

# Beyond techno-science: Transgenic maize in the fight over Mexico's future

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## Abstract

Disputes about genetically engineered crops are linked to wider debates about the globalization of agro-food systems and its consequences for food security, social equity, and rural life. Biotechnology expert discourse rarely addresses these wider issues. An exception is the assessment of transgenic maize by the NAFTA Commission on Environmental Cooperation (CEC), which recommended a moratorium on Mexican imports of US-grown maize. Controversy about “contamination” of indigenous maize varieties by US-grown transgenic corn has been intensified by rising Mexican discontent with the terms of regional economic integration. In this context, scientists and officials were pressured to consider not only risks to maize biodiversity but also the ecological, and cultural characteristics of maize in its Mexican settings and the implications of asymmetric power in North American agricultural trade. In contrast to most narrowly-framed biotechnology risk assessments, the review took account of interventions by rural social movements. While the new moratorium was not adopted by the state, continuing conflicts over GMOs in Mexico have blocked introduction of transgenic maize and have enlarged the political space for debate over Mexico's development direction. These conflicts reflect the differing interests of various state actors and economic sectors with regard to trade liberalization. They also reveal contrasting food-system paradigms: further agricultural modernization, export competition, and food-import dependence versus an alternative vision of revitalized rural life, farmers' rights, and national food sovereignty.

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## 1. Introduction

International processes to establish rules for trade in the products of crop genetic engineering are often polarized and intractable. Most public and expert discourse about genetically modified organisms (GMOs) concerns their possible risks to crop genetic diversity or to the health of humans and other species. However, much more is at issue. Disputes about agricultural biotechnology are linked to wider conflicts about the cultural significance of food and farming, the consequences of trade liberalization and the global restructuring of food systems, and the role of agriculture in development.

International accords – mainly the Cartagena Protocol on Biosafety – and national policies in some regions limit transnational trade in GMOs and their products. Such restrictions pose potential obstacles to the expansion of markets for agricultural inputs and products sold by the transnational firms that dominate trade in seeds, agrochemicals and food commodities (Friedmann, 2005; McMichael, 2005; Murphy, 2006). These firms are both the main agents of agro-food globalization and the primary users, owners, and beneficiaries of genetic engineering technology and patented crop varieties. Thus, the GMO issue is linked to the question of whether agriculture worldwide will be transformed into a fully capitalist and globally integrated enterprise. The desirability of this modernizing trajectory has largely been taken for granted by governments

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and international development agencies. Critics of “industrial” farming in the global North have decried the ecological and social detriments of agribusiness concentration and mechanized monocultures using massive inputs of agrochemicals and energy. Now, transnational networks of small-scale farmers and their supporters are challenging that trajectory in the global South.

This article offers the example of Mexico, where strenuous public opposition to genetically engineered maize has arisen since the 1994 inception of the North American Free Trade Agreement (NAFTA). A moratorium on the planting of transgenic maize in Mexico – which remained effectively in place as of late 2006 – first came about as a result of unease among crop scientists about the unknown effects of GMOs on local farmers’ varieties, which are repositories of valuable crop genetic resources.<sup>1</sup> But Mexican opposition to GMOs is also linked to discontent with the effects of food-trade liberalization on tenuous rural livelihoods and to calls for greater economic autonomy from the United States. GMO disputes provide a platform from which rural-based social movements are advancing calls for more ecologically informed agriculture, food sovereignty, and a distinctive Mexican path to development centered on “revaluation of the countryside” (*revalorización del campo*).

This controversy cannot be understood apart from the political economy of maize, including US–Mexico trade relations and contrasts between the two countries’ maize-centered food and farming systems. Also important is the political ecology of maize in Mexican eco-social systems: its agronomic and nutritive qualities and the mechanisms of reproduction that make maize populations especially diverse, dynamic, and susceptible to the unintended incorporation of genetically altered traits (Cleveland et al., 2005). The political ecology of maize also concerns where, how, and by whom maize is cultivated and consumed, and the meanings of maize: its importance in Mexican indigenous, peasant (*campesino*), and national identity. Nature’s agency is manifest in these disputes in the form of maize as a very particular organism that constantly co-evolves with the knowledge and practices of peasant agriculturalists. This nature of maize has proved inseparable from maize economics and the politics of trade disputes. This linkage supports Castree’s (2002) contention that analytical approaches emphasizing political economy are not antithetical to appreciation of the importance of non-human actants (also see Whatmore, 2002).

Official assessments the risks and benefits of GMOs typically focus on their biological and agronomic characteristics, even when, as in the case of the US National Research Council study, the relevance of “societal values” to policy decisions about GMOs is acknowledged (EPA, 1998; NRC,

2002; The Royal Society, 2002; FAO, 2004). Some studies also consider interactions of transgenic crops with other species in particular agro-ecological settings (DEFRA, 2005). However, the discursive framework of most biotechnology expert discourse remains narrowly techno-scientific, limited by design to data considered amenable to the practice of “sound science”. In Mexico, however, agencies seeking to reassure Mexican legislators, rural communities, and the public have been forced to expand the scope of GMOs evaluation beyond these quantitative, putatively objective criteria. The review of the effects of transgenic maize in Mexico carried out in 2003–2005 by the NAFTA Commission on Environmental Cooperation (CEC) is exceptional with regard to the range of factors considered and the resulting recommendations, which include a moratorium on the importing by Mexico of unmilled US maize.

The CEC study, *Maize and Biodiversity: The Effects of Transgenic Maize in Mexico*, was initiated in response to formal requests in 2002 by Mexican civil-society organizations in the wake of the apparent detection of GMO-“contaminated” maize in Southern Mexico.<sup>2</sup> The discursive scope of the CEC review was relatively broad from the outset, in part because some concerns of the indigenous organizations that demanded the review were shared by Mexican scientists and other experts on biodiversity and transgene flow who were commissioned to advise the study.<sup>3</sup> The review took place at a time of rising social unrest in Mexico’s poorer Southern states and in the context of intensifying public debate about the effects NAFTA. One such effect has been increased pressure on rural livelihoods caused by rising imports of low-priced corn from the US. In this context, the CEC study was designed to consider not only “the potential risks and benefits of transgenic maize” with regard to “genetic diversity and natural ecosystem effects” and “health effects” but also the “social and cultural effects” and effects on “livelihoods and daily life” of genetically engineered maize.

The following sections describe NAFTA’s effects on maize trade, the importance of maize in Mexico, the promotion of transgenic crop exports by the US government, and the unusual process and results of the CEC study. I then discuss how GMO maize disputes reveal divergent interests and development visions of Mexican state agencies, economic sectors, and social movements in the post-NAFTA period. These divergences correspond to those identified by scholars of biodiversity politics in Mexico (Brand and Görg, 2003). However, because of the unique importance of agriculture as a nexus of nature and culture, recent conflicts over biodiversity and biotechnology in Mexico have proved harder to coopt and contain than those scholars predicted. I conclude

<sup>1</sup> ‘Transgenic’ refers to organisms of which the genomes have been intentionally altered by insertion of genetic material from a different organism, frequently one of a different species. Most ‘genetically modified organisms’ are transgenics. I use ‘transgenic’ and the more popular term ‘GMO’ interchangeably here.

<sup>2</sup> I have placed “contamination” in inverted commas because the unquestioned use of this term misleadingly connotes the idea that maize untouched by transgenes is unchanging and untainted by human intervention.

<sup>3</sup> I was one of 27 peer reviewers whose work supplemented that of 19 scientific advisors and 19 chapter authors, themselves all social or natural scientists.

with a discussion of the discourse of food sovereignty in these and other disputes about biotechnology and the future of agriculture in development.

## 2. NAFTA and the cultural economy of maize in Mexico

The North American Free Trade Agreement (NAFTA) between Mexico, Canada, and the United States took effect on 1 January 1994.<sup>4</sup> NAFTA required the phasing out over 15 years of import tariffs and quotas that have partially shielded Mexican producers from competition from cheaper US food and feed grain. Tariffs on maize and beans, the country's most important staples, were scheduled for elimination by 2008. NAFTA represented a continuation of neoliberal policies implemented since the mid-1980s. Its purported rationale for Mexico was to foster economic development based on increased manufactured exports and openness to foreign capital. Federal programs in support of Mexican food prices and rural producers had already been cut under policies to make the country "NAFTA ready".

At the start of NAFTA, US corn sold in Mexico for about half the price of the Mexican product, backed by higher US yields per hectare and subsidies about three times greater than those allowed for Mexican producers (Nadal and Wise, 2004).<sup>5</sup> During the following decade, US corn was sold abroad at an average of 12.4% less than the full cost of producing, handling, and transporting that grain, a huge competitive advantage for US exporters (Murphy et al., 2005). US maize exports to Mexico averaged of five million tons between 1996 and 2004, a 323-percent increase from the pre-NAFTA period, representing more than 20% of Mexican maize consumption (Nadal and Wise, 2004; Zahniser and Coyle, 2004). By 2000, Mexico was the second most important export market for US maize after Japan. Increased sales to Mexico helped to balance losses of US export markets in countries unwilling to accept GMOs, such as the EU and South Korea. Much of the US corn imported by Mexico is used as feed grain for hogs and poultry or for corn-based sweetener and other inputs into processed foods.

