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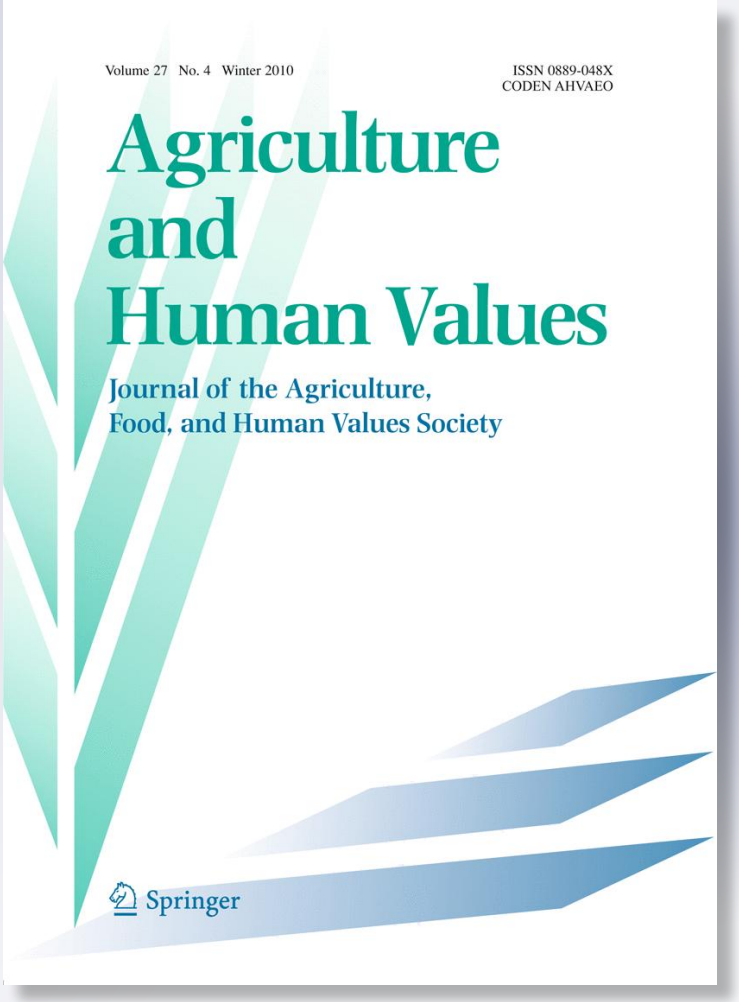

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Anti-genetic engineering activism and scientized politics in the case of "contaminated" Mexican maize

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Abstract The struggle over genetically-engineered (GE) maize in Mexico reveals a deep conflict over the criteria used in the governance of agri-food systems. Policy debate on the topic of GE maize has become "scientized," granting experts a high level of political authority, and narrowing the regulatory domain to matters that can be adjudicated on the basis of scientific information or "managed" by environmental experts. While scientization would seem to narrow opportunities for public participation, this study finds that Mexican activists acting "in defense of maize" engage science in multiple ways, using and producing scientific knowledge as well as treating scientific discussions as a stage for launching complex social critiques. Drawing from research in science and technology studies, this article assesses the impacts and pitfalls of three tactics used by maize activists that respond to the scientization of biotechnology politics: (1) using scientific information as a resource; (2) participating in scientific research; and (3) reframing policy problems as broadly social, rather than as solely scientific or technical. The obstacles that maize activists have faced in carrying out each of these efforts indicate that despite diverse and sophisticated engagements between social movements and the scientific field, scientization remains a significant institutional barrier to democratizing agricultural governance.

Keywords Biotechnology · Culture · Expertise · Maize · Mexico · Scientization · Social movements

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Abbreviations

ANEC	Asociación Nacional de Empresas Comercializadoras de Productores del Campo/National Association of Marketing Organizations of Rural Producers
AJAGI	Asociación Jalisciense de Apoyo a Grupos Indígenas/Jaliscan Association for Support to Indigenous Groups
CASIFOP	Centro de Análisis Social, Información y Formación Popular/Center for Social Analysis, Information, and Popular Training
CEC	Commission for Environmental Cooperation
CECCAM	Centro de Estudios para el Cambio en el Campo Mexicano/Center for the Study of Change in the Mexican Countryside
CENAMI	Centro Nacional de Apoyo a Misiones Indígenas/National Center to Support Indigenous Missions
CNCA	Consejo Nacional para la Cultura y las Artes/National Council for Culture and the Arts
GE	Genetically-engineered
GEA	Grupo de Estudios Ambientales/Environmental Studies Group
ETC	Action Group on Erosion, Technology and Concentration
LBOGM	Ley de Bioseguridad de Organismos Genéticamente Modificados/Biosafety Law for Genetically Modified Organisms
NGO	Non-governmental organization
PROFEPA	Procuraduría Federal de Protección al Ambiente/Federal Prosecutor's Office for Environmental Protection
UNORCA	Unión Nacional de Organizaciones Regionales Campesinas Autónomas/National

