (BBC News 2002). In stark contrast, a small number of countries – Canada, USA and Argentina among the few – have readily adopted GMOs, though only for a circumscribed number of crops.[15] Here, publics have tended to be more – though by no means completely – favorable to GMOs (Newell 2009). While the global context has tended to bifurcate between these two divergent approaches, there are some cases that present a more nuanced approach to GMOs, between categorical rejection and enthusiastic adoption, including India, China and Brazil.[16] However, the rest of this chapter will focus on Australia because its regulatory context occupies a middle ground between the GMO proponents

[14] For example, the EU was forced to rescind its *de facto* blanket moratorium on GM imports by the WTO despite appealing to Cartagena in 2006.

[15] See Prudham and Morris (2006) and Eaton (2013) for analyses of Canadian farmers' refusal to adopt GM wheat.

[16] All of these countries supported Cartagena but are major producers of GM crops (see Table 2).

in countries in the Americas and the GMO skeptics in Asia and Europe, manifesting as a microcosm for the globally bifurcated context. Despite being among the few states who oppose a precautionary protocol, Australia has embraced a mandatory labelling regime for all GM foods, while most Australian states had moratoria on GM crops during the 2000s. Consequently, perhaps better than any other country, a case study of Australia encapsulates the global heterogeneity and geographical variegation in GMO regulation.

The history of GM crops in Australia goes back to the late 1990s.[17] GM cotton was first grown in Queensland and New South Wales in 2000, and GM canola was introduced to New South Wales and Victoria in 2003 (Dibden et al 2013). However, state-based moratoria interfered with the development of the industry until the late 2000s. Consequently, Australia is not among the world leaders in GM production, growing only 700,000 hectares in 2012 (James 2012). Nonetheless, it is one of only two dozen or so countries to have adopted GMO crops at all. At face value, Australia presents an interesting case in the juridico-politics of GMOs. On one hand, Australia was one of the six members of the Miami Group who opposed the adoption of the Cartagena Protocol, seeking an unregulated (or at least under-regulated) free trade regime for GMOs. At the same time, Australia has, unlike Canada, the United States and Argentina, adopted a mandatory labelling regime, partly due to the concerns of major export partners like Japan, and partly due to domestic consumer concerns (Chang 2005). Moreover, in the aftermath of Australia's rejection of Cartagena, every state except Queensland instituted a moratorium on GM crops. In this way, just as with the global picture, the juridico-politics of GMOs in Australia have

[17] The Australian federal Gene Technology Regulator (constituted through the 2000 Gene Technology Act), which is in charge of approving biotechnologies for commercial use (Dibden et al 2011), approved of licenses to Monsanto Australia for GM cotton (insect resistance and herbicide tolerance) as of September 2002 and to Bayer CropScience for canola (herbicide resistance) as of July 2003 (Hindmarsh and Parkinson 2013). Florigene, an Australian-based company that is owned by Suntory was granted license for color-enhanced GM roses in 2009, but the license was surrendered as of 2012 (OTGR 2013).

been captured by a double movement dynamic, as the state has instituted these regulatory measures to ensure that the rate of GMOs' development does not outpace the rate of social adaptation. However, as with Cartagena, the relations of force are necessary to understanding why these countermeasures have ultimately served to strengthen the hegemony of neoliberalism in Australia, as state governments have sought to legitimize the moratoria through discourses of economic rationality rather than environmental justice or democratic engagement.

Biohegemony Down Under

Australia has firmly embraced a neoliberal agricultural policy since the 1980s. It has long been an advocate of free trade in agriculture and has consistently sought to build a global trading regime in agriculture according to the neoliberal principles of the WTO (Capling 2001). As the leading member of the Cairns Group, Australia played a key role in advancing the liberalization of agriculture both at the 1982 GATT meeting and at the Uruguay Round of WTO negotiations against European and Japanese opposition, even if the effect was only partial (Capling 2001). Australia has also long been a proponent of biotechnology (Cocklin et al 2008). As a firm supporter of the TRIPS agreement of the Uruguay Round of WTO negotiations, protection of intellectual property rights has been central to the development of transnationally minded agribusiness in Australia as well as the country's nascent biotech industry, which employed nearly 17,000 people in 2013, up from 6100 people in 2005 (IBISWorld 2013; Cocklin et al 2008). Australia's positive attitude toward biotechnology and agricultural trade liberalization thus run counter to the restrictive and precautionary aims of the Cartagena Protocol. Therefore, it is not surprising that Australia was one of the few countries that opposed a comprehensive, precaution-oriented biosafety protocol at the negotiations over the Cartagena

Protocol from 1996 to 2000 (Andree 2007). By exploring the position Australia took at the Cartagena negotiations along with other members of the Miami Group who opposed a precautionary protocol we can see how its approach to GMOs internationally in the 1990s reflected the neoliberal interests of the corporate biotechnology and agribusiness sectors.

From the start of negotiations, the Miami Group's goal was to keep the Protocol as limited and toothless as possible. It argued that the Protocol should not allow members to make decisions based on the precautionary principle and that the Protocol should not override existing WTO legislation when the two conflict (CBD 2003, Panetta 2000). From the outset, it sought to construct GMOs as indistinct from other organisms, and thus requiring no special regulatory parameters. However, this discourse of "substantial equivalence" failed to resonate with other states as the negotiations went on, leading to the primacy of a precautionary discourse. While the Miami Group sought an agreement that would subordinate Cartagena to the WTO agreements and that held sound science rather than precautionary concerns as the basis for restrictions, neither of these two demands were ultimately heeded: the final wording of the Protocol allows precautionary restrictions and legally trumps other agreements, crucially including the SPS Agreement (CBD 2003).[18] Unlike with the Uruguay Round, where Australia's liberalizing efforts were largely rewarded, the ultimate ruling of Cartagena was the opposite of what Australia had hoped for. Still, an agreement was reached, which meant that members of the CBD (which does not include the United States) accepted the terms of it. Australia was actually positioned to sign the agreement after its initial resolution, but changed its mind in May 2000.

[18]The Miami Group also had a third demand: that LMO-FFPs be exempt from the Advanced Informed Agreement (AIA), an instrument of the CBD which mandates advanced informed consent from the recipient state of potentially hazardous materials. Unlike their other two demands, this demand was accepted by other Parties as a compromise, with LMO-FFPs being regulated through a web-based clearing house mechanism instead of the AIA. However, in the overarching precautionary context, this minor concession to the Miami Group ultimately meant little.

In mid-2000, just a few months after the Cartagena Protocol had finally been agreed upon, the Australian government decided to refer its decision on signing the Protocol to the party room (caucus), where it subsequently decided against signing the Protocol (AAP 2000; Hobart Mercury 2000; Tasmanian Country 2000). After initial pressure from the National Farmers' Federation and later from the Australian Chamber of Commerce and Industry, the Australian government decided that it was not in Australia's interests to sign the treaty right away.

By the end of 2000, the Australian government left little ambiguity as to what it thought of the Protocol in a report by the Productivity Commission, the Australian government's arms-length research and advisory body. The Commission's November 2000 report began by arguing that "it is not clear that trade in living modified organisms presents a significant threat to biodiversity. Nor is it clear why a distinction should be made between the threat presented by importing living modified organisms and that by domestically developed (and released) living modified organisms" (PC 2000: 3). The report continued to say that "a particular concern about this provision is the breadth of discretion it gives to importing parties in making decisions about the grounds for restricting trade" (6). It concluded by stating that "good public policy making requires that regulation be clearly targeted to address a clearly identified problem and should be the most cost-effective means of resolving that problem …the Protocol seems to have much more to do with restricting and hampering trade in genetically modified products, for other reasons, than with protecting biodiversity" (9). This striking rejection of the rationale, content and scope of the Protocol secured Australia's position in opposition to the Protocol.

Clean, green and unmodified

While the picture of Australia's opposition to Cartagena may suggest a uniformly pro-

GMO and pro-market approach, this is not the case. Unlike in North America, where labeling policies have long been eschewed by neoliberal governments, Australia's food safety regulator, Food Standards Australia New Zealand (FSANZ) drafted mandatory labelling legislation for all GM foods in Australia, which became law in 2001 (Chang 2005; FSANZ 2013). Moreover, while Australia's approach to GMO food at the national level has generally been market friendly, things have been different at the state level. According to Cocklin *et al* (2008), Australia's division of powers between the federal government and the states has given states significant capacities to resist national regulatory policies over the environment and natural resources. Within this context, state governments have been wont to resist the pro-GMO pronouncements of Canberra, preferring a more cautious approach to GMOs, or in some cases rejecting them entirely in hopes of cultivating a "clean and green" image for export markets. In every state except Queensland, there has been at least a partial moratorium on GM crops. Furthermore, all of these moratoria emerged within three years of Australia's rejection of the Cartagena Protocol, and in the immediate aftermath of the Gene Regulator approving GM canola and cotton varieties for commercial use. Just as with the European backlash that inspired Cartagena, these policies appear as a spontaneous regulatory backlash to the potentially negative consequences of an unregulated GMO food economy, further evincing Polanyi's theory at the domestic level.

However, while these moratoria have been important checks on the expansion of GMO agriculture, the relations of force can show us why they have not been driven by an environmental activist framing of risk and precaution but by a neoliberal framing of economic rationality. While it was pressure from concerned farmers and consumers that underlay the initial drive for moratoria in New South Wales (NSW) and Victoria in 2003, Hindmarsh and Parkinson (2013) have pointed out that in both states, review panels were conducted on the basis of

economic rationality, with little concern for health and environmental implications. Rather than protecting Victoria and NSW from the long-term effects of GMOs, the moratoria bought state governments time to calculate the rationality of GM agriculture and win over skeptical farmers and publics. Consequently, the moratoria were lifted in 2008 when governments concluded that it was in their state's economic interests to do so, having delayed the introduction of GMO food crops into the three states for at least five years but done little to challenge the neoliberal basis of commercial biotechnology.

However, even within Australia, there is variegation in approaches taken at the state level. Unlike these more populous states, Tasmania has kept its moratoria, renewing it indefinitely in 2014 (Guardian 2014). Tasmania was the first state to institute a moratorium on all GM crops, doing so in 2001 after GM canola field trials were seen to have continually breeched regulations (Hindmarsh and Parkinson 2013; Cocklin et al 2008). However, although biosafety concerns may have been on the minds of many stakeholders, the government's own reasoning behind the moratorium echoed the strategic market calculations of other states, seeking to protect Tasmania's "international market reputation as a producer of pure, quality clean and green food products" (Cocklin et al 2008: 165). Government sources reiterate this economic pragmatism: the Tasmanian Department of Primary Industries, Parks, Water and Environment states that "the Government's current policy is to position Tasmania in the global market place as a producer of food that is genuinely GMO free" (DPIW): in other words, to stake out a place for Tasmania in the niche market of GMO free, or "clean and green" foods.

Drawing on Gramsci, we can see how the relations of force underlying the moratorium are integral to its success. Discursively, a widely entrenched narrative of 'clean and green' stresses Tasmania's role as a niche producer of high-value products. Materially, the absence of

existing modifiable crops from among Tasmania's exports place little pressure on it to lift the moratorium. Moreover, the visibility and success of small-scale farmers (in relation to other states) who are less likely to benefit from monocrop-oriented GMO agriculture further give force to the "clean and green" movement. Just as the relations of force ultimately led other states to abandon their moratoria, they have enabled Tasmanian governments – aided by support in civil society – to generate continued normative political legitimacy for their own. However, we must not forget that it is precisely because of these relations of force that GMO opposition in Tasmania has been framed around strategic economic interests, and not within a wider critique of neoliberal property relations. In other words, the precise outcome of GMO opposition in Tasmania ultimately worked in the interests of those farmers who held enough power to sway the direction of opposition. Their interests, though at odds with biotechnology firms, are in no way at odds with capitalism or even neoliberalism; hence, it was the superficial opposition to GMOs, and not a deeper socioeconomic critique of IPR or agribusiness that drove the moratorium.

Overall, however much Australia's state-by-state moratoria might have hindered the development of the country's GMO crop economy, they have not been carried out according to a logic that subverts or challenges prevailing neoliberal ideology. By using economic justifications such as the desire to wait until market conditions are right, or to pursue a "clean and green" competitive advantage, states have been able to keep their moratoria coherent with the overarching neoliberal, free-market, productivist ideological parameters of Australian economic orthodoxy. In this way, although their instantiation reflects concerns for the potentially adverse effects of treating nature like a commodity, the moratoria show that self-protective measures can be transmogrified to cohere with the hegemonizing project of neoliberalism, what Gramsci called *trasformismo* (Gramsci 1992). In this sense, movements that may initially destabilize or

challenge hegemony are reframed in a way that ignores the underlying basis for the opposition, detaching concern for a particular issue from wider opposition to the existing hegemonic configuration. Instead, the narrower issue is solved through a perspective that reifies or even celebrates the hegemonic discourse. Nonetheless, justifications and rationales are only part of the juridico-political picture. Effects matter. And in effect, the state-based moratoria have either slowed or resisted completely the proliferation of GMO agriculture in Australia. As Polanyi argued, self-protective countermeasures are often more successful at slowing the rate of change than in altering the direction of change. The Australian moratoria – with the exception of Tasmania – appear to have done that, pre-empting an escalation of public backlash and allowing public attitudes to adapt to the emergence of GMO agriculture, possibly facilitating greater social acceptance of GMO agriculture into the future.

The new agrarian double movement

Several critical accounts of GMO agriculture have emphasized the role of law in advancing GMO agriculture as a capital accumulation project, granting rights to corporations and GMO-producing states at the expense of farmers and importing states (Cooper 2008; Pechlaner 2012, 2010; Prudham 2007). In contrast, this chapter has emphasized that law has actually played a more bivalent role in relation to the commercial expansion of GMO agriculture, in a process akin to Polanyi's double movement. Globally, early efforts to ensure conditions of profitability through IPR and free trade have fit with the market expansionist side of the Polanyian framework. Conversely, a number of more recent efforts to restrict GMOs' proliferation, especially with the Cartagena Protocol, have been successful, indicating that the trend is not wholly unidirectional. Moreover, in keeping with Polanyi's theory, the relatively

spontaneous culmination of political dynamics in Europe that gave Cartagena the final thrust it needed to be successful reminds us that self-protection does not need to be part of a deeply held commitment to radical transformation. It can just as easily come as a reaction to the potentially adverse environmental and safety consequences of treating nature like a commodity, unprotected from the expansive forces of the market.

However, the Polanyian dialectic was manifest differently at the national (and sub-national) level. In Australia, the self-protection of society took hold not through a commitment to the Cartagena Protocol, which the Australian government contested and resisted, but through mandatory labelling legislation and state-based moratoria linked to widespread consumer campaigns. While Australia may have bucked the global precautionary trend in its resistance to Cartagena, the actions of various states ultimately adhered to the global pattern of reactive resistance, preventing the unbridled adoption of GMO crops and slowing the rate of change. As with Cartagena, these countermeasures were not the outcome of any deep-seated critique of neoliberalism, productivist agriculture, or even biotechnology. Rather, they were spontaneous responses to the potentially adverse consequences – and public criticism that could possibly follow – of the uncontrolled expansion of GMO agriculture. However, unlike with the Like-minded Group's position at Cartagena, Australia's moratoria were never driven by a deeper, more radical critique of neoliberal hegemony, and with the exception of Tasmania, the moratoria were short-lived, only lasting as long as they were deemed to be economically rational, as public and activist concerns over the potentially adverse effects of GMOs were coopted into calculated "clean and green" business strategies.