The increased flow of maize across the border has been more significant for Mexico than for the United States. Maize covers half of Mexico's cropland, supports about three million farm households, and accounts for two-thirds of total calorie intake. Two-thirds of Mexican maize producers cultivate five hectares or less, most without irrigation. About 80% of maize acreage is planted in native varieties: formal scientific breeding has yet to develop varieties that produce higher yields reliably in these varied, multi-crop agro-ecosystems. While much of this production supports the subsistence of extended families, sales of maize and other

crops have long been important sources of cash income for smallholders (Brush, 2004; Lazos Chavero, 2004; King, 2006). By 2002, prices paid to Mexican maize producers had plunged to less than half their pre-NAFTA levels (Nadal and Wise, 2004). The combination of US food imports and reduced farm supports and prices in Mexico are undoubtedly speeding out-migration to cities and to the north, accelerating the depopulation of rural areas. (Jordan and Sullivan, 2003; Taylor and Dyer, 2003; Fitting, 2006.)

To the surprise of many, most small-scale Mexican farmers refused to abandon maize. Maize production and land area planted in maize remained steady even while reduced prices for maize, beans, and livestock and higher fertilizer and transport costs tightened the cost-price squeeze on *campesinos*. It is not clear how long an aging farm population can maintain current levels of maize production so long as market prices in Mexico, as in the United States, remain below the cost of production.

Many Mexican farmers are well aware that they are subsidizing their own corn production with the proceeds of other crops, or more often, with earnings from family off-farm labor. In talks with campesinos in Oaxaca in 1994, 2003, and 2004, I heard many reasons for what some analysts would consider "economically irrational" behavior. Farmers described a sense of greater security from keeping their own lands, tools, and animals in production. They expressed hopes that at least some of their children would continue farming and maintain local *usos y costumbres*, traditions of reciprocity and local governance that date to pre-conquest times and still guide decisions about land, forest, and water use, labor exchanges, and other questions in many indigenous areas.

In Mexico's highlands and other places where mixed-crop *milpa* farming continues, farmers take great pride in their locally adapted and impressively diverse varieties of maize, beans, squash, other vegetables, and medicinal and culinary herbs. Some of their maize and bean varieties are modern hybrids or contain genes from modern strains. Crops such as fava beans, peas, sorghum, and wheat are of foreign origin, but farmers' varieties of these crops, too, have been improved across generations. Maize varieties, especially, have local names. They are periodically renewed by experimentation with new seeds, usually obtained from other farmers (Perales et al., 2003; Bellon and Berthaud, 2004; Tuxill, 2004). To reinvigorate "tired" strains, some campesinos encourage introgression of genetic material from wild subspecies of teosinte, the ancestor plant known as the "mother of maize". Many rural households maintain specific maize types for aesthetic or ceremonial reasons. Men and women alike expressed disdain for the cooking qualities and "chemical" taste, said to be imparted by preservatives, of tortillas made from imported US grain. The meanings and material significance of maize culture have been amply documented by geographers and ethnographers (Sauer, 1971; González, 2001). The insistence by many Mexican campesinos upon continuing maize cultivation even at their own economic cost reflects the enduring cultural significance of the crop.

<sup>4</sup> NAFTA's start was the reason the EZLN (Zapatista) movement chose the same date to launch their autonomy campaign in the southern Mexican state of Chiapas.

<sup>5</sup> Most US farmers benefit little from the present form of US farm subsidies, which barely make up for the gap between their production costs and the low prices paid by agribusiness oligopolies.

### 3. US government promotion of crop genetic engineering

The commercial planting of transgenic crops began in the United States in 1995. According to the US Department of Agriculture, 52% of US corn planted in 2005 was genetically engineered (USDA, 2005). About two-thirds of that GMO corn was *Bt* maize containing traits derived from the *Bacillus thuringiensis* bacterium that cause the altered plants to produce insecticides. These *Bt* toxins are lethal to many insects of the order Lepidoptera, including larvae that can damage corn, cotton, and other crops. US agro-industrial producers have opted not to segregate these and most other transgenic grains from conventionally-grown grains during shipment, milling, processing, or packaging. Thus, all exports of US maize grain, as well as US soy, rapeseed (canola) and many oils and processed foods are likely to contain or to be derived partially from transgenic crops.

Having placed its bets on transgenic technologies, the US government has worked zealously to convince publics and prime ministers that genetically engineered crops and products are safe, superior, and the solution to virtually all agricultural challenges (McAfee, 2003a). Since 1990, US officials have tried to block and weaken the Cartagena Protocol on Biosafety, the multilateral accord that provides a basis in international law for countries to decline to accept transgenic imports. The US has argued successfully that because it has not ratified the Cartagena Protocol, that Protocol's protections may not be considered by the World Trade Organization in trade disputes concerning transgenic crops and products.

US officials have stressed the promise of future transgenic crops to solve ecological problems of agriculture and alleviate hunger and rural poverty (FAO, 2002). Ignoring the mediocre performance of transgenics in the United States, US President George W. Bush charged African governments and the EU with contributing to hunger in Africa by failing to accept US "high-yield bio-crops" (Fleisher, 2003). US agencies sponsor capacity-building courses, workshops and international expositions and field trips intended to persuade Southern-country scientists, lawyers, and officials to support genetic engineering and enforce intellectual property rights to crop varieties and transgenic technologies.

This avid US government promotion of transgenic crops stems in part from the domestic trade politics and agribusiness influence. US food imports exceed exports in some years and farm exports do little to reduce swelling trade deficits: the proportion of farm products as a share of US exports dropped from 14% to less than 7% over the past two decades (Ray, 2005). Nevertheless, the illusion that US farm exports are vital to the economy and the salvation of hard-pressed farmers remains widespread, encouraged by the global grain-trading firms that benefit most from US and EU farm and export subsidies.

Meanwhile, the means to commercialize a transgenic crop are largely in the hands of transnational corporations. About a half-dozen TNCs dominate markets in farm inputs, including transgenic and conventional hybrid seeds

and the agrochemical packages that those seeds have been bred or engineered to require (Boyd, 2003; McAfee, 2003c; ETC Group, 2005a). Deregulation of GMOs, along with worldwide enforcement of intellectual property rights to genes, genetic engineering technologies, patented organisms, and agrochemicals, would facilitate the expansion of their international markets in farm inputs and products. Further liberalization of food trade would likewise favor these firms and the transnational oligopolies that dominate grain and food trading, transport, processing, and – increasingly – retailing (Heffernan and Hendrickson, 2005).

The US Departments of Agriculture and Commerce have long pushed for food-trade liberalization, contending that countries in the global South will benefit by importing more of their food from the purportedly more efficient US agricultural system. Since the late 1990s, claims about the superiority of transgenics have been added to this argument. But in Mexico and other parts of the global South, criticisms of GMOs have contributed to – or serve as proxies for – counter-arguments in favor of protection of domestic agriculture and "food sovereignty".

### 4. The CEC study: Origins and findings

By the mid-1990s, international maize specialists and Mexican agricultural scientists anticipated that imported US maize might be planted in Mexico. Because each maize plant cross-pollinates with other maize plants, because maize pollen carry transgenes over relatively long distances, they knew that transgenic maize was likely to cross-pollinate with local varieties, transferring genetically engineered traits to those varieties. To prevent this, at least until its consequences were better understood, in 1998 Mexican authorities placed a de facto moratorium on planting of transgenic maize.