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	Union of Regional Autonomous *Campesino* Organizations
UNOSJO	Unión de Organizaciones de la Sierra Juárez de Oaxaca/Union of Organizations of the Sierra Juarez of Oaxaca

Introduction

In 2001, two researchers from the University of California, Berkeley discovered transgenic material in samples of maize taken from a remote area of Oaxaca, Mexico. The finding was remarkable because the Mexican government had never granted approvals for genetically-engineered (GE) maize to be cultivated. A likely source was identified: shipments of maize from the US, containing both conventional and GE grain, which were being distributed widely throughout the countryside. Since then, "transgene flow," or the genetic mixing of GE and conventional crops, has become a divisive topic in Mexico. The controversy pits small-scale maize producers, environmentalists and other critics of GE maize—who claim that genetic contamination threatens biodiversity, economic livelihoods and cultural traditions—against Mexican regulatory authorities and the transnational biotechnology industry—which argue that GE maize will benefit Mexico and that risks to biodiversity can be minimized. The Mexican maize scandal has received a great deal of popular and scholarly attention, including in the pages of this journal (Bellon and Berthaud 2006; Fitting 2006; Nadal 2006a; Soleri and Cleveland 2006). Yet most analyses miss a crucial dimension of the conflict: the ways in which opponents of GE maize interact with the scientific field (for notable exceptions, see McAfee 2008; Delborne 2008). I find that the maize movement engages science in multiple ways, using and producing scientific knowledge as well as treating scientific discussions as a stage for launching complex social critiques of the technology.

The struggle over GE maize in Mexico reveals a deep conflict over the criteria used in the governance of agri-food systems. Policy debate on the topic of GE maize has become "scientized," granting experts a high level of political authority, and narrowing the regulatory domain to matters that can be adjudicated on the basis of scientific information or "managed" by environmental experts. The scientization of biotech politics is not unique to Mexico. Both the World Trade Organization and the United Nations Protocol on Biosafety indicate that scientific risk assessment provides the only legitimate justification for disrupting trade in GE crops (Kinchy et al. 2008). At the national level, science-based and risk-centered regulatory approaches are evident not only in countries whose governments have taken a promotional stance toward biotechnology, such as the US, but also in countries and regions where few approvals for GE crops have been granted, such as the European Union (Levidow 1998; Levidow 2001; Kleinman and Kinchy 2003a, b, 2007). Participatory initiatives such as "GM Nation?" in the UK explicitly aim to increase public involvement in the decision-making process on the commercialization of GE crops (Joss 2005), but the turn toward participation is far from universal. Government agencies in the US, for example, limit public engagement in biotechnology decision making, justifying this stance through appeals to "sound science" (Sarewitz 2004; Jasanoff 2005). Mexico closely resembles the US in this respect. Questions about expertise and lay participation in decisions are contentious there because Mexican authorities have tended to embrace an approach to decision making that relies upon scientific evaluations of risk, rather than encouraging public involvement in the assessment of GE crops.

Critics in the global North have largely adopted the dominant "safety" and "risk" frames, expressing their opposition to GE crops in terms of the scientifically measurable risks of environmental and human health (Buttel 2005). However, there are some important exceptions to this trend. In Europe, anti-GE activists challenged the concept of "substantial equivalence" of GE and non-GE crops. The concept, introduced in the late 1990s, "provided a technocratic basis for scientizing risk assessment policy" (Levidow et al. 2007, 55). Protesters framed the regulatory process as undemocratic, casting GE crops as an "ominous symbol of globalization" (p. 55). Through these acts of redefinition, anti-biotech protesters undermined the legitimacy of the concept of substantial equivalence and, according to Levidow et al. (2007), weakened confidence in the authority of science as a basis for political decision-making. Similarly, French farmers have increasingly framed their objections to GE crops in terms of local food sovereignty and anti-globalization sentiments, displacing the earlier risk-centered discourse (Heller 2001, 2004). In a parallel fashion, Mexican maize activists not only challenge the use of biotechnology, they also democratize science and challenge the basis for regulatory decisions. Moving beyond technical risk assessment, farmers and activists cite intellectual property, indigenous rights, rural livelihoods and the globalization of agriculture among their major concerns about GE maize.