While Polanyi is useful for understanding the context of these transformations, his analysis is insufficiently critical of the way power relations inspire the direction of self-

protection. For that reason, this chapter has drawn on Gramsci's concept of the relations of force to explain how self-protective measures come to reflect the interests of some actors and not others. With Cartagena, despite steadfast efforts of Southern governments and activists, the final Protocol was not comprehensive and eschewed socio-economic considerations, advancing the interests of European consumers and businesses more than Southern farmers. In Australia, the moratoria that emerged were framed within discourses of economic rationality rather than social or ecological justice, advancing the interests of conventional farmers and business groups rather than environmentalists, organic farmers and consumer groups. In both cases, it is important to consider that these were not the only options for framing resistance efforts. A Cartagena Protocol that explicitly challenged the way GMO patent laws enclose the genetic commons, or granted normative legitimacy and legal grounding to the idea that countries are allowed to protect themselves from the potentially adverse socio-economic consequences of free trade – one rooted in biojustice rather than biosafety – would have had vastly different implications for world politics. Moratoria that critically targeted the socioeconomic impacts of gene patents and technology use agreements rather than buffeting the strategic economic advantages of "clean and green" would have likewise had a more transformative political impact domestically in Australia. However, their emergence would have required a different set of relations of force than actually existed. Through Gramsci, we can see the importance of asking *what kind* of self-protection we are getting, and what relations of force enable its emergence.

Ultimately, when considering the juridico-politics of GMOs, what stands out most is how limited the GMO food economy is. Today, two decades after these crops were first grown commercially, there are only four or five crops widely grown in two dozen or so countries, with many countries having rigid restrictions on their import. All expectations – of both proponents

and critics – about their global proliferation have thus far fallen short. In an era of neoliberal hegemony globally, it is no small feat for the anti-GMO movement to have restricted the development of the GMO food economy through popular political struggles and legal measures. Despite its limitations, the biosafety discourse, coupled with other increasingly common-sense discourses of sustainable development have begun to challenge the preponderance of neoliberal ideology. Whether they can continue to hold the door ever so slightly ajar to the possibility of a transformative global movement rooted in eco-social justice remains to be seen.

Appendix 1: GMO production tables

Table 1: Top ten GMO crop-producing countries, 2012

Country	Percentage of global GMO production	Total GM production (ha.)	Main GMO varieties grown
US	40.8	69,500,000	Soybean, maize, cotton, canola
Brazil	21.5	36,600,000	Soybean, maize, cotton
Argentina	14.0	23,900,000	Soybean, maize, cotton
Canada	6.8	11,600,000	Canola, maize, soybean, sugar beet
India	6.3	10,800,000	Cotton
China	2.3	4,000,000	Cotton, papaya, poplar, tomato
Paraguay	2.0	3,400,000	Soybean, maize, cotton
South Africa	1.7	2,900,000	Maize, soybean, cotton
Pakistan	1.6	2,800,000	Cotton
Uruguay	0.8	1,400,000	Soybean, maize
World		**170,300,000**	

Adapted from James (2012).

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Chapter 2: The sticky materiality of neoliberal neonatures

The late-twentieth century rise of biotechnology – and genetically modified organisms (GMOs) in particular – garnered tremendous popular, activist, scholarly and corporate attention. Evaluations of GMO technologies ranged from apocalyptic to utopian but few doubted that GMOs would significantly transform our food system. Some thought they would yield a cornucopia of hardier, tastier and more nutritious crops, while others prophesized an invasion of chimeric Frankenfoods. However, two decades since the commercial release of the first GMO food, FlavrSavr tomatoes, GMOs have been neither a global panacea nor a pandemic. Their modest, if not underwhelming performance may be what needs accounting.

This is not to say there have not been successes, particularly early on in the late 1990s. Two transgenic events – tolerance to herbicides and resistance to pests – have been remarkably implemented, capturing substantial control over some of the world's most significant crops, including corn (32 percent), soybeans (75 percent), cotton (82 percent) and canola (26 percent) (James 2011). From the perspective of Monsanto and a few other corporations, such as Syngenta and Bayer Life Sciences, these innovations have been cash cows, enabling near-monopoly control over not only transgenic seed sales but often other agricultural inputs, such as herbicides as well. But these innovations – among them Roundup Ready soybeans and canola and Bt corn and cotton – are virtually the only commercially successful GMOs. Moreover, all of these innovations were already commercially available in the late 1990s. In the meantime, no further innovations of significance have emerged, while many have faltered, such as Bt potatoes, Roundup Ready wheat, and perhaps most notably, beta-keratin enhanced "Golden Rice." Not unrelated to their economic and technical failures, GMOs have met staunch resistance both from well-organized activists and national, regional and local governments around the world, leading

to moratoria, mandatory labelling, rigorous safety assessments and a legally binding precautionary accord on trade in GMOs in the Cartagena Protocol of 2000. Only two dozen or so countries grow GMO crops as more than a tiny fraction of total agricultural acreage, while Europe, Asia and Africa have almost completely resisted GMO food crops, with only a few exceptions.

No single factor accounts for either the early success or subsequent setbacks of the GMO food economy. To understand the contemporary context, we must consider a multitude of juridico-political, economic, biophysical and cultural factors. This chapter focuses on the material, in particular the economic, considering from a Marxist perspective how the logic of capital has both enabled and constrained the development of the GMO food economy, and how the biophysicality of GMO crops has been manifest as both an opportunity and a challenge to capital.[19] It locates GMOs within the historical context of agrarian capitalism, linking with earlier debates over the problems that agriculture poses to capital as a site of profitable accumulation, showing how both the successes and failures of GMO agriculture can be understood in the wider context of agrarian capitalism, and the problems (and opportunities) that agriculture's unique spatial, temporal and biophysical demands pose to capital. I argue that technologies that can temporarily overcome or reduce these barriers to accumulation hold the potential to be highly profitable and thus successful, while those that do not directly alter the conditions of production will likely be ignored by industry. This dialectic can therefore help

[19] Following Marx (1976), I understand capital as an abstract social relation that takes on concrete forms through actors who possess capital and seek gain profit through the exploitation of human labour. For our purposes here, capital generally refers to biotech corporations and other upstream producers of appropriationist technologies (such as machinery), although it can also manifest itself in the form of farmers, who take on the role of capital to varying degrees when they operate as profit-seeking owners of the means of production in the cultivation process.

explain both the successes and failures of GMO agriculture to date, and demonstrate the extent to which corporate profitability rather than social utility has driven GMO innovation thus far.

The trajectory of GMO technological innovation has been heavily structured by the logic of capital, a condition that accounts for the lack of success in innovations not targeted at reducing the temporal, spatial and biophysical constraints to capital within the production process. For example, herbicide tolerance and pest resistance are both innovations that affect production by changing the ways farmers address the problems posed by weeds and pests. Innovations geared at consumers, which yield value-added end products, but make no difference in the actual production process (such as nutrient-enhancement or slower ripening), have largely failed. However, just as the biophysicality of agriculture poses constraints to the molecular logic of capital, the biophysicality of GMOs themselves pose barriers to innovation. As living organisms, GMOs possess both dynamism and complexity that pose challenges to reductionist science, and have thus posed further barriers to the rapid advancement of the technology.

The chapter begins with an historical overview of the agrarian question, discussing how Marxists have dealt with the problems agriculture poses to capital accumulation and how capital has sought to overcome these problems. Section II seeks to theorize the conditions under which GMO agriculture has been successful, considering how GMOs fit a wider tendency within agricultural capitalism to mitigate spatial, temporal and biophysical barriers to the reduction of labor and production time (and thus to added surplus value) through capital inputs, or what Goodman *et al* (1987) have termed "appropriationism" (1). However, at stake in GMO agriculture is not simply the way biophysical inputs are replaced with synthetic industrial inputs, but how property rights are managed throughout the commodity chain with patents and technology use agreements, ensuring the extraction of rents for patent holders, a logic of

accumulation that Pechlaner (2010) has termed "expropriationism" (245). Through both of these logics, capital is able to subsume elements of the production process, extracting greater surplus value than under an unsubsumed system of production.

However, while Goodman *et al* and Pechlaner respectively have emphasized the roles of appropriationism and expropriationism in underlying and explaining the successes of GMOs, little attention has been paid to how these same logics work to circumscribe the scope of GMO development. This thesis builds on these earlier accounts by arguing and demonstrating that the logic of capital works to both enable and constrain the trajectory of GMO development. Appropriationism and expropriationism are thus significant in understanding not only how and why certain innovations have met with success, but also why so many others have failed. This demonstrates that although capitalism's competitive logic may promote innovation, in biotechnology and elsewhere, it is only certain innovations – and by no means the most socially useful – that can ever be profitably pursued. Moreover, no existing accounts of GMO crops have sought to synthesize the theoretical insights of Goodman *et al* and Pechlaner to demonstrate how appropriationism and expropriationism work in tandem to make certain GMOs profitable for biotech firms and inescapable for farmers. Through a case study of Roundup Ready soybeans in the US, one of the most successful GMO crops to date, this chapter seeks to apply the insights of existing work in helpful ways, demonstrating exactly how and why these logics made Roundup Ready so successful, whilst simultaneously circumscribing the success of later innovations.

Section III turns to a theorization of the barriers to accumulation posed both by the logic of capital and the materiality of GMOs. It considers how consumption-oriented innovations have failed to provide an impetus for capital to invest and thus been ignored, despite great potential benefits to the public. Just as the logic of capital has enabled the development of certain

innovations, it has hindered the development of others. The section also considers a separate set of constrains: the ecological and biophysical barriers to accumulation that are in part a consequence of the inherent dynamism and complexity of the life sciences. Empirically, this section is animated by two case studies. The first considers the Flavr Savr tomato, a transgenic tomato designed to stay ripe longer without spoiling that met with commercial failure. The second examines Golden Rice, a beta-keratin enhanced transgenic rice variety which despite being successfully grown since 1999 has failed to gain approval for commercial release and attracted little interest from investors.

Ultimately, the argument being advanced is not meant to dismiss GMOs as a failed technology. Their failures are overdetermined by the structural contours of global capitalism, among other factors. The GMO food economy that we have today emerged in the context of the particular political economic configuration of neoliberal globalization, and its real-world manifestations cannot be detached from this context. However, a different political economic context, driven by motives other than profit and capital accumulation would enable a different, and perhaps more hopeful, GMO food economy. The story of GMO agriculture is today only a recent iteration of the story of capitalist agriculture. The future of GMO agriculture holds the potential for a wholly different narrative.

Lineages of the Agrarian Question

Since the nineteenth century, various Marxist theorizations of capitalism have sought to understand how and why capital's penetration of agriculture remained partial and contradictory, especially in contrast with industrial manufacturing (Kautsky 1899; Marx 1973, 1967). Marx argued that the substantial gap between labour time (where value is produced) and production

time (which included periods of natural growth that took place outside of human intervention) greatly reduced the potential profitability of agriculture in relation to industry, dissuading capitalists from investing there, since surplus value – and thus profits – can only be accrued while labour is engaged (Mann 1990).[20] For Kautsky (1899), the spatial nature of agricultural production precluded unrestrained expansion and thus accumulation as agricultural producers could only expand by buying other farmers' land, which needed to be situated adjacent to the buyer's existing productive property. Such spatio-temporal restraints, coupled with peasants' willingness to "overexploit" themselves meant that peasant modes of production were able to resist real subsumption by the capitalist system.[21] Kautsky further argued that petty commodity producers may even have a role to play in the maintenance of capitalist political economy by providing a cheap labour source for large farms that would otherwise have insufficient labour-power to be viable. Kautsky's position stood in contrast to that of Lenin (1900), who argued that it was inevitable that the competitive pressures of the market would turn all farmers into either capitalists or proletarians, leading to the erasure of the peasant classes of old. However, at the time, it was Lenin's *Development of Capitalism in Russia* that made the bigger impact, often being heralded as akin to the fourth volume of Capital while Kautsky's work was left relatively untouched (Kautsky 1899). Despite ample evidence to the contrary, agriculture was expected to conform to the inescapable prerogatives of the market; to become indistinct from industrial

[20] According to Mann (1990), Marx argued that competitive pressures will inevitably transform all small-scale farmers into either capitalists or proletarians, a notion which Lenin (1900) assumed and documented empirically in Russia.

[21] Marx (1976) differentiates between formal and real subsumption as stages in the historical development of capitalism characterized by changing relations between labour and capital. Under formal subsumption (the earlier stage), workers do not own the means of production but maintain control over the process of production, merely giving up control of the product of their labour at the final stage. Conversely, real subsumption involves a full-scale detachment of labour from the worker, as the worker loses control over the production process, and her labour becomes another cog in the wheel of production.

production. However, it was only in the late 1970s – partially in the context of a revived Marxist research program – that the agrarian question – and the missteps of past approaches – was returned to in the work of Susan Mann and James Dickenson (1978), with what became known as the "Mann-Dickenson thesis" (Mann 1990: 4).

Mann and Dickenson observed how American agriculture in the 1970s remained largely the domain of "family farms" employing only a couple of seasonal workers, and relying almost exclusively on family labour. That this remained (and remains) the dominant relation of production in agriculture seemed bizarre, given the centrality of agriculture and food to everyday life and the relative speed at which capital had been able to penetrate manufacturing, services and other natural resource industries. Reiterating Marx's earlier claims, they proposed that "capitalist development progresses most rapidly in those spheres where production time can be successfully reduced and where the gap between production time and labor time can be minimized" (Mann 1990: 34). Furthermore, because production time involves natural, biophysical processes, it has, traditionally, been a difficult barrier to overcome, stilting the development of capitalist agriculture. The persistence of the petit-bourgeois labor relation as dominant within agricultural production thus emanates from the barriers to subsumption (and thus accumulation) that the biophysicality of agriculture poses to capital. Importantly, Mann (1990) did not propose these barriers to be absolute, but rather, like all barriers to capital, relative to a particular historical moment.

However, following Henderson (1998), we must consider how although the materiality of agricultural production may pose barriers of temporal delay, spatial distance and biological contingency, the very existence of these barriers – if they can be overcome – pose new opportunities for capital accumulation that would not otherwise exist. In this vein, David

Goodman *et al* (1987) have developed a framework for understanding how capital might overcome the spatial, temporal, and biophysical barriers in agriculture. Focusing less on the problem of labour's subsumption within agriculture than on the challenges posed by agriculture's materiality, Goodman *et al* argued that it was agriculture's status as a "natural production process" that made it distinct from industrial production (1). They argued that because "there was no alternative to the biological transformation of solar energy into food," the industrialization of agriculture "was determined by the structural constraints of the agricultural production process, represented by nature as the biological conversion of energy, as biological time in plant growth and animal gestation, and as space in land-based rural activities" (1-2). These material barriers to accumulation could only be worked around – and not removed directly – through the industrialization of discrete elements of agricultural production. Thus rather than altering the fundamental biophysical processes inherent to agricultural production, they saw capital as pursuing two distinct accumulation strategies that allowed industrial inputs to replace natural ones: "appropriationism" and "substitutionism" (2). "Appropriationism" refers to the replacement of natural, biophysical elements of the agricultural production process with industrially manufactured ones. Examples of this include the use of machinery rather than draft animals, or chemical fertilizers and pesticides instead of manures and natural pest-eaters. In each case, natural, non-commodified inputs (that are not valorized through human labour inputs) are replaced with industrially-produced inputs. These inputs reduce labour time and biological contingency, and thus create a competitive advantage for those farmers who adopt the new technology (at least temporarily). Substitutionism refers to the replacement of agricultural foods with synthetic foods, bypassing agricultural production completely in the total industrial

production of food and fibre. Margarine, a synthetic foodstuff developed in a wholly industrial context is often cited as a key moment in substitutionism (Goodman et al 1987).