The consequences of gene flow from GMO maize are still largely unknown (Ohio State University, 2002; Ellstrand, 2003; McAfee, 2003b; Snow et al., 2005). Some plant geneticists worry that transgene constructs transferred to local maize varieties or to teosinte might confer survival advantages to the resulting hybrids, enabling them to out-compete other maize strains and thus accelerate the loss of useful traits. Another concern among agricultural scientists has been that pollen and root exudates from maize containing Bt or other toxins might harm not only the lepidopteran pests that they are meant to kill, but also butterflies, agronomically beneficial insects, and soil microbes important to soil fertility and plant health.<sup>6</sup>

In November 2001, a widely publicized report in *Nature* described the presence in farmers' maize fields in Oaxaca of genetic material thought to have originated from US *Bt*

<sup>6</sup> Some of the imported US maize has also been genetically engineered to grow in the presence of glyphosate herbicide. Because GMO varieties are not commercially planted in Mexico and RoundUp and other glyphosate herbicides are not yet in use on maize there, the issue of glyphosate-resistance "superweeds" such as those that have appeared in the UN, Canada, and Britain has not yet arisen in Mexico.

maize (Quist and Chapela, 2001). Controversy over the putative benefits and hazards of genetically engineered crops intensified in Mexico and internationally. The risk of negative effects on maize biodiversity was considered serious enough that the Mexico-based International Maize and Wheat Improvement Center (CIMMYT), temporarily stopped adding samples to its maize gene bank to prevent the admixture of seeds containing transgenes. At the April 2002 Sixth Conference of the Parties to the Convention on Biological Diversity, where GMO regulation was already a topic of dispute, scientists from Mexico's National Institute of Ecology (INE) presented their own evidence that transgenic material had found its way into maize in at least one other Mexican state.<sup>7</sup>

Mexican NGOs and Oaxacan community leaders demanded action by the tri-national Commission on Environmental Cooperation (CEC), an advisory body authorized to investigate cross-border environmental problems. Established under a side agreement to the NAFTA treaty, the CEC is mandated to make recommendations on "important environmental matters" to environmental ministers of the NAFTA countries. The petitioners to the CEC included "21 indigenous communities of Oaxaca and three Mexican environmental groups – Greenpeace México, the Mexican Center for Environmental Law, and the Union of Mexican Environmental Groups – eventually supported by more than 90 letters from organizations and institutions throughout the three NAFTA countries." (CEC, 2004, p. 1).

In response, the CEC initiated a study of the likely effects of transgenic maize in Mexico on "the genetic diversity of landraces of maize and wild relatives of maize; agricultural and natural biodiversity, human health, and social values and cultural identity" (p. 8). This process included commissioned background papers, an extensively peer-reviewed draft report drawing on "the best scientific knowledge available", a lively public hearing, and a controversial summary report released in August, 2004. To the consternation of US officials, this report recommends closing Mexico's border to imports of whole grain maize from the United States; only milled corn, it says, should be allowed across the border. The report summary describes this advice as "the unanimous conclusions of our international, independent, and multi-stakeholder advisory group" (p. 4).

Many assessments of the likely risks and benefits of GMOs are designed to exclude factors other than the findings of formal science (OSTP, 1986; NRC, 2002; EFSA, 2005). In contrast, although the majority of its authors and reviewers were natural scientists, the CEC report recognized from the outset that economic, social, and cultural factors are also germane to decisions about GMOs:

The issue of transgenic maize impact on landraces has become entwined with historical issues and grievances affecting rural Mexicans that are not directly associated with either improved maize or traditional landraces. Similarly, those who advocate greater use of genetic engineering and unrestricted trade may have vested interests in aspects of scientific and technical development, trade, political influence, or industrial agriculture in Canada, Mexico and the United States (CEC, 2004, p. 14).

I discuss below how such "vested interests" of industrial sectors, classes, and divisions of government differ in regard to biotechnology regulation, trade, and models of agriculture and development.

Among the CEC report's main findings are that transgenes have entered some landraces in Mexico and are probably impossible to remove. It notes that some transgenic grain acquired from government stores is likely to have been planted even though it was intended for animal feed. The report opines that while transgenes might persist in local varieties, they would be "unlikely to displace more than a tiny fraction of the native gene pool" (p. 17). It finds no evidence that the effects of transgenic varieties on crop biodiversity will be greater than the effects of gene flow from hybrids produced by conventional plant breeding.

The report recognizes that maize genetic diversity is maintained primarily by farming communities in the form of landraces that are in constant flux under the influence of human intention as well as natural selection. It notes that important biodiversity in Mexico includes not only the genus *Zea* (maize and teosinte) but also the assemblages of diverse plants animals in the *milpa* and adjacent natural areas. The effects of transgenes on these organisms and ecosystems, the report observes, should not be assumed to be more harmful or beneficial simply because they result from genetic engineering (p. 19). However, it adds, such effects are unknown and have not been studied in Mexican ecosystems (p. 23). The CEC report notes that, while evidence has not been found that transgenics harm human health, all novel products should be evaluated and new forms of maize need special scrutiny because of the importance of maize in Mexican diets. The authors find that high levels of public concern about possible toxic effects of transgenes also warrant special attention and possibly, new research. They warn that maize that is genetically engineered to produce industrial compounds and pharmaceuticals will pose new and unique risks (p. 20).

### 5. Breaching the boundaries of techno-science: The CEC framework and process

The CEC assessment is unusual in the extent to which factors other than the findings of formal science inform its recommendations and in the process by which its findings were collected. The report notes that "economic pressures associated with modern agriculture and the current

<sup>7</sup> I was present at this presentation by INE scientists Eziqiel Ezcurra and Jorge Soberón.

asymmetries and economics of US–Mexican maize trade could cause some small-scale farmers to abandon their use of indigenous landraces.” (CEC, 2004, p. 17). Separate commissioned chapters, not released to the public but provided to peer reviewers, describe the multi-tiered structure of Mexico’s maize system (Brush, 2004). This complex comprises not only campesinos but also importers, brokers, and transporters, beverage makers, manufacturers of feeds for poultry and hogs, large and small milling enterprises. Just two large corporations dominate the growing Mexican market for dry maize flour and tortillas that substitute for traditional tortillas hand-made from wet ground maize (Zahniser and Coyle, 2004).

Sections of the published CEC study that contrast with most previous scientific evaluations of GMOs concern the place of maize in Mexican culture.

Maize has significant cultural, symbolic, and spiritual values for most Mexicans. This is not the case in Canada and the United States... Risk assessment of transgenic maize in Mexico is inextricably linked to the central role of maize in Mexico’s history and culture, including the beliefs and value systems of indigenous people (CEC, 2004, p 23).

The report observes that many Mexican campesinos regard the presence of transgenes in native varieties as “a direct threat to political autonomy, cultural identity, personal safety and biodiversity” (CEC, 2004).

Such a conclusion was hard to avoid in the wake of the dramatic climax of the data-gathering process. To supplement its community surveys, the CEC Advisory Panel for the report held a public symposium on the draft report in Oaxaca in March 2004. The plan to admit no more than 200 persons was abandoned when several hundred people – the CEC lost count at 383 – demanded entry: students and young activists, private sector, media, and NGO spokespeople, professors, lawyers, public officials, and scores of farmers and community representatives.

The symposium continued into the evening as campesino participants confronted the Commission with hard questions and impassioned testimony about the values and virtues of native maize. The campesinos remained polite but did not hide their anger at being drawn without their consent into a possibly dangerous experiment. Speakers described the sudden appearance of transgenic maize in their markets and fields as a violation of their dignity, a denigration of their knowledge and skills, and a threat to the integrity of their food supplies and farming methods. An older campesino captured the spirit of the crowd when he demanded, “Who are you to tell me about maize? My ancestors have known maize for thousands of years. I myself have been growing caring for its seed for more than 50 years. Maize is my life; maize is our life”.

Were these farmers influenced by exaggerated predictions of genetic disasters voiced by some anti-GMO activists? Undoubtedly some were, although many had also been exposed to opposite, reassuring messages from gov-

ernment officials and scientists. In any case, the campesinos’ testimony surprised at least some of the advisory group members. It was apparent from conversations in the corridors that some council members and advisors had not previously grasped the economic importance of locally adapted maize varieties nor the centrality of maize culture to the identities of rural Mexicans. The chairperson of the panel charged with overseeing the report wrote:

What we learned from our participation is that the conservation of biodiversity cannot be separated from the protection of cultural diversity [and that] the emphasis on ‘scientific method’ and ‘science based’ conclusions can work to exclude indigenous peoples... It appears that the corporations share most of the benefits and the producers and the environment share most of the risks. It can be argued that the identification of benefits and risks is a value judgment, thus great care should be taken about how these benefits and risks are described (Tingley, 2004).

During the eight months between the Oaxaca symposium and the release of the summary report, it was rumored – and I was told by a member of the CEC Advisory Panel – that US members of the CEC Council were blocking the full report’s publication. In a letter to Mexican legislators obtained by Greenpeace México, the transnational biotechnology consortium AgroBio and nine Mexican trade associations representing food processing and retailing firms denounced the report on the grounds that it had exceeded the CEC mandate, contained inconsistencies, and was incompatible with Mexico’s “national development” and international treaty obligations (Greenpeace, 2004).<sup>8</sup> When finally released, the CEC’s summary report contained a disclaimer:

Publication of this report does not constitute endorsement of its contents by the Council of the CEC or the governments of Canada, Mexico or the United States. The Parties’ comments are appended to the report. These comments include observations that some of the recommendations contained therein do not reflect the report’s scientific findings, but rather reflect cultural and social perspectives of the Advisory Group and other entities. (CEC p. 2)

A month after the summary was released, the US Environmental Protection Agency and the Office of the US Trade Representative condemned the report in a joint press release.