Through a case study of the Mexican movement "in defense of maize," this article reviews and critically assesses theories about the scientization of politics and relations between science and social movements. Studies of "democratizing science movements" offer useful insights for agri-food studies not only with respect to

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biotechnology, but in numerous contexts in which scientific assessment and management of risks obscures democratic debate about the cultural and economic implications of ways that food is produced. Research in the sociology of science and social movements indicates that activists become challengers to expert authority by (1) using scientific information as a resource, (2) participating in scientific research, and (3) reframing policy problems as broadly social, rather than scientific or technical. The controversy over GE maize in Mexico provides a rich and complex source of insights about the impacts and pitfalls of each of these activities.

Field research for this study took place from September 2005 to April 2006 in Mexico City and Oaxaca, Mexico. I collected data on the struggles over GE maize and canola through interviews, participant observation, archival research, and analysis of published documents (e.g., scientific papers, newspaper articles, and activist websites). Over 50 semi-structured, in-depth interviews were conducted with activists, farmers, industry representatives, regulatory officials and scientists involved in the conflict over GE maize in Mexico.

My analysis begins with a discussion of the general problem of the scientization of politics, followed by an overview of tactics commonly used by citizen groups when scientization restricts their role in political decision making. The subsequent section provides a case study of the Mexican maize movement, focusing on its diverse and somewhat contradictory interventions into science and expert governance. Finally, I consider the implications of this study for research on agricultural governance more generally.

Scientized politics and social movements

Scholarship on agri-food systems has long been attentive to questions of expertise and local knowledge; however, studies of agricultural governance tend to lack sustained analysis of the relationship between science, governance, and social movements. The following discussion aims to provide a conceptual framework for engaging in such an analysis.

The relationship between experts and politics has been an abiding topic of concern to political theorists since the 1960s. Early investigations focused on the growing political influence of scientists and the problem of technocracy. Habermas (1970) referred to these transformations as the "scientization" of politics, a shift toward a technocratic model of governance in which politics is replaced by a scientifically rationalized administration. Political theorists of the 1960s and 1970s articulated a variety of threats that scientization posed to democratic values, some focusing on the power held by those who control technical information (Snow 1961; Lapp 1965; Price 1965), others more concerned about the camouflaging of value-laden political decisions with the logic of scientific rationality (Benveniste 1973; Noble 1977). Many of the concerns raised decades ago about the scientization of politics are no less relevant today. Industry groups routinely use a concept of "sound science" to maintain the upper hand in political deliberations about a variety of contentious issues, most prominently the regulation of biotechnology. Rachel Morello-Frosch and her colleagues (2006) argue that scientization gives industry, with its assurances of scientific risk assessment, a distinct advantage:

> The insatiable quest for "better science" in policymaking has become a significant and powerful tool used to support dominant political and socioeconomic systems. Through this "scientization" of decision making, industry exerts considerable control over debates regarding the costs, benefits, and potential risks of new technologies and industrial production by deploying scientific experts who work to ensure that battles over policymaking remain scientific, "objective," and effectively separated from the social milieu in which they unfold (Morello-Frosch et al. 2006, p. 245).

The political authority of science may be expanding, often to the benefit of industry, but there are also countervailing trends. Weingart (1999) points out that the increasing use of science to legitimate political decisions, based on its presumed objectivity and disinterestedness, is paradoxically self-destructive. Decision-makers depend on scientific knowledge for the resolution of complex problems, yet scientific experts are rarely able to provide definitive answers (Beck 1992). This leads to escalating competition for scientific advice, whether in the courts, regulatory bodies or policy-making institutions. As a result, science becomes "politicized." As the public becomes increasingly aware that "science can be used to legitimate different political positions and decisions," the basis of legitimization—the presumed nonpartisan nature of scientific knowledge—would seem to be undermined (Weingart 1999, p. 156). Nevertheless, Weingart notes the surprising stability of existing political arrangements in which science is treated as a privileged source of knowledge. Instead of shifting away from technocratic tendencies, many institutions have sought to maintain the political authority of science though a number of strategies, such as concealing schisms within the scientific community and controlling messages repeated in the media (Weingart 1999, p. 159).