In theorizing the structural basis for the problem agriculture poses to capital (Mann 1990) and the means by which this problem can be overcome (Goodman et al 1987), Mann and Goodman *et al* have provided a useful starting point to theorizing the relationship between biophysical properties and the logic of capital in agriculture, and in understanding (at least in part) why we have the food economy that we have. Moreover, there exists a synergistic tension between the two arguments, as Mann (1990) discusses at length in a critical review of Goodman *et al*. If Mann's theory suggests that the problem with agriculture is that its valorization process involves considerable time-lag and uncertainty, Goodman's theory accounts for how this problem can be overcome through synthetic inputs that reduce time lag (since value is realized much more efficiently through industrial production, where not incidentally, labour time and production time are more synchronized) and uncertainty. The contributions of both authors serve as an important starting point, enabling us to understand GMOs as a new wave of appropriationist solutions to the barriers to accumulation located by Mann. However, a deeper analysis is needed to truly understand what is at stake in the GMO food economy. Following Pechlaner (2010), I want to show how GMOs differ from earlier appropriationist innovations in the role patents play in the valorization process, and more to the point, how both the successes *and* limitations of the GMO food economy are specific to the particular biophysicality of GMOs and to the historical moment of neoliberal capitalism.

Theorizing the GMO food economy: (fast)-ripened for profit

Approprationism has been the dominant accumulation strategy for capital within agriculture throughout the twentieth century. In 2007, there were roughly three million people engaged in farming in the United States, and 2.2 million farms; that is only 1.4 people per farm (EPA 2007). Moreover, in 2012, there were only 787,000 hired farm laborers (USDA 2013a). While most of these laborers work on large farms – the nine percent of farms with at least $500,000 per year in sales that account for seventy-five percent of total agricultural output – even these farms employ only a few people (less than four on average) – fewer than a small coffee shop or restaurant. Agribusiness may be big business. Farming is not. Capital has penetrated agriculture not through the actual cultivation process but in the upstream (and downstream) industries that fuel agricultural production. Indeed, the twentieth century has seen a substantial conversion of agricultural input expenses along these very lines: labor costs have fallen precipitously as a percentage of total expenses, while purchased capital inputs, including machinery, chemicals, seeds and feed, have skyrocketed. According to Goodman *et al* (1987), between 1930 and 1974, labor costs fell by seventy-five percent, while chemical costs increased thirteen-fold, feed and seed costs nearly quadrupled, and machinery increased by 2.5 times. Why has appropriationism been the dominant accumulation strategy within American agriculture? The reasons for this are three fold.

First, the actual production process is difficult to control through human labor, produces little surplus value, and has thus generally failed to attract investment from capital. However, industrially-produced capital inputs can be very profitable because they overcome or mitigate immediate barriers to accumulation on the farm (Mann 1989). Second, they are produced in a factory setting. This means that labour time and production time are more synchronized, leading

overall to a higher value agricultural economy. Moreover, none of the spatial, temporal and biological contingencies that (sometimes literally) plague agriculture are present in industry. All of these factors are more conducive to the steady accumulation of profits, and thus render appropriationist input production more attractive to capital than the cultivation process itself. Finally, insofar as they reduce labour time per output, (or land per output) they immediately provide farmers with a competitive advantage. If some farmers acquire a technology, then all others are compelled to obtain it in order to compete with the new standard that has been set. However, once the new standard is generalized, the competitive advantage is erased, and the overall profit rate is reduced for everyone. But the industrial firms that produce appropriation technologies can continue to generate large profits from their technology. Moreover, they will likely yield greater control over farmers given that farmers tend to be caught in an hourglass power matrix within the agricultural commodity chain, pinched between the industrially-oriented upstream input suppliers on one hand, and downstream retailers and processors on the other.

For these various reasons, we can understand why capital has largely favored manufacturing tractors and combines, producing synthetic fertilizers and pesticides, and even breeding high-yielding varieties of hybrid seeds to the dirty work of in-field production (of course, downstream industries such as processing, packing, shipping and retailing are equally important). But to what extent do GMOs fit with the appropriationist model? Writing in 1987, before the practical implications of biotechnology could be known, Goodman *et al* argued that biotechnology could develop as either an appropriationist or a substitutionist technology, with some innovations such as herbicide and pest-resistant crops fitting the framework of earlier appropriationist technologies, while others such as GMO-based artificial sweeteners fitting the

logic of substitutionism. Nearly two decades on we must ask how the practical reality of GMO agriculture may fit (or complicate) existing theories of agrarian capitalism.

In many ways, GMOs – or at least the ones that have met with commercial success – hold parallels with earlier appropriationist technologies. Produced in the high-tech research labs of chemical companies like Monsanto and Bayer, their transgenic traits have been isolated and spliced into existing seeds to make the production process more efficient and predictable. Like other appropriationist technologies, they are synthetic capital inputs that farmers inevitably become compelled to buy if they want to stay competitive. Insect-resistant crops hold much the same function as a newer, more efficient insecticide. Herbicide-tolerant crops enable greater ease (and thus savings) in herbicide applications. However, in one fundamental way, GMOs differ from other appropriationist technologies: they are alive. Their liveliness provides capital with a unique opportunity to synthetically alter the biophysical process of plant growth itself. Yet this liveliness also poses new challenges to capital not encountered in the "harder" fields of chemical and mechanical engineering: specifically, their reproducibility and vivacious dynamism.

While GMOs' status as lively commodities sets them apart from many earlier appropriationist technologies, this dichotomous distinction is complicated by the history of hybrid seeds. Kloppenberg (2004) has carefully documented the way hybrid seeds shifted from a public good created through university research programs to a privatized accumulation strategy for capital. Through his analysis, we can see how GMOs appear as an extension of the logic of accumulation inherent to hybrid seeds, rather than a categorically different phenomenon. However, there are certain important differences between GMOs and hybrid seeds as accumulation strategies. After considering what sets both hybrid seeds and GMOs apart from

other appropriationist technologies, I will explore the differences between hybrid seeds and GMOs.

As Kloppenburg (2004) argues, seeds are unique in their simultaneous role as both product and means of production. That is to say that any crop can either be harvested, sold and eaten, or have its seeds saved and replanted the following year. Indeed, the inability of capital to compel farmers to buy seeds every year instead of saving them has held back capital's penetration of the seed "industry," at least until the advent of hybrid seeds. With hybrid seeds – initially the creative domain of public research universities – farmers had access to high-yielding varieties and other seeds with desirable traits. The catch was that these desirable traits could only last for one generation, and seed-saving meant that these traits would be progressively watered-down, resulting in smaller, less consistent yields. In this context in the 1960s and 70s capital foresaw seed breeding as an area of potential profitability; in the emerging context of neoliberalism, control was wrested from public breeders and placed in private hands (Kloppenburg 2004).[22] However, capital required one more safeguard to ensure secure access to profits from seed-breeding. It needed laws to ensure complete control over the reproductive capacities of their seeds. These came in the Union for the Protection of New Varieties of Plants (UPOV) agreement of 1961, which made it illegal for farmers (or anyone else) to sell saved seeds that came from a patented parent variety. Farmers could still replant their own seeds, but with diminishing returns from the diffusion of desirable traits, seed breeders figured that farmers would rather buy new hybrid seeds every year than save their less desirable offspring.

[22] Kloppenburg (2004) shows how although it was developed by public breeders, the creation of hybrid corn made seed breeding appear profitable to capital, and thus led to the creation of a private seed breeding industry. Beginning in the 1930s and culminating in the 1960s in the United States, private seed breeders gradually gained market share and eventually full control over commercial hybrids, as public breeders ceased to devote research to an area that capital now found profitable enough to invest in.

Much of the story of hybrid seeds applies to GMOs as well; the key difference is the use of transgenic engineering rather than traditional breeding practices to produce targeted phenotypic advantages. However, while hybrid seeds have been bred for the selection of particularly desirable phenotypes – often expressed through the interaction of multiple genes – GMOs are created through the isolation and insertion of a few specific genes of a different species. This means that while qualitatively GMOs may be more distinct from native species, quantitatively it is hybrids that have perhaps the greater genetic differentiation. For this reason, saved GMO seeds are more likely to contain the specific set of transgenes needed to produce the desired trait than hybrid seeds (Kloppenberg 2004). Farmers' ability to save GMO seeds introduced a new contingency into the equation, and thus a new barrier to profitable accumulation that needed to be rectified. The solution to this was a new intellectual property rights (IPR) regime, even more stringent than the UPOV.

Emphasizing this increasingly important role for IPR, Pechlaner (2010, 2012) has proposed an alternative framework for conceptualizing the political economy of GMO agriculture, developing the term "expropriationism" to refer to "an assemblage of legal mechanisms used in concert to shift the relationship between technology producers and developers to restrict the power of farmers and facilitate a new capital accumulation strategy" (2010: 254). While keeping intact the relevance of Goodman *et al*'s earlier concepts of appropriationism and substitutionism, expropriationism refers to the set of patent laws specific to seeds – in particular GMOs – that ensure that their value is controlled by the patent-holder throughout the chain. However, while Pechlaner recognizes that this is not simply a preference but a requirement for capital accumulation to be possible in plant biotechnology, the question of why expropriationism is a requirement for GMOs in particular to be profitable to capital remains.

While patent safeguards are important to the profitability of other inputs such as pesticides, the following reasons account for their unique significance to GMOs.

The costs associated with creating a transgenic plant are very high, and must be borne in every single seed. In industrial manufacturing, the value of a machine is reflected in the labour and capital (dead labor) costs embedded in it. Each new machine of the same type will be produced with the same labour and capital costs, and will thus have the same value. However, with GMOs, this is not the case. This is because what is produced is not a durable good, but an idea. While tremendous labour and capital are expended in the creation of one successful GMO plant, those that follow reproduce naturally, with little human labour inputs in their actual production. For that reason, patent laws that exclude the saving of seeds are necessary (otherwise the value of GMO seeds would be virtually zero – no more than any other seeds – considering how little it costs a farmer to save seeds and sell them). In other words, because the amount of socially necessary labour time embedded in a first generation GMO is enormous, and the amount embedded in posterior generations is virtually zero, biotech firms require control over the distribution of second-generation seeds to make sure that the costs of creating the first generation can be amortized across the second generation (and beyond).

Expropriationism has been advanced through two means: traditional patent laws, and what are termed technology use agreements (TUAs). With traditional patent laws, biotech firms simply rely on the patent protection granted to biotechnological innovations under the *Diamond vs. Chakrabarty* ruling of 1980, which declared that patents could be claimed on organisms containing a novel gene produced through biotechnology. Technology use agreements, on the other hand, reflect a more rigorous attempt by biotech firms – Monsanto in particular – to control

profits, and in the process, to control their farmer customers.[23] TUAs are private agreements signed between farmers and patent holders at the time of purchase that grant the patent holder a number of rights, and the farmer a number of restrictions over use and control of the seeds (Andree 2007; Charles 2001). Apart from forbidding farmers from saving or selling seed, they require farmers to use specific chemical inputs (such as herbicides), usually manufactured by the biotech firm itself. They also grant biotech firms the right to periodically inspect the buyer's farm for up to three years (Andree 2007; Kloppenburg 2004). TUAs operate as if the licensing agreement behind a particular software; just as Microsoft requires its computer hardware manufacturers to include other software packages along with its Windows operating system (in effect requiring consumers to buy these other software packages when they buy a Windows computer), biotech firms sell their own software – transgenic traits – embedded in the "hardware" of actual seeds, and likewise linked through licensing agreements to the purchase of other commodities, in this case chemical inputs. While it may seem dramatic, this software analogy was at the centre of the mind of Monsanto CEO Robert Shapiro when the company decided to pursue its TUA policy (Charles 2001). Overall, IPR has been the solution to the problems posed by the seed's status as a lively commodity, with both reproductive and contingent properties. It has enabled GMOs – albeit in certain limited instances – to be profitable for lead firms like Monsanto. In examining one of the most profitable cases – that of Monsanto's Roundup Ready soybeans in the US – we can see how the logics of appropriationism and expropriationism have been successfully applied in practice.

[23] One reason why Monsanto mandated separate TUAs with its customers was because its herbicide Roundup was already off-patent by the mid-1990s. TUA's enabled Monsanto to go further than it could under existing patent law in requiring its customers to use its brand of glyphosate herbicide only, rather than generic alternatives (Pechlaner 2012).

Super Soya: Riding the train to profits

Herbicide-tolerant soybeans are often invoked as a paradigmatic example of the success of GMO crops, and with good reason. In 2012, herbicide tolerant soybeans counted for 93 percent of soybeans in the US (having peaked around 2007), and 75 percent globally (USDA 2013b; James 2011). Moreover, they have represented close to 100 percent of soybeans in Argentina (the world's third producer of soybeans) since the early 2000s and have steadily been taken up in the world's second largest producer, Brazil, where they accounted for 71 percent as of 2009 (GMO Compass 2010). Two types of herbicide-tolerant soybeans (and other crops) exist: Liberty Link soybeans made by Bayer Crop Industries and resistant to the glufosinate-based herbicide Liberty (Basta) and Roundup Ready soybeans made by Monsanto and resistant to the glyphosate-based herbicide Roundup. However, 91 percent of GMO soybeans planted belong to the Roundup Ready variety (Pechlaner 2012). Roundup Ready soybeans were first created in 1989, achieved regulatory approval in the US in 1994, and first went on the market in 1996 (Charles 2001). Their success for Monsanto has been unprecedented, and they represent a leading example of the dual logics of appropriationism and expropriationism.

The herbicide Roundup, or glyphosate, first emerged in the 1970s. It was different from earlier herbicides because it degraded quickly and did not kill weeds for a week or more, rather than immediately (Charles 2001). Roundup's relatively low toxicity also made it seem more environmentally friendly than other options and its broad-spectrum applicability made it useful in a variety of situations. Glyphosate kills plants by deactivating an enzyme (only found in plants) necessary for amino-acid creation, thus starving the plants of nutrients (Charles 2001). Even in 1995, glyphosate only accounted for a fifth of all herbicides used on soybeans in the US

(Carpenter and Gianessi 1999). Monsanto figured that the broad-spectrum applicability and relatively low environmental impact of Roundup could be a major draw, but only if they could make its application easy for farmers, a task that required that the crop itself become tolerant. If farmers could replace all other herbicides with Roundup, they would save money, and Monsanto's profits from Roundup sales would be substantial. Monsanto would have a massive market for both their transgenic soybean seeds and their trademark herbicide. Consequently, "Roundup tolerance became the project that bankrolled Monsanto's pursuit of genetically engineered crops" (Charles 2001: 60).

However, Monsanto faced challenges from the outset. Soybeans were initially recalcitrant crops, refusing to accept transgenic DNA (Charles 2001). Approaches that had worked with earlier test crops were unsuccessful with soybeans. Monsanto needed both a bacterium capable of synthesizing the target enzyme whose DNA could be used and a means of inserting that DNA into the soybeans (Charles 2001). The solution to the problem of glyphosate's target enzyme came in an unorthodox place: not in Monsanto's St. Louis laboratories but in a sludge pond on the edge of its Louisiana Roundup factory, where glyphosate-resistant bacteria had festered in the slime of glyphosate residue ponds. Monsanto had stumbled across the source of their target gene, but the question of how to insert it into a soybean plant remained. It was only through the invention of the gene gun – a tool that enabled scientists to shoot strands of DNA into target cells – that this was made possible (Charles 2001). After developing their herbicide-tolerant soybeans in a laboratory setting in 1988, Monsanto formed a partnership deal with Asgrow, a major soybean seed breeder, to develop herbicide tolerance in the most productive breeds of soybeans to which Asgrow had patents. This partnership also included Agracetus, the company that had invented the gene gun in 1986. By

1991, they had succeeded in creating Roundup tolerance in Asgrow's soybean varieties (Charles 2001).