<sup>8</sup> According to Greenpeace México, the signatories to the letter were AgroBio, la Confederación de Cámaras Industriales (Concamin), Consejo Nacional Agropecuario, Consejo Nacional para el Abasto de Granos y Oleaginosas (Conago), Consejo Mexicano de la Industria de Productos de Consumo A.C. (Conmexico), Cámara Nacional del Maíz Industrializado (Canami), AgroBIO México, A.C., Asociación de Proveedores de Productos Agropecuarios de México, A.C. (Appamex) y la Asociación Nacional de Tiendas de Autoservicio y Departamentales (Antad).

This report is fundamentally flawed and unscientific; *key recommendations are not based on sound science*, and are contradicted by the report's own scientific findings. The authors acknowledge that no economic analysis of their recommendations was conducted, and that *many of these recommendations are based solely on socio-cultural considerations* (US Department of State, 2004, emphasis added).

## 6. Enforcing the boundaries of technoscience

This attempt to distance the “scientific” from the “cultural and social” echoes the discursive maneuvers by US negotiators in other international regulatory processes. US officials have insisted on the prominent use of term “sound science” in negotiations of the WTO agreements on Sanitary and Phytosanitary Standards and Technical Barriers to Trade and the Codex Alimentarius guidelines for international food safety regulations. At the Biosafety Protocol negotiations I observed in 2000, US delegates objected without success to Article 26 of the accord. Article 26 permits parties to take account of “socio-economic considerations arising from the impact of living modified organisms on the conservation and sustainable use of biological diversity, especially with regard to the value of biological diversity to indigenous and local communities”. (CBD, 2002). The US delegation also tried but failed to block inclusion of the term “precautionary principle” on grounds that it is inconsistent with “sound science”.

I have argued elsewhere that the US interpretation of “sound science” with regard to assessment of GMO risks relies on idealized versions of molecular biology and on reductionist representations of the interactions of genetic information, organisms, and their environments (McAfee, 2003b). US guidelines for the safe use of transgenic crops – model regulations that US agencies export through their biotechnology capacity-building activities – are based on the unwarranted assumption that the effects of transgenes can be adequately observed, confined, and controlled outside the laboratory and on the disingenuous notion that corporations can safely self-monitor the effects of the GMOs they sell (Jaffe, 2003). If such US “sound science” guidelines are inadequate for managing GMOs in modern, monocrop farming, they are even more deficient in settings where multiple and genetically diverse crops and varieties are grown together and where grain for planting is not sharply distinguished from grain for eating, as in Mexico and much of the global South (McAfee, 2004).

This politically convenient approach to GMO safety is built upon the conceptual bifurcation of “nature” and “society”. It relies on the ecologically naïve notion that the risks and benefits of transgenic crops can be assessed without consideration of the variability and unpredictability of the natural environments in which they are cultivated. It depends on the presumption that biotechnology is “only” technology, ignoring the ways that contemporary sciences, and environmental science in particular, are

shaped by social institutions, economic constraints and incentives, and varying human values and agendas (Forst, 2002; Yearly, 2005; Jasanoff, 2006).

In contrast, the CEC report foregrounds the culture-nature nexus. Indeed, it would have been impossible to address the study's self-defined problem – will transgene flow harm crop genetic diversity *and* human well-being in Mexico? – without considering the *in situ* characteristics of maize in its primary center of genetic diversity and in diverse eco-social systems. By the CEC group's own standards of scientific inquiry, it was necessary to address issues of how, by whom, and under what social and economic conditions maize is actually cultivated and consumed. Insofar as the CEC report applies scientific modes of inquiry to factors that other approaches dismiss as “non-scientific”, it may provide a useful precedent for GMO risk-benefit analyses elsewhere.

Since the CEC review, disputes in Mexico about transgenic crops have continued. In their analysis of conflicts about non-agricultural genetic resources in Mexico Brand and Görg (2003) found that Mexican biodiversity politics have created “contradictory relationship between different regulatory levels on different spatial scales (international, regional, local)” (pp. 222–223). Mexican delegates to international negotiations, agricultural and food industry entrepreneurs, regulatory and scientific agencies, farmers, and rural communities espouse a spectrum of positions on transgenic maize. This range of stances corresponds roughly to the array of “neoliberal, technocratic national, and left-nationalist” positions described by Brand and Görg.

The spectrum of positions noted by Brand and Görg can indeed be observed in Mexico's maize disputes. However, the controversy has not yielded the compromises and stabilization that Brand and Görg predicted would enable the “appropriation of nature [by] the life science industries”. Instead, it has added to the widening polarization in Mexico over the country's economic future and the role of its southern states and agrarian communities in that future. Moreover, Brand and Görg's conclusion that Mexico's restructuring allows “little room for optimism regarding the opportunity for local actors to articulate their interests” (p. 232) appears premature. As in other countries, conflicts over GMO crops are providing a platform from which peasant organizations and other GMO opponents have cast their arguments in terms of calls for “food sovereignty”. Proponents of food sovereignty and advocates of food-trade liberalization adhere to contrary premises about the benefits of agricultural modernization, economic globalization, and related cultural and ecological change. The positions of the protagonists in Mexico's GMO disputes reflect these contrasting paradigms.

## 7. Mexico's biosafety law and continuing conflicts over GMOs

Continuing GMO disputes in Mexico illustrate the depth of dissent over the values of rural life and the role

of agriculture in development. While some scientists based in Mexico's Environment ministry actively oppose legalization of transgenic maize, other agencies of the Mexican federal government, notably the Ministry of Agriculture (SAGARPA), have pressed for deregulation of GMOs as part of their effort to promote liberalization of agricultural trade. Two years after the passage in 2004 of a controversial law legalizing the planting of GMO maize in Mexico, these conflicts were still blocking the law's implementation.

In 2002, scientists from INE reported evidence of transgene constructs in indigenous maize fields. INE researchers supported the CEC investigation. They also contributed to a 2003–2004 study by Mexican and US researchers that failed to detect transgenes in 18 locations in Oaxaca's Sierra Juarez, where the presence of GMO fragments in farmers' maize varieties had previously been reported (Ortiz García et al., 2005). Continuing disagreements among academics reflect incomplete scientific data and differences over how to interpret the evidence found thus far. Also at issue is whether "scientific" studies should take account of increased risks to maize biodiversity caused by economic pressures on traditional agriculturalists (Soleri et al., 2006; Raven, 2005; Cleveland et al., 2005; Ortiz García et al., 2006).

Six weeks after the CEC symposium, the lower house of Mexico's national legislature approved a new Biosafety Law. After an acrimonious debate, a solid majority Mexico's Senate voted for the *Ley de Bioseguridad de Organismos Genéticamente Modificados*, meant to take effect in May 2005. In principle, the law permits commercial planting of transgenic maize and other crops but makes importing, testing, and planting of transgenic maize subject to permissions on a case-by-case basis and forbids GMO planting inside to-be-undefined "restricted zones" of crop genetic diversity. It creates a national Commission on Biosafety, calls for new biosafety standards and food labeling rules, and mandates funds for collecting data on indigenous genetic resources, monitoring GMOs, and implementing the international Biosafety Protocol. (Government of Mexico, 2005). It enumerates fines for violation of the law but without clear enforcement mechanisms and provides for involvement of at least five state agencies in biotechnology regulation. In its content and complexity, the Biosafety law echoes a continuing ambivalence about GMOs.

The *Ley de Bioseguridad* was endorsed by leaders of the Mexican Academy of Sciences, who stressed the urgency of regulating GMOs now that their presence was a *fait accompli*. However, 60 Mexican scientists signed a strongly-worded petition calling for continuation of the transgenic maize moratorium and for government support of technologies more suitable to national food self-reliance and biological and cultural diversity (La Jornada, 2005; Bejarano, 2005). As of the end of 2006, notwithstanding the development of a "Maize Master Plan" and despite public complaints from transnational biotechnology firms and Mexican agro-industrialists, even experimental planting of transgenic maize remained illegal in Mexico (Suárez, 2006; Food Chemical News, 2006).

Meanwhile, Mexican federal agencies have worked to weaken the regulation of international trade in GMOs. During 2003, the three NAFTA governments tried to preempt the Cartagena Protocol on Biosafety by forging a separate accord. That arrangement, promoted by the industry lobbying body, the International Grain Trade Coalition, provides for weaker labeling requirements than those endorsed by the majority of Protocol countries (IGTC, 2004). At the 2004 and 2006 Meetings of the Parties to the Protocol, Mexican delegates pressed for weaker labeling rules and raised last-minute objections to negotiated text. The agreement was reworded to exempt shipments between parties and non-parties from Protocol labeling rules. Since the US and Canada are non-parties, this change enables Mexico to apply weaker labeling rules with its NAFTA partners (ITCSD, 2006; IISD, 2006).

The ploys took place against a backdrop of protests by Mexican environmental and farmers' organizations (Greenpeace México, 2005). A statement by 17 Mexican non-government organizations denounced Mexico's biosafety law – dubbed the "Monsanto law" by these critics – for neglecting the principles of scientific precaution and prior informed consent, for failing to consult those likely to be affected by GMOs, for failing to provide to make violators of the law liable, and for failing to take a holistic approach to biosafety. Such an approach, the NGOs said, requires safeguarding farmers' rights to continuing producing and exchanging seeds freely and without fear of transgenic "contamination", a condition essential to "national food sovereignty" (CIEPAC, 2005).

As Brand and Görg (2003) demonstrated with regard to Mexican conflicts over bioprospecting and patenting of genetic resources, the contrasting positions taken by actors in these conflicts are linked to their differing roles in promoting or opposing Mexico's transition to a post-fordist "national competition state". This transition is based on neo-liberal program of privatization, openness to foreign capital, and dissolution of the corporatist structures which had included and coopted rural *ejido* communities and indigenous communes areas. Brand and Görg analyze conflicts over naturally occurring genetic resources such as those found in medicinal plants and other organisms of interest to pharmaceutical firms. They describe how Mexico's international negotiators and representatives of its economic, agricultural, and environmental ministries have aimed to facilitate "the valorization of nature for capitalism" by endorsing private intellectual property rights to this genetic information. But because many indigenous Mexicans have knowledge of the useful properties of natural genetic resources, they say, this "valorization of nature for capitalism" has simultaneously fostered both increased appreciation of "'marginalized' rural areas and especially indigenous peoples" (p. 222) by the would-be owners of genetic resources, and opposition by indigenous organizations to "biopiracy".

In Mexico's GMO maize conflicts, as in the biopolitics analyzed by Brand and Görg, Mexican officials responsible for trade and agricultural policy have worked to advance the

private control and commodification of genetic resources. By opposing domestic restrictions on GMOs and attempting to weaken the Cartagena Protocol, they serve the interests of the transnational seed, grain, and agrochemical firms in expanding their markets in Mexico worldwide (Cevallos, 2006). Another continuity between Mexico's biopiracy disputes and recent maize struggles has been the assertion of a middle-ground, nationalist position by some scientists, environment ministry staff, legislators, and others who favor agricultural modernization but with greater Mexican control over biotechnology, genetic resources, and food supplies.

The biopolitics of transgenic maize reveals other contradictions in the "valorization of nature" associated with biotechnology. Brand and Görg (2003) posit that insofar as the neoliberal development project valorizes nature in the form of genetic resources, it can "open political space" for "marginalized" peoples (p. 222). However, while the appropriation of nature by capital is contested within the Mexican state, in Mexican society, and internationally, "state politics are focused on the creation of a stable framework to appropriate genetic resources" by capital (p. 226). Brand and Görg observe that biodiversity politics tends to reproduce relations of domination (p. 222). This is consistent with McCarthy and Prudham's (2004) argument that neoliberalism's environmental projects "necessarily imagine and legitimate particular social orders" (p. 277). Brand and Görg conclude pessimistically that given the power relations involved, the political opening for "local actors" provided by struggles over genetic resources in Mexico is small and likely to be transient (p. 232).

As Brand and Görg contend, the federal state has indeed worked to facilitate capital accumulation through a model of agriculture based on proprietary control of genetic resources and technologies. However, maize biopolitics involves a different constellation of relationships between nature, society, and capital than those depicted by Brand and Görg. The difference has to do with the position of agriculture as the central nexus of nature and society and the distinction between naturally occurring biodiversity and agricultural biodiversity. In the case of pharmaceutical bioprospecting, as soon as "wild" biodiversity in the form of biological materials of potential profitable use has been identified and appropriated, the fate of "local actors" who may have guided prospectors to those resources is of no further consequence to investors and biotechnologists.

In contrast, crop genetic resources are a constantly evolving co-creation of people and nature. Maize biodiversity is maintained and renewed by the active, intentional practices of small-scale farmers. By continuing to save and select seeds, campesinos conserve maize varieties and adapt them to multiple and changing micro-conditions and climates. The CEC study recognized that the decline and possible demise of small-scale producers is the greatest threat to maize biodiversity. This is so whether or not transgenic traits in themselves are harmful to maize gene pools.

Neither maize biodiversity nor the future of its co-creators is of concern to the Mexican state agencies that have

promoted NAFTA, cut tariffs on imported maize, and reduced Mexico's remaining small-farm subsidies. Nor is *in situ* maize diversity of concern to the biotechnology and agrochemical firms that dominate global corn agribusiness. For Dupont and Monsanto, the maize genetic resources already held in their private gene banks are sufficient to maintain and expand the corn monocultures that are the largest source of their profits (ETC Group, 2005b). But maize genetic resources are of great value not to peasant producers and their allies; they are also of worth to modern crop breeders, agronomists, and rural development advocates based in Mexican universities, CIMMYT, and other public institutions. The conservation of this maize biodiversity depends on the future of Mexico's agrarian communities. This helps to explain why conflicts over GMO maize persist and help to widen the political space for counter-movements and alternative discourses.

## 8. Mexican social movements, neoliberalism, and the politics of food sovereignty

Innovative as it was, the CEC study stopped short of fully addressing the questions the Commission itself had posed: What is the likely fate of maize genetic resources if current trends continue, and how can "human health, and social values and cultural identity" (CEC, 2004, p. 8) in rural Mexico best be enhanced? The report notes the negative effects on rural livelihoods of the "current asymmetries and economics of US–Mexican maize trade" (p. 17), but full analysis of such effects exceeds the scope of the study as it was defined. It is nevertheless worth asking: what might be some causal linkages between these "symmetries and economics", transgenic maize, and Mexican lives and landscapes?

To tackle this, one would need to compare not only corn yields but also the organization of maize production in Mexico and its northern neighbors: their different labor systems and technologies, and the institutions – farm payments, export credits, liberalized trade regimes – that enable US-based firms to sell maize abroad for less than its cost of production. Such analysis would assess the consequences of increasing control by a shrinking number of transnational firms over crop purchasing, processing, transportation, and retailing and the influence of these firms on agricultural research and regulation. It would consider whether claims about the superiority of transgenic varieties have bolstered the extension of property rights to seeds, genes, and genomic technologies, and whether this trend contributes to decreasing diversity in foods and agroecosystems worldwide. To assess the effects of dwindling diversity, one would need to compare both the advantages and the externalized costs of globalized, industrial agriculture to the benefits and drawbacks of other agro-food systems, including consumption of energy and water, land degradation or enhancement, labor quantities and conditions, food quality and access, and the social and psychological effects of changes in the countryside.

Such issues are far beyond the discursive scope of most agro-biotechnology assessments, even those as broadly framed as the CEC study. However, they are not beyond the scope of the politics of food sovereignty as it is put forward by networks of rural social movements and by the NGOs fighting the agricultural liberalization provisions of NAFTA, the WTO, and other neoliberal regimes. Food sovereignty's object of attention is agro-food systems and the fields of power in which the global restructuring of these systems is taking place. Rather than accepting the nature-society distinction, food sovereignty discourse highlights the connections between food and the natural and social conditions in which food production, exchange, and consumption take place and have meaning.

Food sovereignty has become a prominent theme in the discourse of resistance to GMOs in Mexico. During the biosafety law debates, a coalition of eight civil-society organizations led by Mexico's National Association of Rural Commercial Producers (ANEC) denounced the law as an outcome of power relations in the North American agro-economy. The new law, they stated, favors only the few beneficiaries of traffic in cheap corn: transnational agribusiness firms and Mexican companies producing maize flour and animal feed. Through this law, said ANEC,

the development of GMOs is legally legitimized as if biotechnology were the only the only sustainable alternative for saving rural Mexico. ... as if our sole advantage lay in the race with the US and Europe to increase production. ... Behind this law lurks a foreign model of agriculture that would be forced on us so we could compete with the rest of the world as the only path to food sovereignty.... Another North American model of green revolution while we face the collapse of that model of "modern" agriculture in [Northern and Western regions of the country] is unacceptable. ... When will Mexican institutions promote models of agriculture based on campesino experience and on scientific knowledge that considers our biological diversity and distinct ecological conditions? (AMUCSS et al., 2004; my translation)

Civil society opposition to agricultural liberalization and GMO deregulation in Mexico are the outcome of decades of rural organizing and farmer-scientist exchanges. Campesino and indigenous organizations, academics, and activists have held Forums in Defense of Maize where these ideas have been debated and elaborated. They have participated in international conferences and protests along with other networks of farmers and activists, including Via Campesina, Brazil's Movimento Sem Terra, and peasant organizations from other Latin America countries, India, Bangladesh, Thailand, the Philippines, Indonesia, East, West, and Southern Africa, the United States, and Europe.

Conflicts over GMO regulation in Mexico have been sharpened by 11 years' experience with the impacts on rural spaces of NAFTA and neoliberal reforms (Wise et al., 2003). A coalition of organizations claiming to represent 25 million

Mexican agriculturalists coalesced under the slogan "El Campo No Aguanta Más" (The Countryside Can't Bear Anymore). Its members blocked highways and border crossings, and negotiated, albeit with meager success, with President Vicente Fox. In 2004, they called for Mexican food sovereignty and a program to "save and recognize the value of the Mexican countryside", a moratorium on implementation of the agricultural section of NAFTA and joint evaluation, with farmer participation, of both NAFTA and the US Farm Bill (*El Campos No Aguanta Mas*, 2004).