Monsanto now faced a new problem of how to infiltrate the soybean seed market. While Pioneer Hi-bred, the largest breeder of soybean seeds in the US, was unwilling to pay more than half a million dollars for the use of Monsanto's Roundup Ready gene, Monsanto needed another revenue stream if it was going to make any profits from their innovation directly, besides simply through increased herbicide sales (Charles 2001). The solution to this came in the form of technology fees, whereby Monsanto would license its genes directly to the farmers themselves. License agreements would also prevent farmers from saving seeds. When farmers would buy the seeds, they would buy the physical seeds from a seed breeder and the legal right to use the seeds (under certain conditions) from Monsanto. Seed companies could concentrate on selling seeds for the same prices they normally would, and Monsanto could continue to sell their value-added inputs; only now, those inputs took the form of genetic material within the seeds themselves, as well as their trademark herbicide. Since Monsanto's technology use agreements precluded farmers from saving seeds, it meant that seed breeders had the benefit of selling seed every year to farmers without the cost of being blamed by farmers for this infringement on their freedom. Monsanto could mandate that farmers use Roundup exclusively (rather than off-patent glyphosate herbicides), and had the right to monitor and inspect fields to ensure compliance. Farmers that did not comply were forced to pay 120 times the cost of the technology fee (Pechlaner 2010).[24]

[24] The 120-multiplyer clause was ultimately struck down by the US Supreme Court, but the other provisions of the TUAs remain (Pechlaner 2012).

What effect did the near-unanimous switch to Roundup Ready soybeans have on the American soybean industry? For Monsanto, it meant unprecedented sales of Roundup: the herbicide became the highest-selling chemical input in the history of agriculture as early as 2001 (Mascarenhas and Busch 2006). For the farmers, switching to Roundup Ready enabled reduced labour costs, as fewer herbicide applications were required (Benbrook 2001). Roundup Ready also enabled a switch to no-tillage growing practices, which also amounted to reduced labour costs (Qaim and Traxler 2005). Furthermore, herbicide costs fell due to the ability to rely on Roundup alone. Table 1 evidences these trends: it shows how chemical input costs, including herbicides, declined following the 1996 introduction of Roundup Ready soybeans. Conversely, the costs of seeds increased rapidly during the 2000s, owing to the ability of seed breeders to charge more for their high-demand transgenic seeds as well as the new costs for farmers of entering TUAs with Monsanto. Thus aside from farmers and Monsanto, Roundup Ready soybeans have been profitable for Monsanto's partnership seed breeders. For them, the TUAs have meant that farmers are required to return to them, year after year, to buy new seeds; consequently, their sales have increased as well. Initially, the losers were the producers of other herbicides, who saw their share of the herbicide market plummet as early as the late 1990s (Carpenter and Gianessi 1999).

Table 2: US annual soybean production: Input costs in US dollars per planted acre

	1975	1986	1990	1996	2000	2006	2012
Seeds	8.32	10.82	12.47	15.01	19.18	32.30	62.68
Chemicals	10.19	12.37	20.48	24.95	22.32	14.46	17.49
Variable expenses	38.23	49.08	69.69	80.00	77.28	93.41	148.72

Costs/revenue in dollars per planted acre. Source: USDA 2013c, 2013d.

Roundup Ready soybeans fully evidence how the dual logics of appropriationism and expropriationism are at work in the contemporary project of agricultural biotechnological capitalism. Roundup Ready soybeans represent a productive capital input that gives adopters a competitive advantage over non-adopters. It enables reduced labour and capital costs, thus generating savings and increased revenues. Farmers have the option of reducing their labour costs or expanding acreage for the same amount of labour (Pechlaner 2012). Consequently, other farmers are compelled to participate in the new regime in order to keep up with the competition. Like earlier appropriationist innovations, it enables farmers to employ industrial inputs to control the agricultural process more directly. Costs are reduced, as well as contingencies. The crops themselves are rendered part of the industrial fabric of production, as they are immune to the toxic effects of the herbicide. Farmers can spray without worrying about the volatility of their soybeans; the beans are engineered to withstand chemical inputs. In this way, the seeds become machine like, synthetically designed to work with rather than against the other synthetic inputs.

However, while the logic of appropriationism is central to Roundup Ready soybeans' success as profitable fixes for Monsanto and its seed-breeding partners, perhaps even more so is the logic of expropriationism. Through the TUAs, Monsanto is able to guarantee access to stable profits, as farmers are prevented from saving seeds and required to buy Roundup. Monsanto is able to set the price of these inputs – both licenses for its genes and its herbicide – at rates low enough to ensure that farmers continue to sign on, rather than being driven by market forces. In fact, without these agreements, both the off-patent availability of glyphosate and the ability of farmers to save seeds would render Roundup Ready a losing endeavor for Monsanto. Roundup

Ready soybeans' appropriationist benefits may be what renders them beneficial – even necessary – for farmers in a competitive context; but only under the expropriationist legal regime can Monsanto ensure that the greatest benefits of its investment return home. It then follows that the logic of expropriationism is indispensable to understanding the success of agricultural biotechnology.

Unruly transgenes, uninterested markets

If the logic of capital has enabled certain GMO technologies to be wildly profitable, as competitive market pressures compel farmers to adopt transgenic varieties or lose out, it has also played a role in hindering the development of others. While herbicide tolerance and insect resistance for soy, cotton, maize, canola, sugar beet and alfalfa have been successful, there are three factors that make these crops distinct from most others. First, they are all among the most widely grown crops in the United States and beyond; they thus each hold the potential for enormous profits. Second, none of them are primarily consumed directly by consumers; all of them are either used in processed foods (maize, sugar beet, soy), fed to animals (alfalfa, soy, maize), made into oils (canola, soy), or not eaten at all (cotton). They thus lack the symbolic value of culturally significant dietary staple foods such as wheat and potatoes, both of which failed to launch in North America in Roundup Ready and Bt varieties respectively. Third, they have all relied on approprationism, making agricultural production more efficient for farmers, rather than appealing to consumers' desires for more nutritious or tasty food. These anomalies are not incidental; rather, they define both the successes and limitations of the GMO food economy. While there are a multitude of factors that explain this context – cultural, political,

economic, ecological and social – this section will focus on the economic and ecological rationales for the lack of success of GMO innovations that stray from the three above conditions.

First, market size is a significant factor in structuring which sorts of innovations will be seen as worthwhile for biotechnology capital. From the outset, the costs of producing a transgenic variety for a major crop such as corn is not much different from the cost of developing a transgenic variety for a minor crop such as parsnips. But the potential profits are wildly different. This is why only the most widely grown crops have been seriously taken on by biotech firms. Second, because GMO foods are not usually consumed directly, consumer backlash has been smaller than for foods with a greater symbolic value, such as wheat or potatoes (Andree 2011). Perceived consumer and producer backlash against Roundup Ready wheat led Monsanto to pull research on the product after farmers said they would be unwilling to grow it (Eaton 2013, Pechlaner 2012). The same corporation withdrew its Bt potato, the NewLeaf, after two of the largest commercial buyers of potatoes, McCain and McDonalds, announced that they would only be using GM-free potatoes, citing consumer concerns (Pechlaner 2012). Even GMOs that use standard transgenic traits (herbicide tolerance and insect resistance) in these two widely grown crops have failed due to public concerns, articulated through farmers and major buyers alike. The relative symbolic value held by wheat and potatoes led to a backlash where there had been none for other, less symbolically important crops.

Third, GM crops that do not make the production process more efficient for farmers – i.e., evince appropriationism – have failed, such as the FlavrSavr tomato and Golden Rice. This is because there is no structural pressure on farmers to adopt these technologies. Without providing increased yields or decreased production costs, the only way these innovations could be profitable is if publics are willing to pay significantly more for them. However, the historical

success of the anti-GMO movement, coupled with people's unfamiliarity with the technology and its implications have meant that there is very little reason for the industry to bank on public opinion remaining consistently favorable. Appropriationist GMOs are profitable insofar as the public accepts them as "substantially equivalent" or interchangeable with cisgenic varieties. Value-added GMOs could only be profitable if publics valued them higher than cisgenic varieties, an unlikely proposition at best. For this reason, we have seen little research into nutritionally- or taste-enhanced GMOs, and the one such GMO that has been brought to market – Calgene's FlavrSavr tomato – was an abject failure. A second such GMO which became the poster-child for GMOs potentially humanitarian ends, beta-keratin-enhanced Golden Rice, was of no interest to capital, and has yet to gain regulatory approval now fifteen years after it was first tested in the field.

To these three main reasons for the limitedness of the GMO food economy can be added two more. Fourth, there is the issue of biological contingency, even obstinence. Fifth, and related to all of these, is the issue of cost. As the case study of Roundup Ready soybeans has shown, successful GMO development sometimes requires both substantial amounts of R&D funding and a good dose of luck. The complexity and contingency of living matter is still beyond our coherent grasp, and has thus frustrated many biotech firms used to dealing with the relative predictability of inert chemicals.

Calgene learned this the hard way with its FlavrSavr tomato. While it may have ultimately gotten the molecular science right in its slow-ripening gene that enabled test-tube tomatoes to remain ripe for weeks without spoiling, its first (and only) year of commercial development was an unmitigated disaster. On one hand, Calgene had failed to account for the complexity of growing tomatoes in the real world: in order for its tomatoes to compete with

existing cisgenic varieties, Calgene had to produce transgenic versions of specific tomato varietals that had been bred to thrive in the ecology of each region where they were planted (Charles 2001). There was not simply this thing called a "tomato" that would be the same anywhere; there were dozens of different tomatoes, each bred to be optimally attuned to the unique and dynamic biophysicality of the microclimates within which it was embedded. Calgene's harvests ended up being significantly lower than those of cisgenic tomatoes, and the FlavrSavr lost it millions of dollars in revenue. On the other hand, the ripeness of Calgene's tomatoes ended up having negative side effects: many of the tomatoes ended up getting crushed in transit (Charles 2001). Once again, the biophysicality of the crop instantiated new barriers to the realization of a business venture that made sense in the abstract.[25]

One might suggest that the failure of FlavrSavr speaks more to the bunglings of one small upstart biotech firm than to inherent barriers to the successful commercial development of GMO crops that stray from the principles articulated above. True, Calgene might have taken more care to ensure that they had a better handle on how to grow tomatoes before they planted their transgenic seeds. But the fact that slow-ripening tomatoes did not attract interest from more established biotech players such as Monsanto, or that existing seed breeders did not seek partnerships with Calgene – as well as consumers' general disinterest with the product despite its unquestionable usefulness in theory – suggest that there is more at stake here than the

[25] It is nonetheless important to remember that the materiality of the crop can be mobilized as a productive tool in capital accumulation as much as it can be a barrier to accumulation. Pechlaner (2012) provides contrasting examples of this potentiality: on one hand, she shows how the spread of GM canola pollen into neighbouring organic fields created significant backlash and a legal challenge to Monsanto from a group of organic farmers in Saskatchewan. On the other hand, she documents how drift of Roundup herbicide from Roundup Ready cotton fields to conventional cotton fields in Mississippi compelled conventional farmers to adopt Roundup Ready cotton so that their crops would not be destroyed by the drifting Roundup. It is the political response of those affected by the 'messiness' of GMOs' biophysicality that determines whether that messiness can hinder or advance a project of capital accumulation.

mismanaged business ventures of one company. Tomatoes, ubiquitous as they are, simply did not have the profit potential to interest the big players in agbiotech who might have had the resources to successfully make the product a commercial success. Moreover, without the structural incentive for adoption that an appropriationist technology would provide to farmers, there was no competitive advantage for farmers who adopted the tomato and thus no guarantee of any profits to biotech firms or farmers. Without significant consumer demand, nobody – not the seed breeders, nor the large biotech firms, nor farmers themselves – could justify getting involved in such a precarious project.

If FlavrSavr tomatoes mark the first major failure of commercial agbiotech, Golden Rice marks the most disappointing for proponents of biotechnology. Golden Rice was developed as a public research project, spearheaded by Ingo Potrykus and Peter Beyer, university researchers in Switzerland (Potrykus 2001). Funded primarily by the philanthropic Rockefeller Foundation (and only to a limited extent by for-profit sources), they created rice that had enhanced levels of beta-keratin, a precursor to vitamin A, through the insertion of genes from bacteria and daffodils, presenting their results in March of 1999. Their goal was to solve the problem of vitamin A deficiency in the Global South by offering the rice for free to peasant farmers, whilst maintaining a for-profit side project developed in partnership with British agrichemical firm Zeneca that would sell the rice to commercial growers. After successfully demonstrating the technology and eventually publishing the results of their research in *Nature* in 2000, Potrykus was surprised to find out that nearly seventy patents on gene sequences and gene transfer techniques had been infringed upon in the creation of Golden Rice (Hessler 2011). Unable to navigate these regulatory hurdles alone, Potrykus and Beyer made a deal with Zeneca, who agreed to help the Golden Rice developers negotiate the IPR barriers in exchange for the commercial rights to the

technology (Potrykus 2001). However, beginning with Monsanto, the biotech firms who held these patents granted free licenses to the creators of Golden Rice. Given the positive press this generated, coupled with the failure of Golden Rice to generate any commercial revenue fifteen years on, this appears in hindsight to have been a wise choice. Although Zeneca, which became Syngenta in 2000 initially agreed to support Potrykus through a partnership, the corporation eventually rescinded its commercial project, "…because the chance for a financial return at the level of the investment was too low" (Potrykus 2012: 468). Even though Zeneca had been spared of conducting any of the R&D prior to the successful development of Golden Rice plants, and had opportunistically made use of Potrykus' sudden need for an industrial partner, it still concluded that it had nothing to gain from involvement in the Golden Rice project.

Why has Golden Rice remained in a time warp for fifteen years while other GMO varieties have surged ahead? Ingo Potrykus categorically blames onerous regulations and testing requirements for stalling its development (2012, 2010). He sees the regulatory barriers as having required years of unnecessary testing that has still yet to garner approval. Certainly, the regulatory barriers, themselves the result of public ambivalences over the technology, have drastically slowed the process of approval and commercial release. However, faced with the same regulatory barriers, other corporations have had little trouble achieving regulatory approval in significantly less time. For example, seven years separated the successful creation of herbicide-tolerant soybeans and the first season of commercial planting of Roundup Ready soy. Similar timelines apply to the other commercially successful crops. If Golden Rice had been pioneered by a multi-billion dollar corporation like Monsanto or Syngenta, which had the resources to negotiate regulatory barriers and conduct extensive health, safety, and environmental testing, it may have been approved for commercial release by now. But the point

remains that such an innovation is doubtful to interest any profit-seeking corporation given the unlikelihood that any profits would ever result from it. Golden Rice neither enhances productive efficiency for farmers nor benefits consumers in the West – those with money. It neither relies on appropriationism to ensure farmer uptake nor expropriationism to guarantee revenue streams for the patent holder. Even despite its humanitarian goals and nutritional benefits, it has still sparked popular backlash and consumer ambivalence. In short, within the confines of a capitalist GMO economy, it remains unlikely that Golden Rice will provide the profit motivation necessary for commercial success.

Conclusion

The story of GMOs – their successes and failures – is only the latest chapter in the story of agricultural capitalism. The path of their development has been significantly conditioned by the materiality of agricultural capitalism. GMOs have been successful because they help overcome barriers to accumulation inherent to the biophysicality of agriculture. They reduced labour or other capital input costs. In this way, their commercial success has paralleled earlier appropriationist technologies, including machinery and chemical inputs. As on-farm labour and production is replaced with off-farm, industrial labour and production, the barriers to accumulation posed by agriculture's inherent materiality are diminished. However, GMOs, like hybrid seeds before them, differ from other appropriationist technologies. Their liveliness and in particular their reproducibility represents a distinction that produces both new challenges and new opportunities. There are challenges of maintaining control, not just of the reproductive capacities of the seeds, but of how ownership rights can be preserved for patent holders beyond the first generation of the plants. This challenge has necessitated a stringent intellectual property

rights regime, which has substantially empowered biotechnology firms, and been termed expropriationism (Pechlaner 2010).