Mexico's National Union of Autonomous Regional Farmers' Organizations (UNORCA), which represents food producers organizations in 27 Mexico states, contends that 12 US, Mexican and transnational agro-food firms are NAFTA's primary beneficiaries. UNORCA, too, has called for a moratorium on NAFTA's agricultural sections on grounds that food imports and prices have soared, producer prices have fallen and the countryside is in crisis (UNORCA, 2004). UNORCA's statements emphasize the linkages between transgenic crops, loss of food sovereignty, the privileging of economic over ecological efficiency (UNORCA, 2002).

In international trade and food policy debates, food sovereignty serves as a discursive counterpoint to claims that food security and sustainable development are best achieved through liberalization and new technology. Food sovereignty was introduced into these debates in the 1990s by Via Campesina, a coalition of local and national organizations with an estimated combined membership of more than two million peasants, fishers, and agricultural laborers on six continents. Via Campesina defines food sovereignty as the right and the ability of "peoples", countries, and "unions of states" to define their own agricultural and food policies (Via Campesina, 2003). Food sovereignty discourse links agro-food globalization and the ruin of small and medium-scale farmers in the global South and North (Forum for Food Sovereignty, 2002; McMichael, 2005; Via Campesina, 2005; Windfuhr and Jon-sén, 2005). For most food sovereignty proponents, opposition to crop genetic engineering is both a core principle and an opening for questioning the legitimacy of the WTO and the dominance of trade rules over the use values and cultural meanings of food (Via Campesina, 2004).<sup>9</sup>

<sup>9</sup> Among the most active and influential of the are Focus on the Global South (Based in South and Southeast Asia), Via Campesina, Réseau des organisations paysannes et de producteurs agricoles de l'Afrique de l'Ouest (ROPPA), FoodFirst Information and Action Network (FIAN, based in Europe), Pesticide Action Network Asia-Pacific, GRAIN, Assessoria e Serviços a Projetos em Agricultura Alternativa (Brazil), Intermediate Technology Development Group, The International Indian Treaty Council, The US National Family Farm Coalition, ETC Group, and Friends of the Earth International. In contrast, more mainstream private international aid agencies, such as OXFAM, have placed their hopes on reform of the WTO Agreement of Agriculture to achieve greater access to Northern markets for agricultural exports from the global South, a strategy that more radical groups say cannot be a sound basis for development. Other aid agencies, NGOs, and networks, such as Action-Aid International and Christian Aid (UK), the Institute for Agriculture and Trade Policy, and Third World Network have tried to straggle this divide by pursuing both strong critique and constructive reform of the WTO.

Food sovereignty advocates support farmers' rights to save, exchange, and breed seeds and crop varieties and denounce private intellectual property claims on plant and animal varieties (GRAIN, 2005). Many of the rural social movement organizations calling for food sovereignty are involved in land occupations and other agrarian reform struggles. (Rosset et al., 2006) Via Campesina's food sovereignty manifestos also emphasize the rights of agricultural laborers, recognition of women food producers, and the rights of consumers to know where, how, and by whom their food was produced.

Food sovereignty proponents call for food systems that are as local as possible, for both ecological and social reasons, but most do not reject trade or advocate autarky. They hold that food is first a source of nutrition and only secondarily an item of commerce, and argue that healthy agrarian communities, backed by national policies to support domestic food production, are better guarantors of food security than a globalized agro-food system in which most countries depend on food imports. They argue that decentralized, diverse, and locally adapted farming systems are or can be made more environmentally sustainable than a globalized agro-food system (FOEI, 2003; McAfee, 2006).

As disillusion with the promises of liberalized trade deepens, there is growing interest among development analysts and Southern-country officials in alternatives to full deregulation. Among themes gaining – or regaining – currency are the “right to protect” and the “obligation to support” domestic food producers and agro-industries (IATP, 2004). Critics of agricultural trade liberalization call for multilateral management of supplies of foods and other internationally traded commodities to break the cycle beggar-they-neighbor competition for export markets (Robbins, 2003; Koning et al., 2004; Via Campesina, 2005). They contend that a global pandemic of low farm-gate prices, exacerbated by farm commodity dumping by the US and Europe, is displacing farmers and destroying rural economies in the global North and South alike (Murphy et al., 2005; Wise, 2005).

The concept of food sovereignty is an expression of a particular conjuncture in the international political economy of food. It straddles tensions that are likely to become more apparent as its advocates work to put it into practice. Nevertheless, it is influential because it denies the dichotomy between food as a commodity, on the one hand, and food as a product of labor and nature and a source of individual and social life, on the other hand. Food sovereignty discourse challenges the unsupportable binaries of nature/culture, traditional/modern, and global/local. At a time when the globalization of agriculture is deepening such divisions through the further extension of commodity relations into agro-food systems worldwide, calls for food sovereignty are resonating widely among rural social movements.

## 9. Conclusion

The CEC process demonstrates the futility of resolving biotechnology conflicts by confining risk assessments to

the terrain of techno-science. The ongoing battle over GMOS in Mexico cannot be separated from conflicts over Mexico's place in the world economy, the ecologies and meanings of farming and food, and the consequences of agro-food industrialization for rural livelihoods and landscapes. Thus, the question of transgenic maize is necessarily also an question about Mexico's choice of development pathways.

## References

- AMUCSS et al., 2004. Porque el campo no aguanta mas: posición en cuanto al proyecto de la ley de biodiversidad y organismos genéticamente Modificados. Document obtained by author in Oaxaca, Mexico, March 2004.
- Bejarano, F., 2005. La contaminación genética de maíces nativos y la polémica ley de Bioseguridad en Mexico. In: Proceedings of the First International Conference on Transgenics in Santo Domingo June 2–3, Hotel Clarión, Santo Domingo, Dominican Republic, pp. 29–51.
- Bellon, M.R., Berthaud, J., 2004. Transgenic maize and the evolution of landrace diversity in Mexico: the importance of farmers' behavior. *Plant Physiology* 134 (3), 883–888.
- Boyd, W., 2003. Wonderful potencies? Deep Structure and the problem of monopoly in agricultural biotechnology. In: Schurman, R., Takahashi-Kelso, D. (Eds.), *Engineering Trouble: Genetic Engineering and its Discontents*. University of California Press, Berkeley, CA.
- Brand, U., Görg, C., 2003. The state and the regulation of biodiversity: international biopolitics and the case of Mexico. *Geoforum* 34, 221–233.
- Brush, S., 2004. Assessment of social and cultural effects associated with transgenic maize production. Chapter prepared for Maize and Biodiversity: The Effects of Transgenic Maize in Mexico North America Commission on Environmental cooperation (CEC), Mexico City.
- Castree, N., 2002. False antitheses? Marxism, nature and actor-networks. *Antipode* 34 (1), 111–146.
- CBD (Convention on Biological Diversity), 2002. Text of the Cartagena Protocol on Biosafety. <<http://www.biodiv.org/biosafety/protocol.asp>>.
- CEC (North America Commission on Environmental Cooperation), 2004. Maize and Biodiversity: The Effects of Transgenic maize in Mexico: Key Findings and Recommendations. <<http://www.cec.org/maize/>>.
- Cevallos, D., 2006. Monsanto Stands Firm on GM Maize in Mexico. Interpress Service News Agency November 10. <<http://ipsnews.net/news.asp?idnews=35440>>.
- CIEPAC, (El Centro de Investigaciones Económicas y Políticas de Acción Comunitaria, A.C.), 2005. 10 Principios Básicos para la Ley De Bioseguridad y Organismos Genéticamente Modificados. <<http://www.ciepac.org/biodiversity/leybioseg.htm>>.
- Cleveland, D.A., Soleri, D., Aragón Cuevas, F., Crossa, J., Gepts, P., 2005. Detecting (trans)gene flow to landraces in centers of crop origin; Lessons from the case of maize in Mexico. *Environmental Biosafety Research* 4, 197–208.
- DEFRA (UK Department for Environment, Food and Rural Affairs), 2005. Farm Scale Evaluations of Genetically Modified Herbicide Tolerant Crops *Philosophical Transactions of the Royal Society*. <[www.pubs.royalsoc.ac.uk](http://www.pubs.royalsoc.ac.uk)>.
- EFSA (European Food Safety Authority), 2005. Guidance Document of the Scientific Panel on Genetically Modified Organisms for the Risk Assessment of Genetically Modified Plants and Derived Food and Feed. <[http://www.efsa.eu.int/science/gmo/gmo\\_guidance/660\\_en.html](http://www.efsa.eu.int/science/gmo/gmo_guidance/660_en.html)>.
- El Campos No Aguanta Mas/The Countryside Can't Bear Any More, 2004. Seis propuestas para la salvación y revalorización del campo mexicano. <[http://www.interaction.org/files.cgi/1899\\_Propuestas\\_de\\_las\\_organizaciones\\_rurales\\_mexicanos.doc](http://www.interaction.org/files.cgi/1899_Propuestas_de_las_organizaciones_rurales_mexicanos.doc)>.