The converse of this process has been the failure of numerous innovations that do not cohere with the industrial logic inherent to successful GMOs. Biotechnology multinationals have eschewed innovations that address consumer health, nutrition or aesthetic considerations because of the uncertainty of any success in these innovations. Without any structural impetus for farmers to adopt transgenic crops that do not inherently improve the production process, there is no guarantee that such crops would even be planted, let alone sold in grocery stores for a premium. In this way, the logic of agricultural capitalism has significantly narrowed the spectrum of GMO development. However, if the current situation is the result of a particular set of material constraints inherent to the logic of capital, this does not inevitablize it. A categorical rejection of GMOs without consideration of the contingency of their location within neoliberal political economies only serves to further entrench and naturalize the hegemony of capitalism. A critical reformulation of the global food economy must start with a decoupling of the biotech baby from the neoliberal bathwater.

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Chapter 3: Writing (righting) technonatures

Much has been made of the relative success of opposition movements to GMO agriculture (Herring 2008; Kwiecinski 2009; Purdue 2000; Schurman 2004; Schurman and Munro 2011). Indeed, although agricultural biotechnology has made major inroads in key volume crops such as corn, cotton, soy and canola, the GMO food economy remains very circumscribed, limited to only two dozen countries (James 2012). Other, more culturally important crops such as wheat, potatoes, tomatoes and rice have failed as successful GMO products, and at least 64 countries have instituted bans, moratoria or mandatory labelling policies (CFFS 2013). Global social movements and national governments have further iterated their concerns through the Cartagena Protocol on Biosafety of the Convention on Biological Diversity (CBD) and the CBD's standing moratorium on Genetic Use Restriction Technologies (GURTs), or terminator technology. Public and activist pressure has driven retailer-based bans in Britain and elsewhere in Europe and beyond. Given GMO agriculture's current imbrication within neoliberal capitalism and its role in contemporary processes of commodification, the relative success of GMO opposition represents an important (though tenuous) victory for progressive struggles against neoliberal hegemony, and an important case study for those seeking to understand the wider potentialities of the resistance politics successfully employed in anti-GMO activism.

These resistance politics have been advanced through real-world, on-the-ground, material struggles. But they have also relied on particular discourses, narratives or semiotic framings to be intelligible and thus successful. The various ways GMO agriculture has come to be framed semiotically, both within and outside of activist opposition circles have had a constitutive effect on the direction and results of the movement. While several discourses have provided important

framings of GMOs among activists and the public at large, a narrative of GMOs as unnatural, impure, or at odds with the purity of nature has been resonant, and successful in mobilizing resistant energies. However, while much has been written about the relative success of anti-GMO activism (Schurman and Munro 2009, 2010; Andree 2007), and about the role of nature narratives in GMO discourse (Hansen 2006, Levidow 2000, Haraway 1997, Hughes 2005, Kwiecinski 2009; Shaw 2002), the two conversations appear to be relatively segregated. Only Schurman and Munro (2010, 2009) and Schurman (2004) have examined the use of nature narratives in the context of activist struggles, and these studies neither located these narratives within their wider cultural context nor critically examined their political implications. In contrast, this chapter seeks to explain not only why these narratives were effective in mobilizing opposition but also why they have troubling political consequences that need to be carefully considered when assessing the value of such narratives to activist campaigns going forward.

This chapter argues that natural purity discourses have been central to the success of GMO activism, as they have mobilized widely resonant nature-culture dualisms that separate the natural world from the human world. However, these dualisms have long been used to justify gendered, racial, class and colonial patterns of oppression and domination, providing 'nature' as a justification for unequal power relations. Moreover, appeals to natural purity alone obscure the pernicious political economic impacts of GMOs under neoliberalism, where they have represented a further advance of the commodification of nature, empowering large biotech and seed corporations at the expense of farmers. In this way the argument developed corresponds with the insights of Haraway (1997), Hansen (2006) and others who have each provided instructive critiques of the problems with nature narratives in anti-GMO discourse. However, *pace* Haraway, I argue that natural purity discourses are not only problematic, but ultimately

unnecessary for the success of opposition to GMOs. Activist campaigns that have directly targeted the political economic, neocolonial, and class-based implications of GMOs *within the particular context of neoliberalism* have also had successes without resorting to appeals to the purity of nature. In this way, they have embodied Gramsci's (1992) notion of *good sense*, or a critical awareness of the underlying structural basis for existing conditions, rather than *common sense*, or the uncritical assumptions that perpetuate and reinforce an existing hegemonic configuration, with which we might characterize the natural purity wing of the anti-GMO movement. The successes of these campaigns suggest that while nature-culture dualisms remain politically effective normative groundings, concerns over equity, farmers' rights, accountability and democracy retain potential as terrains of ideological struggle. However, we must be careful to avoid eschewing the strategic political value of common sense framings altogether. Even good sense resistance efforts occur within an overarching context wherein common sense tropes and narratives remain widely popular. Movements that can strategically coopt the popular intelligibility of common sense framings within an analysis that is still firmly rooted in good sense critique, hold particular promise going forward for those seeking to challenge existing structures of power from a perspective that is immediately resonant. As a spatially variegated and multifarious component of the wider struggle against neoliberalism and the new enclosures, GMO activism can, and must, seize this normative terrain going forward.

The chapter begins with a brief discussion of the semiotic fluidity of nature and the role of natural discourses in Western environmentalism. Next, it examines specifically how natural purity narratives have been mobilized within anti-GMO discourse, demonstrating the political efficacy of resistance efforts that appeal to the purity of nature with a number of examples from various sections of civil society. It then seeks to locate these resistance efforts within wider

cultural discourses, analyzing each of them rhetorically to show how they cohere with wider western cultural motifs, thus considering the basis for their normative success. Appeals to natural purity have been a common and often successful strategy within anti-GMO discourse because such narratives resonate with deeper western cultural myths and beliefs about nature-culture dualisms, concern for racial or national purity, and an abhorrence of defilement, dirt, pollution, contamination or monstrousness: what Douglas (1966) has termed, "matter out of place" (35). The chapter then critically assesses the problematic implications of these natural purity discourses: how they reinforce the validity of nature-culture dualisms whilst obfuscating the contingent reality of GMO agriculture's imbrication to neoliberal capitalism. Finally, the chapter explores a set of alternative opposition struggles against GMOs that directly call into question its political economic impacts, drawing on two cases: resistance to the commercialization of GMO wheat in Canada, and resistance to terminator technology around the world. The successes of these two campaigns indicate that anti-GMO opposition does not have to revolve around nature purity discourses to be successful. Overall, the relative success of anti-GMO activism demonstrates how natural purity narratives are rhetorically very powerful. Yet it also demonstrates that though comparatively difficult, deeper critical attacks on neoliberal hegemony are not only possible but necessary, and the successes of those efforts must inform critical activist struggles against GMO agriculture and beyond in the future.

Discourses of nature

Though it is hard to assess exactly how discourses of nature have impacted public opinion on GMOs, research suggests that especially in Europe, they have played a major role in generating opposition to the technology. According to the Public Acceptance of Agricultural

Biotechnologies project of the Centre for Studies in Environmental Change, the idea that GMOs are unnatural is a major source of concern in Europe (Marris 2001; Marris et al 2001). In a more recent study, Mielby *et al*, found that 72 percent of EU citizens consider GMOs to be "fundamentally unnatural" (2013: 479). Similarly, Shaw's (2002) more detailed survey of public perceptions toward GMOs in the UK found that "across the range of … participants, there was a 'gut feeling' that the transfer of genes across the species barrier represented the 'crossing of a line' that should not be crossed" (281). While such findings are not universal and are much less pronounced in North America and in parts of the Global South (Hoban 2004), these results generally indicate a widespread public ambivalence or opposition to GMOs based on the belief that they are unnatural.

It is not by accident that discourses of nature have come to play an important role in anti-GMO activist campaigns. Nature is one of the most politically loaded and normatively significant terms in Western discourse (Williams 1980). Haraway (1997) reminds us that nature "has been the key operator in foundational, grounding discourses for a very long time" (102). However, nature is itself a politically indeterminate concept: "It is the … semantic richness of 'nature', the ability of the word and the concept to accommodate a multitude of contradictory meanings, that makes it a powerful and flexible construct in virtually any public debate or controversy" (Hansen 2006: 813). Consequently, there are multiple natural narratives that dominate Western orientations to nature. These narratives are mobilized in popular explanations of human-nature interactions within different contexts to explain different circumstances for different ends and with different effects.

Why are appeals to nature, indeterminate a concept though it may be, so effective? According to Hansen (2006), appeals to "nature" can be rhetorically very powerful and

persuasive, and are often made to overshadow or "naturalize" truth claims that are actually quite tenuous and political:

> …invoking 'nature' serves to inoculate against criticism or further scrutiny and to invest partisan arguments and interests with moral or universal authority and legitimacy. Uses or constructions of 'nature' are inevitably and invariably 'ideological' in the sense that they serve ultimately the purpose, as all public discourse, of presenting particular views, understandings and interests as being 'for the common good', 'universal' and 'right'. Appeals to nature or to natural qualities are … powerful because they invoke genuine, eternal and non-negotiable qualities (813).

Hansen (2006) argues that in keeping with this semiotic fluidity, a number of different narratives of nature exist, including nature-as-threat, nature-as-challenge, nature-as-vulnerable and nature-as-imperfect. However, within the context of anti-GMO discourse, the most important one of these is nature-as-pure. Within the nature-as-pure narrative, "nature" is presented as an inherently good, safe, secure, just and healthy place or state, powerfully contrasted with the bad, unknown, dangerous, unpredictable, and even immoral connotations of non-natural interference in nature (Hansen 2006). Moreover, nature is assumed to exist pre-discursively (Soper 1995), and thus few questions are asked as to what constitutes the boundary between the natural and non-natural. For Hansen (2006) "it is perhaps in this sense that the uses of 'nature', 'natural' and 'naturally' can be described as truly ideological, that is, they serve to perpetuate the notion of a common … understanding about the distinction between nature/the natural and that which has been scientifically or otherwise altered or interfered with" (830). Not only is nature inherently pure and just; the "nature" of "nature" is assumed to be intuitive, self-evident and absolute.

While of special importance to anti-GMO activism, natural purity discourses have long been foundational to Western environmentalism. As Sturgeon (2009) has argued, "dominant Western cultural myths have presented nature as a foundation of truth while at the same time

imagining history as a story of the movement from nature to culture … it is not accidental that the embodiment of nature as the source of truth, inspiration, and inevitability develops in some of the same historical and cultural contexts … that see the rise of a particular form of environmentalism" (13). This discourse of nature has been pervasive in the conservationist movement, which has typically seen nature as separate from humanity, and often more sacred and pure. Indeed, the wilderness ecology movement, dating back to the days of Sierra Club founder John Muir, has often mobilized images of nature-as-pure to generate public concern for urbanization and resource use, whilst calling for total preservation or "dehumanization" of landscapes, often in the face of indigenous land claims (Kosek 2005; Tsing 2005). As will be explored below, there are important connections between wilderness ecology and the nature-purity section of the anti-GMO movement. From this basic understanding of the cultural foundation for valuing natural purity, and the rhetorical power that nature, and appeals to nature, holds within the Western cultural imaginary, I examine how natural purity narratives have been used in GMO opposition movements.

Writing technonatures

Opposition to GMOs is manifest in a wide array of arenas: among environmental NGOs such as Greenpeace and Earth First!; among political parties ranging from green and social democratic parties to far more conservative parties such as the Austrian Freedom Party; among activist intellectuals like Vandana Shiva (Mies and Shiva 1993; Shiva 1989) and Jeremy Rifkin (Howard and Rifkin 1977; Rifkin 1997), and in many cases within the mainstream media. While the bases for opposition are diverse and target economic, ecological, health, and ethical implications of the technologies (Cook et al 2004), many actors have been animated by concerns

that GMOs are unnatural: that they violate the sanctity or purity of nature or transgress non-negotiable natural boundaries and represent a reckoning with nature that is sure to have dire consequences. These discourses have been manifest in at least three areas, which I delineate as activist movements; media representations; and electoral politics. I will quickly give examples of this tendency in all of these areas to show how while far from the sole force behind opposition to GMOs, the notion that GMOs transgress or trouble boundaries of what counts as "nature" and what represents an appropriate human relationship with nature has formed a significant moral basis for opposition.

Activist opposition

Levidow (2000) has argued that "in general, environmentalist movements have recast 'nature' as a realm of purity, morality and fragility" (326). Various activist groups have mobilized notions of the unnaturalness of GMOs to animate their resistance. For example, during the late 1990s, the GenetiX Snowball was launched as a direct action campaign in Britain (Wall 2000). It involved "participants visiting a site where genetically modified crops ha[d] been planted" where they would "dig or pull up a number of plants, wrap them neatly in biohazard bags and then turn themselves over to the police" (82). In 1999, another direct action campaign that involved the destruction of 150 GM trees owned by Zeneca Corporation took place in Britain. The anonymous perpetrators explained their actions, stating that "those who are manipulating the DNA of trees … show contempt for our planet and the life it supports" (85). These two examples show how the idea that GMOs are unnatural is mobilized by activists to draw attention. In the first instance, GMOs are compared to biohazardous or radioactive materials, contaminating the environment and requiring immediate and total removal. The

second example of anti-GMO activism uses language of "contempt" to refer to the actions of scientists and corporations involved in the production of GM trees. In this case, GMOs exemplify a disregard for the sacred laws of nature to which we are beholden.

Anti-GMO activists have often relied upon narratives that link GMOs with pollution, contamination, Frankenstein or monstrousness (Schurman and Munro 2009). We see the use of such metaphors in an activist campaign from New Zealand. The group Mothers Against Genetic Engineering in Food and the Environment (MAdGE) waged a campaign against research into cow's milk with transgenic human enzymes that could be fed to human infants (Bloomfield and Doolin 2011). Appearing on billboards in Auckland, their ads featured images of a four-breasted woman attached to an industrial milking machine with a GE branding on her buttocks. Elsewhere MAdGE argued that "if women's essence, their milk, their means of nourishing their young is taken away from them, usurped and commodified, the damage to their life force is unimaginable" (MAdGE 2003). The article suggests that it would take "monstrous arrogance to even contemplate interfering with the material essence of womanhood." Here, women's "essence" as nurturers and baby-feeders is invoked to deride a "monstrous" transgression of the natural order, reinforcing coherent metaphors of GMOs as monstrous or Frankenfoods, interfering in an essential nature and an essential womanhood. They go on to state that "no commercially made formula has ever been able to replicate mother's milk. Doesn't that tell us something, not just about its complexity, but about its uniqueness, its perfect natural design?" Women's "essence" – materialized in their breast milk – is framed as a "perfect natural design," a gift from God or his secular alias Nature. If women's essence is perfect, pure, and sacred, then the creation of a chimeric transgenic milk product is the opposite: defiled and sacrilegious. Its very existence represents an affront to the order of Nature; an unwarranted boundary-crossing that disrupts the

essential order of things. Between the monstrous corporeality of the cow-woman depicted in billboards and concerns over the "monstrous" interference in the essence of womanhood provided by transgenic milk, we can see how semiotic connections between appropriate bodies, appropriate gender roles and appropriate patterns of socio-natural interaction are made, with each emanating from the same essential natural order. Our intuitive understandings of what women are supposed to look like and supposed to do activate concerns for the self-evidently unnatural ways in which these natures are transgressed by the milk.

Media opposition

The media has also mobilized narratives of nature in their construction of GMO discourse. While pro-industry framings have also been common, this section examines oppositional framings in the media. Flipse and Osseweijer's (2013) case study of three prominent GMO storylines in Britain in the late 1990s and early 2000s found media attention to be negative, sensational, and relatively brief. Hansen (2006) found that 24 percent of all reporting on biotechnology and genetics in the print media used the words "nature," "natural," or "naturally." He later found that although uses of these terms within media discourse were not wholly negative, a significant portion of media representation of biotechnology invoked "nature" or "the natural" to animate concerns about the morality or riskiness of the technology. This further suggests that whether for conscious political reasons or simply because such messaging sells, the media has also played a role in advancing the narrative that GMOs are unnatural. As Schurman and Munro (2009) have noted, such media attention has, particularly in the UK, had a significant impact on public opinion and thus on the retail end of the GM food commodity chain, with

mainstream media sources reproducing the language of activist campaigns, referring to "mutant crops," "genetic contamination" and "Frankenfoods" (Levidow 2000).

Generally speaking, the uses of such discourses by media have had conservatizing political effects. For example, Hughes (2005) has shown how the anti-GMO campaign in Britain, led by the media and organizations, was organized around appeals to British nationalism and the importance of a pure, clean, British countryside. Nonetheless, the political implications of appeals to natural purity are not inherently reactionary. Some have emphasized concerns over the threat posed by GMO contamination to national purity. Others, such as polemicist Jeremy Rifkin's (1997) popular works have expressed concerns with the way biotechnology and the patenting, valorization and commercialization of genes may potentially lead to future where wealthy consumers purchase superior genes for their progeny, and class and racial divides come to be genetically constituted. In this case, Rifkin's concern for transgressing natural boundaries amounts to a fear of the further encroachment of capital into that which had previously been immune to it. Yet as we shall see, discourses of natural purity can be just as much mobilized to advance the scope of the market and neoliberal rationality as to critique it.

Electoral political discourses

Lastly, discourses of natural purity, cleanliness, pollution and contamination have been used in electoral politics, with significant effects. While green parties have generally opposed GMOs for many reasons what is significant is that opposition to GMOs has extended into electoral politics far beyond the environmental left. As the below examples of Tasmania and Austria demonstrate, the resonance of anti-GMO politics both with neoliberal governments and political parties of the far right highlights the dangers of this indeterminacy.

The Australian state of Tasmania has sought to develop a reputation as a niche producer of high-end produce for export both nationally and overseas (ABC 2014). In achieving this end, the state has cultivated an image of "clean and green" (Cocklin 2008). Central to this clean and green imaginary is Tasmania's eschewal of GMOs. While Australia has federally been a proponent of GMOs (even opposing the Cartagena Protocol on Biosafety), and most states now grow GMO canola or cotton, Tasmania has remained stridently opposed to GMO agriculture, instituting a moratorium in 2001 that has been extended indefinitely as of 2014. The links between Clean and Green and the GMO moratorium are not incidental. In fact, the cleanness and greenness of Tasmania – its ecological purity – is dependent on the perceived genetic purity of its crops. It cannot be clean (a synonym for pure) or green (a synonym for natural or in-sync with nature) if it is polluted or contaminated by transgenic crops. With Clean and Green Tasmania, we can see how genetic purity represents not only a safety standard or moral imperative, but a shrewd marketing strategy for a small, relatively distant territory. In this instance, natural purity is invoked to give Tasmanian producers a leg up in international markets and domestically, particularly among consumers who seek to cultivate a "clean and green" self-image through their lifestyle choices. Rather than approaching GMO resistance from a concern over global equity and the pernicious effects of nature's commodification, Clean and Green Tasmania reproduces neoliberal rationality as a calculated business strategy to boost consumer interest in their brand. The Clean and Green "brand" (and they do call it a brand) gives Tasmanian produce a value-added boost, generating greater profits for Tasmanian agricultural businesses (Greens 2013). As public policy, opposition to GMOs has made economic sense for Tasmania, fully in keeping with neoliberal ideology. However, even on the right, the discourses of natural purity have been mobilized against GMOs towards various ends and not simply in accordance with calculative

niche-market business rationality. This is well evinced with the politics of Austria's far-right Freedom Party (FPO).

Austria is among the most anti-GMO countries in the world. A full seventy-eight percent of Austrians feel that GMO food is "fundamentally unnatural" and that it makes them feel uneasy (EC 2010: 26), and Austria once sought a blanket ban on GMOs, a policy that has been rejected by the EU (Lee 2008). While opposition to GMOs includes the green and social democratic parties Grune and SPO respectively, it also takes root with the FPO. The FPO is notorious for being staunchly anti-immigrant, a policy approach that it assumed in the early 1990s at the same time as it experienced a substantial jump in opinion polls, from below ten percent to the high teens and low twenties. In their current 288 page handbook (FPO 2013), they devote a twenty page section to the problems with immigrants and asylum seekers, and the need for immigrants to return home, a policy called "minus-immigration," all the while claiming that "Austria is not a country of immigration" (FPO 2013: 30). Numerous anecdata of non-Austrian people doing bad things coupled with daunting immigration statistics and foreboding references to Islamic fundamentalism pervade this section of the handbook. At the same time, they devote a large section to GMOs, which they categorically oppose as contaminating substances (70). It is not difficult to see the semiotic connection here between transgenic crops that contaminate or pollute the purity of Austria's crops and soils and immigrant groups whose cultural or racial inappropriateness contaminates or pollutes the purity of Austrian soil or the Austrian "nation." Here, Haraway (1997) reminds us that "transgenic border-crossing signifies serious challenges to the 'sanctity of life' for many members of Western cultures, which historically have been obsessed with racial purity, categories authorized by nature, and the well-defined self" (60). Immigration, like GMOs, disrupts those well-defined notions of selfhood and nature.

GMOs as matter out of place: Evaluating the success of natural purity narratives

How do we evaluate what is at stake in these activist campaigns? What accounts for the discursive purchase they have generated? It is important to note that appeals to the purity of nature are diverse, as are their political implications. The opposition campaigns discussed above are demonstrative of two different framings of nature and the role of GMOs therein. These frames enable us to understand both what is so effective and ultimately problematic about these particular expressions of anti-GMO activism. While the first, "natural sanctity," stresses the inherent goodness of natural purity and thus the inherent wrong of its transgression, the second, "natural boundaries," stresses the ill effects that are borne out of transgressing natural boundaries. In this way, far more than concerns over natural sanctity, concerns over the violation of natural boundaries often emanate from real and legitimate worries over the problematic consequences of boundary crossings. Thus, in some cases, they hold the potential to be constructively reshaped into deeper systemic critiques of the adverse effects of oppressive social systems. However, both of these framings tend to play upon metaphors of pollution, contamination and monstrousness, drawing connections between GMOs and other objects and subject positions that have been derided for their violation of natural distinctions.

Part of what makes these metaphors so successful is their wider cultural resonance. Kwiecinski (2009) has observed that GMOs operate as a modern-day taboo. Taboos exist in every society, and often exist to maintain boundaries between discrete, socially relevant objects or categories (Kwiecinski 2009). Though they often emerge for important social or sanitary reasons, they take on a life of their own. One of the most salient ontological boundaries in Western society has been that between nature and culture (Plumwood 1993, Sturgeon 2006). As

living creations of Western technoscience, GMOs disrupt the nature-culture dualism; they disrupt the sacredness of nature. By crossing this boundary, they become taboo. In conceiving of GMOs as a modern-day taboo, we can understand the success of discourses that frame them as pollutants or contaminants. These discourses of pollution, contamination, and even monstrousness can all be understood as relating to Mary Douglas' conception of dirt as "matter out of place" (1966: 35). For Douglas, dirt and dirtiness are not inherent conditions; they represent the situational transgression of boundaries of appropriateness. Empty beer cans become pollution when they are left at the beach, but not when they are recycled. Pollution and contamination thus represent the violation of boundaries of purity, and the discursive purchase of these metaphors partially emanates from wider cultural concerns about unwarranted boundary crossings and violations of nature-culture dualisms. Thus with GMOs as with sexual or hygiene taboos, there is both an inherent distaste for the boundary violation and a fear of the consequences that it will bring. I differentiate between concerns over the violation of natural sanctity on one hand, and the violation of natural boundaries on the other, and discuss how each has played a role in structuring different scripts of the anti-GMO movement.

Natural sanctity

References to contamination, pollution and Frankenstein have given discursive purchase to the idea that GMOs violate the sanctity of nature (Hansen 2006; Schurman and Munro 2009; Hammond 2004). Within this trope of natural sanctity, the purity of nature is seen to be fundamentally threatened by "contamination" from GMOs. It is within this narrative that the GenetiX Snowball campaign can be understood as constructing GMOs as contaminating, hazardous objects that are incompatible with nature. As Levidow (2000) stresses, this discourse

of pollution presents GMOs as not simply a health and safety threat, but as an inherent moral wrong, "irreducible to scientific measurement or management" (347). Efforts to disrupt field trials or "decontaminate" are therefore framed as morally just and legitimate; the restoration of a natural order. It is not hard to see how concerns over pollution or contamination correlate with wider cultural concerns with dirt and defilement (Douglas 1966). Indeed, precisely what makes GMOs "pollution" is the fact that they violate sacred boundaries between nature and culture; that they are seen as *essentially* different from their cisgenic relatives, despite near identical genetics.

Along with pollution discourses, Frankensteinian discourses also inspire concerns with matter out of place. Frankenstein's creation was a monstrous, grotesque figure. His very construction disrupted boundaries of appropriate conditions of human creation and human embodiment. The monster's mere existence was an inherent wrong, a defilement of the laws of nature, to which his hideous appearance was testament. The bolt through his neck reinforces the inherent grotesqueness of a cyborg figure in the western cultural imaginary. Along with the Frankenfoods trope, we see this image reproduced with the cow-woman of MAdGE's campaign against GMO milk. She embodies the "monstrous" intervention of technoscience into the sacred, perfect domain of Nature (MAdGE 2003). Just like the bolt in Frankenstein's neck, the extra two breasts and the industrial milking machine attached to her are "matter out of place;" transgressing the natural boundaries between essentially constituted objects of knowledge (Douglas 1966; Haraway 1991). In this way, the Frankenfood metaphor, as with pollution and contamination metaphors, stresses the inherent wrongs with such boundary crossings and violations of natural purity.

Natural boundaries

However, this inherent disgust with the border-violence caused by GMOs is not the only way purity discourses have emboldened concern for GMOs. For some, the impurity or unnaturalness of GMOs leads to concerns over potentially negative if not disastrous consequences of their use. In this case, it is not simply the fact that they are unnatural that causes concern, but the connection between unnaturalness and unintended or unknown consequences that generates public apprehension. Fears over nature "hitting back" are mobilized on this discursive terrain. Within this narrative, nature is often given a certain agency, and we are told that "'nature will do this … nature will react, nature will respond with vengeance'…" (Hansen 2006: 826). In general, this signifies the concern that scientists and humans more widely will pay for interfering in the natural order of things. It is in this sense that we can understand some of the concerns that led to the precautionary approach of the Cartagena Protocol on Biosafety. Moreover, the activist campaigns against Zeneca's GM trees that spoke of "contempt" for nature resonates within this discourse: by violating and undermining nature's authority and will, we will pay unforeseen consequences.

It is here that we can see a different use of metaphors of pollution, contamination, foreignness and monstrousness. For it is not simply the inherent defilement caused by pollution and contamination that makes it wrong; it is the implications of this that we fear. Pollution and dirt are not simply inherently repulsive; they are the harbingers of disease and destruction. Monsters are not simply scary because they are ugly but because they threaten us with bodily harm. Thus it is the unknowability of the consequences of violating natural purity that pose a separate set of concerns to those of the inherent immorality of genetic defilement.

Here we see connections with the metaphor of the flood. The flood represents an awesome nature with destructive consequences. It might have been prevented if we had set up better barriers to ensure the separation of the inside from the outside. The flood is "matter out of place" in the most extreme sense but it is also significant in its consequences (Douglas 1966; Hughes 2005). What matters is not only the violation of natural purity in and of itself, but the potentially dangerous consequences of such a violation. Floods of immigrants and GMO crops alike bring unforeseen and uncontrollable consequences. But commercial GM agriculture has also been responsible for a different kind of flood that has likewise garnered backlash: the flood of capital.

Dating back to Marx, capital has often been framed as both flood-like and vampiric, consuming everything in its path and progressively sucking the life-force out of its extra-market Other.[26] Within this discourse, natural boundaries represent the last bastion of hope for a world independent of the dictates of the market and appeals to nature animate an anti-eugenic movement that lambasts a world where genes, bodies, body parts, and personal attributes come to be produced as commodities rather than granted by "nature." This narrative, which animates Jeremy Rifkin's (1997) work, seeks to defend a boundary between the sacred nature that is immune to capital's vampiric tendencies and the profane world of the market. In this way, fears of the consequences of a pure nature being flooded by the selfish, corrupting auspices of capital embolden the left struggle against the commodification of life, but not from a perspective that recognizes the contingency of biotechnology's current imbrication with neoliberalism.

[26] David McNally (2012) has shown how stories of vampires and monsters have long played a part in the folklore of capitalism, from the early modern Europe through Marx to contemporary Africa.

Thus, we can see how in keeping with Douglas (1966), much of the cachet of these scripts comes from the way they resonate with wider cultural fears about pollution and contamination and specifically the transgression of nature-culture dualisms. Both the inherent wrongness of transgressing culturally significant boundaries and fear of the consequences of such border crossings animate opposition to GMOs as technologies that violate nature-culture dualisms and threaten or undermine the purity of nature. However, as the next section explores, this is not without political consequences.

Problems with nature purity

Although they may have been strategically useful for mobilizing public awareness and concern over the surreptitious introduction of GM foods into the food system, nature purity discourses are problematic for two reasons. First, appeals to nature have been used to justify racist, sexist, heterosexist and colonial systems of oppression and domination, whilst underpinning common conservative justifications for material inequality (Sturgeon 2009). Instead of being part of the struggle for a more socially just world, the nature purity side of the anti-GMO campaign acts to further entrench nature-essentialism. Central to feminist, antiracist, queer and postcolonial struggles is the destabilization and problematization of truth claims rooted in nature (Soper 1995). This is because "nature" has been used as a justification for white, male and Western superiority. The ideas that women are "naturally" more emotional, weaker, or less intelligent than men; that colonized peoples are "closer to nature" and therefore less civilized than Westerners; that the sexuality of queer people is inherently "unnatural;" that it is "human nature" to be greedy and selfish; or that "natural selection" is what determines who is rich and who is poor have long been mobilized as justifications for systemic oppression. It is not only

transgenic crops that are seen as monstrous, contaminating and polluting. We must ask which forms of human corporeality and self-expression come to be similarly framed and defamed when such discourses are allowed to stand for truth.

This semantic link between eschewing GMOs' unnaturalness and the social implications of understanding certain human subjectivities as "unnatural" or "out of place" is no more obvious than in the policies of Austria's Freedom Party. Their overall policy approach to GMOs demonstrates concern over purity, contamination, dirt; and parallels their attitudes toward immigrants. Just as they eschew the violation of the genetic purity of their crops, they do not want the genetic purity of the Austrian nation to be contaminated with foreign blood and culture. It is not hard to see in such purity-based rejections of contaminant populations, whether transgenic crops or asylum seekers, the encroaching veil of eugenics. As Haraway (1997) says, "the history and current politics of racial and immigration discourses in Europe and the United States ought to set off acute anxiety ... [We] cannot help but hear in the biotechnology debates the unintended tones of fear of the alien and suspicion of the mixed" (61).[27] If part of the project of radical emancipatory politics has been to deconstruct and dispel the notion that there is a "natural" order that is inherently "pure," "true" and "just," then invocations of the nature-as-pure narrative run counter to that project. They reinforce the notion that there is a nature that holds the essence of truth; that governs us and dictates the contours of morality to us, and that we must accept and obey. Rather than appealing to natural essentialisms as the MAdGE campaign does, we must critique, deconstruct and interrogate such claims to nature-as-truth.

[27] See also Kosek (2004) for an analysis of the connection between wilderness ecology and discourses of racial purity in contemporary New Mexico and in American history.