- Ellstrand, N.C., 2003. Current knowledge of gene flow in plants: implications for transgene flow. Department of Botany and Plant Sciences, and Center for Conservation Biology, University of California, Riverside, CA 92521-0124, USA. <[ellstrand@ucr.ac1.ucr.edu](mailto:ellstrand@ucr.ac1.ucr.edu)>, <<http://www.cpb.ucdavis.edu/bioinv/downloads/core2004/Transgene%20flow%20Ellstrand%202003.pdf>>.
- EPA (US Environmental Protection Agency), 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F, April 1998 Final. EPA, Washington DC.
- ETC Group, 2005a. Oligopoly, Inc.: ETC Communiqué November/December 2005 Issue # 91. <<http://www.etcgroup.org/search.asp?type=communique>>.
- ETC Group, 2005b. Global Seed Industry Concentration: ETC Communiqué, September/October 2005 Issue # 90. <<http://www.etcgroup.org/documents/Comm90GlobalSeed.pdf>>.
- FAO (Food and Agriculture Organization of the United Nations), 2002. US Secretary of Agriculture: 'The World Must Unite To Fight Hunger and Poverty; Success Will Require an International Coalition', Press Release 01/85 C9. <[http://www.fao.org/WAICENT/OIS/PRESS\\_NE/PRESSENG/2001/pren0185.htm](http://www.fao.org/WAICENT/OIS/PRESS_NE/PRESSENG/2001/pren0185.htm)>.
- FAO (Food and Agriculture Organization of the United Nations), 2004. Pest Risk Analysis for Quarantine Pests, Including Analysis of Environmental Risks and Living Modified Organisms. International Standards For Phytosanitary Measures Publication No. 11, Secretariat of the International Plant Protection Convention, <<https://www.ippc.int/servlet/CDServlet?status=ND0xMzM5OS4zNDE2MyY2PWVuJjMzPXB1YmxpY2F0aW9ucyZzNz1pbmZv>>.
- Fitting, E., 2006. Importing corn, exporting labor: the neoliberal corn regime, GMOs, and the erosion of Mexican biodiversity. *Agriculture and Human Values* 23, 15–26.
- Fleisher, A., 2003. West Africa: Background Briefing on the President's Meetings with President Wade and with the Leaders of the West African Democracies. Transcript, The White House, Washington, DC. <<http://www.whitehouse.gov/news/releases/2003/07/20030708-9.html>>.
- FOEI (Friends of the Earth International), 2003. Trade and People's Food Sovereignty. Position Paper, Trade, Environment And Sustainability Programme. Friends of the Earth International Secretariat, P.O. Box 19199, Amsterdam, The Netherlands.
- Food Chemical News, 2006. Mexico puts Transgenic trials on hold. reproduced by the Pew Initiative on Food and Biotechnology, November 13, 2006. <<http://pewagbiotech.org/newsroom/summaries/display.php3?NewsID=1031>>.
- Forsyth, T., 2002. *Critical Political Ecology: The Politics of Environmental Science*. Routledge, Oxford, UK.
- Forum for Food Sovereignty, 2002. Food Sovereignty: A Right For All: Political Statement of the NGO/CSO Forum for Food Sovereignty, 8–13 June, 2002, Rome, <<http://www.foodfirst.org/node/209>>.
- Friedmann, H., 2005. Feeding the empire: the pathologies of globalized agriculture. In: Panitch, L., Leys, C. (Eds.), *The Empire Reloaded*. Merlin Press, London.
- González, R.J., 2001. *Zapotec Science: Farming and Food in the Northern Sierra of Oaxaca*. University of Texas Press, Austin.
- Government of Mexico, 2005. Ley de Bioseguridad de Organismos Genéticamente Modificados <<http://www.salud.gob.mx/unidades/cdi/nom/comp/ley180305.html>> (published March 18).
- GRAIN, 2005. Food Sovereignty: turning the global food system upside down. Seedling, May. <<http://www.grain.org/nfg/?id=317>>.
- Greenpeace México, 2004. Agroindustriales intentan sabotear el informe de la CCA. Agro-industrialists attempt to sabotage the CEC report. <<http://www.greenpeace.org/mexico/news/agroindustriales-intentan-sabo#>>.
- Greenpeace México, 2005. Exigen ONG a legisladores rechazar presiones de Estados Unidos y exigir que se haga público el informe sobre maíz de CCA September 21. <<http://www.greenpeace.org/mexico/press/releases/exigen-ong-a-legisladores-rech>>.
- Heffernan, W., Hendrickson, M., 2005. The Global Food System: A Research Agenda: The Overview. Department of Rural Sociology, University of Missouri, Columbia, MO 65211. [hendrickson@missouri.edu](mailto:hendrickson@missouri.edu) <<http://www.agribusinessaccountability.org/page/374/1>>.
- IATP (Institute for Agriculture and Trade Policy), 2004. Conference Report: Sustaining a Future for Agriculture Geneva, Switzerland, 15–19 November. <<http://www.tradeobservatory.org/search.cfm>>.
- IGTC (International Grain Trade Association), 2004. Notice To Trade #2. <[www.naega.org/images/IGTC\\_2005.pdf](http://www.naega.org/images/IGTC_2005.pdf)>.
- IISD (International Institute for Sustainable Development), 2006. Highlights for Friday 17 March, p. 7, and Summary Report, Third Meeting of Parties to the Cartagena Protocol on Biosafety, 13–17 March, Curitiba, Brazil. <<http://www.iisd.ca/biodiv/bs%2DCoPmop3/>>.
- ITCSD (International Centre for Trade and Sustainable Development). 2006. Constructive ambiguity saves LMO labeling discussions at MOP-3. BRIDGES Trade BioRes 6, 5 March 17. <<http://www.ictsd.org/biores/06-03-17/story1.htm>>.
- Jaffe, G., 2003. Planting Trouble: Are Farmers Squandering Bt Corn Technology? An Analysis of USDA Data Showing Significant Non-compliance With EPA's Refuge Requirements. Center for Science in the Public Interest, 1875 Connecticut Avenue, NW, Suite 300, Washington, DC 20009.
- Jasanoff, S., 2006. *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton University Press, Princeton, NJ.
- Jordan, M., Sullivan, K., 2003. Trade brings riches, but not to Mexico's poor. *The Washington Post* 22 March.
- King, A., 2006. Ten Years with NAFTA: A Review of the Literature and an Analysis of Farmer Responses in Sonora and Veracruz, Mexico. CIMMYT Special Report 06-01. CIMMYT/Congressional Hunger Center, Mexico, DF.
- Koning, N., Calo, M., Jongeneel, R., 2004. Fair trade in tropical crops is possible: international commodity agreements revisited. Wageningen North-south Discussion Paper no. 3. <<http://www.north-south.nl/files/Debate/Fairtrade.pdf>>.
- La Jornada, 2005. Científicos y académicos rechazan la actual propuesta de ley de Bioseguridad de OGM's. December 8, México City, México.
- Lazos Chavero, E., 2004. Las variedades locales de maíz: amenazas para su conservación. UNAM (National Autonomous University of Mexico).
- McAfee, K., 2003a. Corn culture and dangerous DNA: real and imagined consequences of maize gene flow in Oaxaca. *Journal of Latin American Geography* 2, 11–42.
- McAfee, K., 2003b. Neoliberalism on the molecular scale: economic and genetic reductionism in biotechnology battles. *Geoforum* 34, 203–219.
- McAfee, K., 2003c. Plants, Power, and Intellectual Property in the New Global Governance Regimes. In: Schurman, R., Takahashi-Kelso, D. (Eds.), *Engineering Trouble: Genetic Engineering and its Discontents*. University of California Press, Berkeley, CA.
- McAfee, K., 2004. Geographies of risk and difference in crop genetic engineering. *Geographical Review* 94, 80–106.
- McAfee, K., 2006. Sustainability and social justice in the global food system. In: Cohn, A., Cook, J., Fernández, M., McAfee, K., Reider, R., Steward, C. (Eds.), *Agroecology and the Struggle for Food Sovereignty in the Americas*. International Institute for Environment and Development <<http://www.ied.org/pubs/display.php?o=14506IIED&n=2&l=59&a=R%20N&x=Y>>.
- McCarthy, J., Prudham, W.S., 2004. Neoliberal nature and the nature of neoliberalism. *Geoforum* 35 (3), 275–283.
- McMichael, Philip., 2005. Global development and the corporate food regime. In: Buttel, F.H., McMichael, P. (Eds.), *New Directions in the Sociology of Global Development*. Elsevier, Oxford, UK.
- Murphy, S., 2006. Concentrated Market Power and Agricultural Trade. EcoFair Trade Dialog Discussion Paper #1. Heinrich Böll Stiftung, Berlin.
- Murphy, S. et al., 2005. *WTO Agreement on Agriculture: A Decade of Dumping 4*: Institute for Agriculture and Trade Policy 2105 First Avenue South Minneapolis, MN 55404, USA.
- Nadal, A., Wise, T.A., 2004. The Environmental Costs of Agricultural Trade Liberalization: Mexico–US Maize Trade Under NAFTA. Working Group on Development and Environment in the Americas