Second, nature-as-pure narratives are problematic because they prevent us from seeing how GMOs current manifestation is a result of contingent and mutable political economic arrangements that are themselves necessarily violent but not necessary. Outright rejections of GMOs based on their "unnaturalness" force us into a dichotomy whereby we can either have GMOs governed within the framework of neoliberal capitalism, or we must get rid of them altogether. The potential for GMOs to be incorporated into an agri-food system that is socially just is precluded from the discussion, and the tenuous and contingent link between biotechnology and neoliberalism goes unchallenged. Rifkin's concern for the ethical implications of a world where market rationality and the profit motive dictate everything (including our very genes), and nothing is left to "nature," is understandable and strategically useful. But this is a world of our current capitalist system given technological omnipotence and ethical free-reign, and not an intrinsic consequence of technoscientific development itself. Moreover, while the political economic implications of Rifkin's ethical critique may be encouraging as a warning against the long-term consequences of biotechnological capitalism, the case of Tasmania's Clean and Green policy demonstrates that these discourses can just as easily be mobilized in the interests of capital and to the cause of neoliberalization. Tasmania uses the neoliberal cultural lexicon to achieve its brand status as clean and green. Without a deeper critique of the pernicious effects of GMO agriculture as it is currently constituted under capitalism, oppositional movements that lambast GMOs' violation of nature can just as likely be the basis of a new niche-market accumulation strategy for capital as an emancipatory resistance effort against it.

Alternative discourses, alternative activisms

Discourses of natural purity have thus had a profound effect in anchoring much of the anti-GMO movement, and are integral to our understanding of the cultural politics of GMOs. However, they have not been the only effective resistance strategy. As this section will show, activist campaigns that directly target the problematic political economic implications of GMOs as they are currently constituted within capitalism have also had notable, though modest successes. Two examples – Canadian farmers' resistance to Monsanto's Roundup Ready wheat and the global campaign to ban terminator technology – evince this nascent trend. Together, they speak of the potential for an alternative approach to anti-GMO activism that is cognizant of the contextually specific problematic effects of GMOs as they currently exist within neoliberal capitalism, and demonstrate what Gramsci (1992) called good sense.

Roundup Ready wheat

In *Growing resistance: Canadian farmers and the politics of genetically modified wheat*, Emily Eaton (2013), whose work I draw on heavily in this section, shows how Canadian farmers successfully fought against Roundup Ready (RR) wheat in a way that did not rely on appeals to natural purity, but rather challenged the specific problems with RR wheat and the undemocratic, neoliberal framework behind its planned introduction. While the campaign was launched in 2001, by 2004, Monsanto announced that it would be withdrawing its application for commercial release of RR wheat after years and billions of dollars' worth of work on the project. It was not concerns of natural purity or Frankenfoods that mobilized resistance to RR wheat, but rather a largely (but not exclusively) producer-led campaign that targeted and problematized the specific contextual problems of RR wheat. Various agricultural organizations from across the Prairie

Provinces including the Canadian Wheat Board (CWB) united behind the idea that RR wheat was neither necessary nor beneficial for Canadian farmers and the Canadian wheat economy. They argued that agronomically, the herbicide-tolerance trait was not necessary to solve weed problems specific to wheat, but would conversely have negative ecological effects as the transgenes flowed horizontally to other plants, including weeds. In other words, the costs would likely outweigh the benefits, unlike with canola, which many of the same farmers had enthusiastically adopted. Economically, they argued that RR wheat did not make sense either: wheat is a staple crop in the prairies, and the high quality and nutritional value of Canadian wheat is valued on international markets, despite the relatively unproductive yields that prairie farmers garner. Given the high value ascribed to Canadian wheat and the opposition to GMOs in Europe and Japan, two of Canada's major export markets, RR wheat would tarnish the image of Canadian wheat and seriously endanger its export potential. Though this market-based argument against GMOs echoes the logic of Tasmania's clean and green project, the campaign against RR wheat went far beyond this narrow economistic frame.

Politically, the opposition movement derided Monsanto's attempts to pursue the commercialization of RR wheat in a way that was unaccountable and undemocratic. Monsanto's refusal to disclose publically their field test results and the biotech industry's vehement opposition to GMO labelling solidified an image of power-hungry, unaccountable corporations increasingly gaining control over farmers' livelihoods. However, while discourses of democracy, accountability and collective decision-making animated the movement, lurking beneath the surface was a more forceful political economic critique. Ever since the late nineteenth century, Canadian wheat farmers had banded together in solidarity to fend off the advances of both capital and the state. Indeed, they played a key role in the development and success of the NDP,

particularly in Saskatchewan, where the party formed the first social democratic government in Canada in 1944. Despite a wildly different context under neoliberalism in the early 2000s, Canadian prairie wheat farmers chose to frame their opposition to GMO wheat in a discourse of collective decision-making for the public good rather than individual market rationality. Moreover, they quietly admonished the political economic impacts RR would have on them. Having perhaps learned from their experiences with GMO canola,[28] farmers saw RR wheat as a technology designed to generate maximal profits for Monsanto whilst making farmers themselves evermore dependent on the corporation for seeds and pesticides. Indeed, in a declarative statement made by the CWB about RR wheat that was signed by farmers all over the world, the technology was framed "as a means for multinational seed companies to strip farmers of their capacity to reproduce seed outside of the market" (Eaton 2013: 144). In problematizing the ways markets and multinational corporations immobilize and disempower farmers, the statement squarely places its opposition in the context of political economic relations rather than with the technology itself.

Overall, we can see with Roundup Ready wheat the success of an opposition movement that is cognizant of the contextual political economic dynamics of its struggle. Rather than rejecting GMOs categorically, framing their opposition in nature-essentialist terms, or reflecting the concerns of wealthy consumers, this movement located its opposition with the specific agronomic and economic problems posed by RR wheat to the Canadian wheat economy, and ultimately, to the livelihoods of farmers themselves. More importantly, it recognized the problems with a set of political-economic relations that were undemocratic and unaccountable,

[28] As Pechlaner (2012) recounts, GMO canola came to operate as a technology treadmill that farmers adopted hesitantly due to competitive market pressures and despite a sense of injustice.

empowering to corporations at the expense of farmers. Though often hidden, social justice concerns and even a critique of neoliberal social relations were embedded within the critique. That these concerns animated a Northern struggle against GMOs is also significant, reminding us that corporate power, neoliberalization, and commodification are not only of concern in the global South, but in the North as well, where nature purity discourses have been most salient (Cronon 1995) and where much of the wilderness ecology movement has its roots (Guha 1997). This enables us to see that while concerns of the agronomic and economic impacts of any GMO variety are context-specific, the wider dynamics of neoliberal enclosure and farmers' disempowerment are endemic to GMO agriculture, at least under neoliberalism. These concerns are well voiced through another successful resistance struggle that also targeted the pernicious political economic impacts of GMO agriculture's power relations, though primarily in the global South, in the struggle against GURTs, or as they were effectively labeled by Canadian NGO Rural Advancement Fund International (RAFI, now ETC Group), terminator technology. [29]

Terminator terminated

The now infamous terminator technology (TT) was developed as a transgenic event by Delta and Pine Land, an American cottonseed breeder, in the mid-1990s. The technology's purported purpose is to render the seeds of each crop sterile, preventing the environmental release of second-generation crops, and ensuring greater controllability over transgenic plants in the environment. However, for opponents, TT also holds a darker promise, as it precludes

[29] While RAFI's coining of the "Terminator" metaphor may appear to be "anti-cyborg" (Haraway 1991) what is problematic about the Terminator is not only his cyborgness, but rather how he embodies American militarism, corporate technoscience, death and destruction. The metaphor thus encompasses critiques of imperialism, militarism and techno-capitalism whilst resonating with popular essentialist concerns over cyborg unnaturalness.

farmers from saving seeds, thus ensuring their continual need to purchase new seeds each season. It thus has the potential to render farmers more subservient to seed breeders and biotech firms, whose intellectual property rights become biophysically enshrined in the seeds themselves. Critics argue that by deepening farmers' dependency and vulnerability, the technology offers to further entrench relations of inequality between the North and South and between farmers and agribusiness, further advancing the commodification of agriculture, and dismantling traditional, communal, and non-market practices of seed-saving. However, resistance to TT has been strident, successful, and driven by a forceful critique of the problematic socio-economic consequences of the technology for farmers. Within two years of the first patents for TT being issued, the global opposition movement had not only won a global moratorium on the technology but had also forced Monsanto to distance itself from the technology and abandon plans for its commercialization (Srinavasan and Thirtle 2003). Spearheaded by groups in the Global North such as RAFI, the Spanish NGO GRAIN and by partner groups in the South, the global campaign against TT represents an important moment in the resistance movement against both GMO agriculture and neoliberalism more generally.

The first tangible political victory against TT came mere months after the patent was granted to Delta and Pine. In May 1998, members of the Convention on Biodiversity (CBD) met at the Fourth Conference of the Parties meeting (COP 4) in Bratislava, Slovakia. For the first time, countries discussed the nascent TT, concluding that further consideration of the technology would be required. When the Parties met again at COP 5 in 2000, they agreed on a moratorium on field testing for TT (Oguamanam 2005). Significantly, and in contrast with the CBD's subsequently negotiated Biosafety Protocol, COP 5 made specific reference to "socio-economic impacts" of the technology, citing these as a reasonable justification for proscribing commercial

release (CBD 2000). In the meantime, governments in the North and South had instituted or pushed for their own moratoria, activist campaigns had further advanced their cause, and Monsanto had announced that it would not be pursuing commercial development of the technology despite a plan to buy patent-holding Delta and Pine. At least for the time being, TT had been resoundingly rejected by the international community.

How was the campaign against TT so successful, and what sort of political discourses did it mobilize in its efforts? The campaign against Terminator Technology started with activist work conducted by RAFI in 1998 (Scoones 2008). The group uncovered Delta and Pine's secret patent on TT and made it public through a campaign that coined the terminator metaphor. RAFI then partnered with international groups, particularly in India, waging a campaign against terminator technology, or "suicide seeds." RAFI produced regular press releases documenting and providing critical analysis on new developments with TT, maintaining pressure on delegates at the CBD meetings and elsewhere. It also issued a mass letter-writing campaign to US Agriculture Secretary Dan Glickman and to hundreds of other officials from around the world (RAFI 1998f). Finally, RAFI members participated in numerous public fora including the COP 4 meeting, where members spoke out against the technology (RAFI 1998c).

Central to RAFI's campaign was an emphasis on the political economic impacts of the technology.[30] In its first ever report on terminator technology issued only weeks after Delta and Pine Land had secured a patent for the technology RAFI (1998a) argued that terminator technology "…threatens to eliminate the age-old right of farmers to save seed from their harvest and it jeopardizes the food security of 1.4 billion people … who depend on farm-saved seed" (1). Later reports would argue that terminator technology was merely a mechanism for biotech firms

[30] RAFI also uses an understanding of the problematic impacts of past technologies to embolden its critiques.

to capture greater profits (1998c), that it would force farmers to rely on markets rather than communal practices for their livelihoods (1998e), and that even public breeders would be pressured by neoliberal administrative logic to adopt TT (1998b).

RAFI further critiqued the way intellectual property rights and patent laws undergirded the massive power shift away from peasant farmers and toward seed multinationals, thereby drawing attention to how terminator technology's imbrication with wider neoliberal institutions was at the heart of its pernicious political economic impacts for farmers (1998d). Finally, RAFI called upon a different role for the USDA, one that would be in the interests of the public rather than seed-breeding corporations (1999). Ultimately, even with the 2000 global moratorium on field testing agreed upon at COP 5, RAFI expressed disdain, decrying the CBD's inability to agree upon a total ban for TT despite some support for a total ban among Southern countries (2000). Its continued and relentless pressure on CBD members likely played an important role in ensuring that the moratorium was extended indefinitely at the COP 8 meeting in 2006.

The success of the anti-terminator campaign by RAFI and other groups shows the potential for resistance efforts that stress the political economic impacts of technologies and the ways they are regulated (or not). RAFI's approach consistently articulated how terminator technology would merely be a return to neo-colonial relations, as poor Southern farmers would be further disempowered and taken advantage of by large Northern corporations. It critiqued the marketization of social relations and showed how such marketization would necessarily have class-based effects that would further disempower those who were already poor. RAFI connected its critique of terminator technology with wider struggles over food sovereignty waged by groups such as *La Via Campesina*. Importantly, as with the campaign against Roundup Ready wheat, RAFI never resorted to direct critiques of terminator technology as "unnatural," or to blanket

rejections of GMO agriculture. It squarely focused its criticism on terminator technology and the specific socio-economic impacts it would have.

Overall, as with the campaign against RR wheat, the anti-terminator campaign evinces the success of anti-GMO activism that is rooted in a deeper critique of neoliberalism and colonialism. Though far from the norm and not without limits, the successes of these two struggles demonstrate the potential for activist struggles that directly target the socio-economic effects of a technology within a particular political economic regime, rather than simply the technology itself. In understanding what differentiates these campaigns from the nature-purity driven opposition discussed earlier, it is helpful to consider Gramsci's (1992) notion of good sense versus common sense. Gramsci saw common sense as the uncritical set of ideas through which an existing hegemonic ideology is reproduced in everyday life. In its simplistic commitment to nature-culture dualisms and disregard for questions of power and justice, nature purity discourses bespeak a common sense perspective on GMOs. In contrast to common sense, Gramsci saw good sense as the critical, subversive perspective reached through an immanent critique of existing hegemonic power relations. Good sense lays bare the unjust foundations of a hegemonic configuration and is thus a necessary starting point for any counter-hegemonic struggle. In this sense, the two oppositional campaigns discussed here represent good sense, and thus provide a necessary starting point for further counterhegemonic struggles, whether against the neoliberal GMO food economy, the commodification of nature, or capitalism more broadly.

However, we cannot detach the success of RAFI's campaign (nor the campaign against RR wheat) from the overarching context of nature-essentialist opposition to GMOs. Despite its own avoidance of such overt rhetoric, RAFI benefited from the cultural resonance of nature-purity narratives. Moreover, RAFI mobilized powerful images of suicide seeds and terminators

to advance its campaign, subtly evoking concerns over suicide as a violation of the natural right to life, or with the terminator's unnatural cyborg figure. In this context, we must ask whether there remains space for an approach to activism that can strategically channel the affective energies of essentialisms whilst remaining primarily driven by a critique of underlying political economic conditions. It is possible that in the short term, mobilizing scripts and tropes that resonate with popular natural narratives whilst firmly situating one's own analysis within a deeper critique of commodification holds potential for future activists that seek to oppose the commodification of nature, with GMOs or otherwise, as RAFI has done here. Finding a way to strategically mobilize common sense framings whilst ultimately destabilizing those framings is a challenge, but one that may nonetheless bear fruit for future activist campaigns. Such a tactic is paradoxically reminiscent of what Gramsci called *trasformismo*, or the process through which resistance efforts are coopted within a hegemonic framework, transmogrified to support rather than subvert the normative basis for a hegemonic configuration. Perhaps what is called for then is a process of counter-trasformismo, as activist struggles strategically appropriate hegemonic framings, such as nature purity narratives, reshaping them into part of a wider counter-hegemonic critique and struggle against neoliberalism.

Conclusion: Rewriting technonatures

This thesis has sought to orient understandings of the role played by discourses of nature in shaping the political and economic trajectories of GMO agriculture. It has demonstrated how the semiotic fluidity of nature has been mobilized differentially among a multiplicity of movements that share little beyond their rejection of GMOs as unnatural. It has shown how the position of those opposed to GMOs because they are "unnatural" is rooted in a discourse of

natural purity that sees GMOs as a transgression of an inviolable boundary between the human and natural words and therefore inherently unjust or as dangerous pollutants likely to have unforeseeable negative consequences. This thesis has sought to critically explore some of the implications of this narrative of natural purity. In valorizing the natural as a pre-discursive essence of truth, natural purity discourses do little to deconstruct the way naturalizations have been used to legitimize sexist, racist, heterosexist and colonial systems of injustice and oppression. Rather, they revitalize the discursive purchase of appeals to nature as a justification for the way things are, and thus indirectly serve to reinforce existing power relations.

Moreover, these discourses do little to challenge the critical, though contingent, reality of GMOs' location within the wider framework of neoliberal social relations. To this end, they not only leave unchecked the political economic and class consequences of GMOs are they are currently constituted, but preclude any role for biotechnology in a socially just future. As we have seen, this political indeterminacy makes natural purity discourses just as much an effective tool for far-right anti-immigrant groups or a clever business strategy for niche-market producers as for progressive opponents of agricultural biotechnology. However, though in the minority, the success of resistance efforts to RR wheat in Canada and to terminator technology around the world show that deeper political economic critiques of GMOs as imbricated within processes of neoliberal enclosure and commodification can also be effective. This thesis has thus explored the cultural origins of natural purity narratives, how they operate in GMO discourse, why they have been so culturally resonant and thus effective, and why they nonetheless remain politically problematic. It has also shown that alternative strategies are both possible and necessary, but that they may yet benefit from strategic appropriations of common sense discourses whilst retaining a

firm grounding in structural critique. It is these good sense alternatives that hold the seeds to a socially just future world that may or may not contain GMOs.

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Conclusion: Biohegemony, interrupted

This thesis has sought to account for the limitedness of the GMO food economy, and in so doing locate our understanding of GMO agriculture within wider discussions of neoliberal natures and the variegated and contradictory process of nature's commodification. This study of GMO agriculture has evinced Castree's (2003) claim that neoliberalization takes on different forms depending on the sort of nature being commodified. However, while Castree seeks to emphasize how natures' materialities condition differentiated processes of commodification, neoliberalizations differ not only in relation to the biophysical characteristics of each nature being commodified but equally according to cultural, social and political economic factors. Without necessarily providing great depth of insight into any of these factors, this thesis has sought to demonstrate how they each contribute to the particular neoliberal nature that is GMO agriculture, though in ways that can be both intersecting and contradictory. This concluding section will begin by briefly recounting each chapter. Then it will consider the conceptual implications this research has provided. Finally it will discuss what the consequences of this analysis are for questions of political praxis.

In chapter one, I have argued that the juridico-politics of GMO agriculture, both at a global level and in the case of Australia, have emerged through a Polanyian-style double movement (Polanyi 1944). The 1980s and 1990s saw the creation of numerous laws and legal decisions, including patent laws, intellectual property rights, and minimalist biosafety regulations, a set of regimes that demonstrate the market expansion side of Polanyi's double movement. Conversely, the late 1990s and early 2000s saw the rise of a regulatory countermovement, as a myriad of forces, including the work of civil society organizations, shifting public opinion, and other biosafety scares culminated in a successful movement to re-embed global trade in GMOs in

a comprehensive biosafety accord in the Cartagena Protocol. This shift corresponded with Polanyi's "self-protection of society," as European governments responded to an abrupt change in public attitudes at the turn of the century around GMOs. These concerns centered on the potential ill effects of treating nature, in this case GMO crops and the environments with which they interface, as fictitious commodities, rather than part of a complex and delicate natural environment that requires safeguards from the expansive forces of the free market. This shift was multiscalar in nature, as numerous national and subnational jurisdictions set up moratoria, mandatory labelling policies and stricter regulatory regimes, including in Australia.

However, while a Polanyian framework is a useful starting point for understanding the success of this regulatory countermovement, I argue that the work of Antonio Gramsci enables us to understand why this movement ultimately failed to challenge the underlying neoliberal ideology of both the GMO food economy and the juridico-political regime through which it is regulated. Without relations of force strong enough to advance their critique of the underlying neoliberal relations of GMO agriculture, activists and Southern governments were unable to keep socio-economic considerations on the agenda at Cartagena, and the Protocol failed to challenge the neoliberal logic of the WTO's Sanitary and Phytosanitary (SPS) Agreement (aside from its important inclusion of the precautionary principle). More radical efforts at incorporating socioeconomic concerns into the Protocol were simply co-opted into an agreement that reflected European interests, allowing consideration of GMOs' health and environmental impacts but not its socioeconomic impacts. Thus with Gramsci and Polanyi, we can see not only how this regulatory countermovement was successful in slowing the development of the GMO food economy, against the grain of neoliberalism, but also how it ultimately failed to challenge the neoliberal basis of the GMO food economy in any meaningful way.

The juridico-politics of GMOs are also central to our understanding of their political economy. As chapter two has shown, GMO agriculture is impossible without the patent laws and intellectual property rights granted in the first phase of Polanyi's double movement as explored in the first chapter. Chapter two has explored how GMO agriculture fits within wider analyses of agricultural capitalism. Drawing on the work of Goodman *et al* (1987) and Pechlaner (2010, 2012) I have shown how GMOs overcome barriers to accumulation provided by the particular materiality of agriculture through the dual logics of appropriationism and expropriationism. As appropriationist technologies, GMOs fit within a long line of synthetic industrial inputs to agriculture that increase profits by reducing labour time or diminishing the non-identity of production time and labour time (Mann 1989). However, as lively commodities, their reproducibility creates new problems to capital, as value can only be realized for first generation seeds. Consequently, patent laws and technology use agreements that forbid seed-saving among farmers or require royalty payments, what Pechlaner (2012, 2010) calls "expropriationism," have been necessary for GMO agriculture to be profitable and thus functional for capital. The biophysicality of the crops has thus conditioned and been conditioned by the juridical regimes set up to regulate them. Building on the conceptual insights of Goodman *et al*, Pechlaner and Mann, I argue that the types of GMOs we have today, and that we are likely to have under capitalism have been widely conditioned by the biophysicality and thus potential profitability of crops. Innovations that provide productive advantages to farmers (however short term they are) can be, and have been, immensely successful. Conversely, innovations that target consumer preferences or farmers outside of the market economy without the means to pay will not be successful and have thus far failed in practice. In this way, the logic of capital limits the scope of GMO expansion as much as it enables it. However, integral to the argument is that this is not an

inherent condition of GMO agriculture: the types of GMOs we have (and do not have) are largely an effect of GMO agriculture's current imbrication with neoliberal capitalism. They have been developed because they bring the most profits to corporations, not because they are necessarily more beneficial to farmers or the public.

If, as chapter two has argued, GMOs targeted at consumers have largely failed, with publics unwilling to pay more for GMOs as conventional foods, we must ask why this has been the case. How have cultural and semiotic factors influenced (and been influenced by) the political economy of GMO agriculture? Chapter three has argued that central to the success of anti-GMO opposition has been the way GMOs have been discursively constructed as unnatural. Drawing on the work Hansen (2006), Haraway (1997), Sturgeon (2006) and Douglas (1966), it argues that a particular narrative of nature as pure has framed much of GMO opposition movements. This narrative relies on a widely resonant nature-culture dualism that dichotomizes nature and culture and places culture as essentially outside of and opposite to nature. Within this framing, as human-engineered living organisms, GMOs disrupt the nature-culture dualism and are seen as violations of the purity of nature. Thus many elements of the multifarious anti-GMO campaign have mobilized discourses of pollution, contamination, monstrousness and Frankenstein to construct GMOs as essentially unnatural, reflecting Douglas' (1966) understanding of "matter out of place" as cultural practices or states of being that are inappropriate or disruptive of boundaries. While this understanding of GMOs as "matter out of place" or taboo helps us understand why the framing of GMOs as unnatural has been so successful for the opposition, it is also problematic as it reproduces nature essentialist ideologies whilst evading deeper concerns for the socioeconomic impacts of GMOs under capitalism. Fortunately, though, a minority of anti-GMO activism has not only taken a more critical

approach to their resistance by challenging the pernicious socio-economic and anti-democratic effects of GMOs as they currently exist under neoliberalism without resorting to appeals to the purity of nature, but done so successfully. The successes of resistance efforts to GMO wheat in Canada and terminator technology around the world thus show the nascent potential of more critical oppositions to GMOs under the specific context of neoliberalism.

Conceptual implications

Karl Marx (2004) famously stated in the *Theses on Feuerbach* that "the philosophers have only interpreted the world, in various ways; the point is to change it" (22). I would argue that the point is both to interpret and to change the world. Therefore, any valuable contribution to critical research must be capable of opening new ground both conceptually and provide practical directions for those yearning to turn the critical insights reached into praxis. This thesis has used a multidimensional lens to understand how and why the GMO food economy of today is as limited as it is. But what critical insights does this leave us with, beyond the narrow confines of a conversation about the history of GMO agriculture? I would like to speak to two sets of implications that this research may provide. First, I will consider the conceptual implications for future research that this thesis has provided. Second, I will explore the implications for political activism and praxis.

Three implications for future research stand out. First, while the juridico-political, political economic and cultural-semiotic dimensions all remain important on their own, it is important to recognize that the reason why the GMO food economy has developed the way it has – as somewhat successful, but limited, contradictory and spatially variegated – can only be explained through not only an understanding of each of these three dimensions, but by observing

how they relate to each other. As Hansen (2006) has shown, nature holds tremendous normative purchase and political charge, though its politics are ultimately indeterminate. The role played by natural narratives within Western societies in influencing framings of particular nature-cultures and processes of natural neoliberalization must be accounted for in research on neoliberal natures. At the same time, nature's materiality holds tremendous importance. Though existing research in human geography remains cognizant of the need to account for the specific biophysicality of particular natures in understanding processes of neoliberalization (Castree 2003, Prudham 2005, Bakker 2003), future research would do well to consider not only how the materiality of natures impact processes of commodification, but how materialities interact with cultural-semiotic, juridico-political and political-economic processes as well (see also Prudham 2007). This thesis demonstrated these connections, whether through the impact GMOs' novelty had on juridico-political regimes (engendering concerns about unknowable risks and thus prompting a discourse of precaution); the effect of GMOs' liveliness on political economic relations (obligating firms to pursue expropriationist accumulation strategies in order to earn profits beyond the first generation) or the implications of GURTs' cultural-semiotic association with suicide, death and destruction.

Second, this research has implications for how we can understand the role of law under neoliberalism and with regard to the commodification of nature. In particular, by bringing together the insights of Gramsci and Polanyi, future research into nature's neoliberalization will have a better understanding of the complex political dynamics that simultaneously reinforce and challenge hegemony. Observing the role states play as both promoters of capitalist expansion and protectors from the adverse effects of capitalist expansion, as Polanyi would suggest, is vital to our understanding of the role of law in neoliberalizing processes more generally. Simultaneously,

recognizing the importance of relations of force in determining which discursive framing or set of material practices come to be widely accepted, in other words, what sort of regulations we get, is likewise crucial to our understanding of the implications of juridico-political regimes for neoliberalism.

Finally, this research has generally taken a wide lens approach to understanding the global GMO food economy. Some will see this as a shortcoming, as it precluded any comprehensive, in-depth analysis of any particular case. While various examples, including Australia, the United States, Canada, the UK, Europe and New Zealand (all Western countries) informed the analysis, the trends observed should not be assumed to be universally generalizable. Not all of the dynamics discussed here are present around the world. Some are only specific to particular locations. The GMO food economy and GMO food politics remain highly variegated according to space and scale. The strength of such a wide lens has been the ability to provide a broad scope of analysis that enables us to observe connections across space and between scales. However, future research ought to consider with deeper rigor how and whether the trends observed generally in this thesis are present at different scales and in different places.

Praxis implications

While conceptual implications are important to critical research, we must not eschew normative implications either. As Castree (2003) argues, we need to demonstrate not only what is wrong with the existing system but what sort of possible future worlds we might inhabit. I want to talk about what the political implications of each of the dynamics discussed in this thesis are and what they demonstrate in terms of the potential for moving to another world and away from neoliberalism. Bakker (2010) reminds us that if neoliberalism represents the expansion of

the market side of Polanyi's double movement, then we need to pursue self-protective efforts of "restraining technoscience, reinventing capitalism, and re-imagining our worldviews, scalar politics and scalar ontologies of socio-nature" (727). What lessons do the three chapters in this thesis provide us with going forward in terms of political praxis?

As with the negotiations of the Cartagena Protocol, the contradictory nature of capitalism renders it liable to serendipitous moments of flux and radical possibility. However, in order to seize these moments, relations of force congruent with radical transformation must already be in place. Already, with the Copenhagen Accord and the 2008 recession, we have seen that more often than not, these opportunities are squandered rather than seized, and the precarious puzzle is pieced together the same as it was before. In this era of ecological and social upheaval, it is how we make use of these fleeting moments of radical possibility that will determine what sort of future world we inhabit. Chapter one showed that the self-protection of society remains a realistic course of action for those set to lose out over processes of neoliberalization. However, the moment of radical possibility has to be seized; otherwise it will be coopted into the existing hegemonic formulation as occurred ultimately with Cartagena, against the wishes of activist campaigners and even some Southern governments.

Chapter two has taught us that GMO innovations have largely been conditioned by the web of social relations under which we are currently situated. Under capitalism, GMOs will only emerge if they are profitable, and their effects are likely to be more empowering to capital than to anyone else. The likelihood of innovations that demonstrably benefit publics is very low, and circumscribed by the logic of capital. A different system with a different logic would produce a different set of GMOs, designed to do different things than those that have thus far been successful. Activists would be wise to point to the potential for a different, more hopeful GMO

food economy under a different set of property relations. As Kloppenburg (2006) has argued with respect to hybrid seeds, the profit motive ensures that under capitalism, only seeds that benefit capital will be pursued, while under a democratic, publically-controlled seed breeding program (whether GMO or otherwise), other, more socially useful adaptations might be given priority.

Moreover, the culture of GMO resistance, rooted in a discourse of nature as pure, has been successful and has resonated, stirring effective resistance measures. This is part of what is behind the success of Cartagena and other restrictive juridico-political measures as well as the failure of consumer-oriented products as discussed in chapter two. Consequently, we have a lot to learn from why this resistance was so successful: why invoking nature in this way stirred publics in ways that other issues did not. At the same time, nature essentialism and appeals to the purity of nature are problematic and ought to be avoided. The challenge then must be to ask how the restive energies stirred by GMOs can be harnessed into a more critical opposition movement that sees connections between issues like GMOs and systems of oppression and violence such as neoliberalism, such as with the campaigns against Roundup Ready wheat or terminator technology. The success of anti-GMO politics have clearly shown us that it is possible to generate widespread opposition to processes rooted in dynamics of commodification, neocolonialism and the disenfranchisement of farmers around the world. However, such campaigns were in the minority, and the movement's general lack of recognition of the structural dynamics that make GMOs in their current configuration problematic were not often acknowledged. While the opposition to GMO agriculture has shown that people are willing to resist and struggle against processes of neoliberalization there has to be a clearer consciousness-

raising effort made on the part of activists to ensure that the framing that takes place is one that is truly commensurate with systemic change.

Otherwise, without getting to the root, future movements will only be co-opted in the same way as what happened with Clean and Green Tasmania or the Cartagena Protocol. Without having done the dirty work of intellectual and moral reform necessary to build a counterhegemonic movement (Gramsci 1992), without building up those relations of force, opposition movements will be forced to accept piecemeal changes within the overarching context of neoliberalism. Returning to Polanyi, how can we ensure that societal self-protection does not simply save the system from itself, but engenders a full-scale shift towards a better future? And how can we shift the narrative from one where technoscience and capitalism are intrinsically intertwined as chief perpetrators of social and ecological injustice to one where technoscience is liberated from the clench of market logic and thus rendered liberatory in itself? Building on the work of the anti-terminator campaign and the campaign against Roundup Ready wheat, we can see that the seeds for this transformation are already being sown.

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