- Discussion Paper Number 4, Tufts University, Medford, MA 02155, USA. <<http://ase.tufts.edu/gdae>>.
- NRC (National Research Council), 2002. Environmental Effects of Transgenic Plants: The Scope and Adequacy of Regulation. Committee on Environmental Impacts Associated with Commercialization of Transgenic Plants. Board on Agriculture and Natural Resources. Division on Earth and Life Studies. Washington, DC.
- Ohio State University, 2002. Scientific Methods Workshop: Ecological and Agronomic Consequences of Gene Flow from Transgenic Crops to Wild Relatives, 5–6 March, Columbus, Ohio. <[http://www.biosci.ohio-state.edu/~lspencer/gene\\_flow.htm](http://www.biosci.ohio-state.edu/~lspencer/gene_flow.htm)>.
- Ortiz García, S., Ezcurra, E., Schoel, B., Acevedo, F., Soberón, J., Snow, A.A., 2005. Absence of detectable transgenes in local landraces of maize in Oaxaca, Mexico (2003–2004). Proceedings of the National Academy of Sciences 102, 1294–12338 <<http://www.pnas.org/cgi/content/abstract/102/35/12338>>.
- Ortiz García, S., Ezcurra, E., Schoel, B., Acevedo, F., Soberón, J., Snow, A.A., 2006. Transgenic Maize in Mexico. *BioScience* 56 (9), 709.
- OSTP (US Office of Science and Technology Policy), 1986. Coordinated Framework for Regulation of Biotechnology. <[http://usbiotechreg.nbio.gov/Coordinated\\_Framework\\_1986\\_Federal\\_Register.html](http://usbiotechreg.nbio.gov/Coordinated_Framework_1986_Federal_Register.html)>.
- Perales, H., Brush, S.B., Qualset, C.O., 2003. Dynamic management of maize landraces in central Mexico. *Economic Botany* 57 (1), 21–34.
- Quist, D., Chapela, I.H., 2001. Transgenic DNA introgressed into traditional maize landraces in Oaxaca, Mexico. *Nature* 414 (6863), 541–543.
- Raven, P.H., 2005. Transgenes in Mexican maize: Desirability or inevitability? Proceedings of the National Academy of Sciences 102, 13003–13004.
- Ray, D., 2005. Agricultural balance of trade. *MidAmerica Farmer Grower* 22 (8).
- Robbins, P., 2003. *Stolen Fruit: The Tropical Commodities Disaster*. Zed Books, London.
- Rosset, P., Monsalve, S., Vicente Vázquez, S., Carino, J.K., 2006. Agrarian Reform in the Context of Food Sovereignty, the Right to Food and Cultural Diversity: Land, Territory and Dignity Civil Society Issue Paper, International Conference on Agrarian Reform and Rural Development: New Challenges and Options for Revitalizing Rural Communities. Porto Alegre, Brazil, 7–10 March 2006, UN Food and Agriculture Organization.
- Sauer, C.O., 1971. *Sixteenth Century North America: The Land and People as Seen by European*. University of California Press, Berkeley, CA.
- Snow, A.A., Andow, D., Gepts, P., Hallerman, E.M., Power, A., Tiedje, J.M., Wolfenbarger, L., 2005. Genetically engineered organisms and the environment: current status and recommendations. *Ecological Applications* 15, 377–404, Position paper of the Ecological Society of America <[http://www.esa.org/pao/esaPositions/Papers/geo\\_position.htm](http://www.esa.org/pao/esaPositions/Papers/geo_position.htm)>.
- Soleri, D., Cleveland, D.A., Aragón Cuevas, F., 2006. Transgenic crops and varietal diversity: the case of maize in Mexico. *BioScience* 56 (6), 503–513.
- Suárez C.V., 2006. El caso del proyecto Maestro de Maíz. Rumbo Rural Agencia Legislativa 14 January–April. [www.cedrssa.gob.mx/documentos/RumboRural/RR3.pdf](http://www.cedrssa.gob.mx/documentos/RumboRural/RR3.pdf).
- Taylor, E., Dyer, G., 2003. NAFTA, Trade, and Migration. Carnegie Endowment for International Peace, 1779 Massachusetts Ave. NW, Washington, DC, 20036-2103.
- The Royal Society, 2002. *Genetically Modified Plants for Food Use and Human Health – an Update*. Policy Document 4/02, February. London, UK.
- Tingley, D., 2004. Letter from the chair of the Joint Public Advisory Committee to the US, Mexican, and Canadian representatives to the NACLA Commission for Environmental Cooperation, April 13.
- Tuxill, J., 2004. Agrarian change and crop diversity in Mayan Milpas of Yucatan, Mexico: implications for *in situ* conservation. Ph.D. thesis. Yale School of Forestry and Environmental Studies, New Haven, CT.
- UNORCA (Unión de Organizaciones Regionales Campesinas Autónoma), 2002. La defensa de la soberanía alimentaria y los recursos: la gran tarea. ING. Castillo, Comisión Ejecutiva Nacion al Universidad Autónoma, Chapingo, México. <<http://www.unorca.org.mx/posicion/8.htm>>.
- UNORCA (Unión de Organizaciones Regionales Campesinas Autónoma), 2004. La Agricultura a Diez Años del TLCAN, Una Perspectiva desde el Movimiento Campesino. Alberto Gómez Flores, Coordinador Ejecutivo Nacional de la UNORCA. <<http://www.unorca.org.mx/posicion/2.htm>>.
- USDA (US Department of Agriculture) Economic Research Service, 2005. Adoption of Genetically Engineered Crops in the US. <<http://www.ers.usda.gov/Data/BiotechCrops/ExtentofAdoptionTable1.htm>>.
- US Department of State, 2004. US Calls NAFTA Environmental Report “Flawed, Unscientific. November 8. <[http://www.ustr.gov/Document\\_Library/Press\\_Releases/2004/November/US\\_Calls\\_NAFTA\\_Environmental\\_Report\\_Flawed\\_Unscientific.html](http://www.ustr.gov/Document_Library/Press_Releases/2004/November/US_Calls_NAFTA_Environmental_Report_Flawed_Unscientific.html)>.
- Via Campesina, 2003. What is Food Sovereignty? Position Paper. <[http://www.viacampesina.org/en/index.php?option=com\\_content&task=view&id=227&Itemid=135](http://www.viacampesina.org/en/index.php?option=com_content&task=view&id=227&Itemid=135)>.
- Via Campesina, 2004. FAO promotes GMOs, Slap in the Face of Those Who Defend Food Sovereignty Press Release Friday, 21 May. <[http://viacampesina.org/main\\_en/index.php?option=com\\_content&task=view&id=45&Itemid=27](http://viacampesina.org/main_en/index.php?option=com_content&task=view&id=45&Itemid=27)>.
- Via Campesina, 2005. Position of La Via Campesina on Trade Towards WTO meeting in Hong Kong. Position Paper. <[http://www.viacampesina.org/hongkong/index2.php?option=com\\_content&do\\_pdf=1&id=67](http://www.viacampesina.org/hongkong/index2.php?option=com_content&do_pdf=1&id=67)>.
- Whatmore, S., 2002. *Hybrid Geographies: Natures, Cultures Spaces*. Sage, London.
- Windfuhr, M., Jonsén, J., 2005. *Food Sovereignty: Towards Democracy in Localized Food Systems*, FIAN-International. Available from: ITDG Publishing, Bourton Hall, Bourton-on-Dunsmore, Rugby, Warwickshire, CV23 9QZ, UK. <<http://www.itpubs.org.uk>>.
- Wise, T.A., 2005. Identifying the real winners from US agricultural policies. *Global Environment and Development*, Tufts University. <<http://www.ase.tufts.edu/gdae/Pubs/wp/05-07RealWinnersUSAg.pdf>>.
- Wise, T.A., Salazar, H., Carlsen, L. (Eds.), 2003. *Confronting Globalization: Economic Integration and Popular Resistance in Mexico*. Kumarian Press, Westport, CT.
- Yearly, Steven., 2005. *Making Sense of Science: Understanding the Social Study of Science*. Sage, London.
- Zahniser, S., Coyle, W., 2004. US–Mexico corn trade during the NAFTA era: new twists to an old story? Electronic Outlook Report. US Department of Agriculture Economic Research Service FDS-04D-01 <<http://www.ers.usda.gov>>.