A more significant challenge to the scientization of politics may be seen in efforts to democratize expert advice, at least in some contexts. Numerous scholars have observed an increase in public involvement in the

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governance of science and technology, especially in Europe (Abels 2002; Elam and Bertilsson 2003; Maasen and Weingart 2005a, b; Leach et al. 2005). A variety of mechanisms, such as consensus conferences (Einsiedel et al. 2001; Dryzek and Tucker 2008; Guston 1999; Powell and Colin 2008) and science shops (Leydesdorff and Ward 2005) have been created to facilitate the participation of ordinary citizens in the evaluation of science and technology. Maasen and Weingart (2005a, b) describe this political shift as going "from a legitimation through knowledge to a legitimation through participation" (p. 2). A variety of scholars have enthusiastically described examples of participatory processes as models for reinvigorating democratic values in the face of scientized politics (Sclove 1995; Fischer 2000; Kleinman 2000; Irwin 1995; Leach et al. 2005). However, the prevalence and influence of these democratizing processes remain unclear.

Although one effect of the scientization of politics is to suppress public debate, often to the benefit of industry, paradoxically, it has also fueled social movements. In numerous examples, the use of scientific expertise to legitimize undesirable political decisions has been met by fierce opposition. McCormick (2007) refers to social movements that challenge the expanding political authority of science as "democratizing science movements" because they "attempt to reclaim citizens' power by making lay knowledge legitimate in science, policy and public debate" (p. 609). Moore (2006) notes that the significance of these movements is not only to produce immediate political outcomes (which are not always in activists' favor); they may also challenge, in the long term, the taken for granted authority of scientific expertise.

Research on social movements and science offers useful contributions to studies of agricultural governance, highlighting the ways in which activists confront the political authority of science. Activists may use scientific information as a resource; engage in participatory research; and reframe "technical" problems to include social, cultural and economic impacts (see Table 1). Often, these tactics are used in combination—they overlap and complement one another. Considered separately for analytical purposes, however, the potential impact of each of these tactics is different, from damaging the public perception of science to democratizing political decision-making processes.

First, activists—from transnational NGOs to small grassroots groups—make use of scientific studies and expert opinions in order to raise the visibility of their concerns about the negative impacts of science and technology. In order to gather and interpret relevant scientific information, activists may collaborate with or hire experts on issues involving complex technical information. Of course, using science as a resource is often more complicated than it sounds. Activists often find that the scientific information they need is not publicly available, and therefore part of their efforts include pressing for the release of scientific data that has been suppressed by industry or government agencies. Grassroots groups fighting corporate polluters may distrust experts and the institutions of science, and therefore seek out scientific information from sources that they find more trustworthy (Couch and Kroll-Smith 2000). And activists may be dismayed to find that science does not provide clear and unambiguous answers (Yearley 1992). Despite the challenges, the use of science may have immediate effects; for instance, when community activists successfully use scientific studies as evidence in lawsuits against corporations or government agencies (Brown and Mikkelsen 1990; Jasanoff 1995). Scientific claims may also be crucial to generating new agendas for advocacy groups, as when Greenpeace compiled evidence of a link between chlorine and breast cancer, an issue that then was pursued by breast cancer activists and international organizations (Driedger and Eyles 2001). In the longer term, activist use of science may damage the public perception of science as neutral, apolitical and trustworthy, thus leading to greater skepticism about the capacity of state regulatory agencies (Weingart 1999). Effects on participants in the movement themselves may be varied. On one hand, activists who become highly informed on the scientific issues related to their cause may feel empowered and capable of confronting authorities (Epstein 1996). On the other hand, this approach to activism requires a certain amount of reliance on scientific experts to carry out needed studies, and activists may become frustrated with the slow pace of professional scientific research.

In some cases, activists go from being users of scientific knowledge and collaborators with experts to producing science themselves. This is a second tactic for challenging the political authority of science. Participatory research refers to the active participation of ordinary citizens in the conduct of a scientific study. Farmers, activists, and other non-professionals design a research study—often with the aid of professional scientists—and collect and analyze data relevant to their concerns (Fischer 2000; Brown et al. 2004; Corburn 2005; Hess 2009). The impacts of these types of efforts are varied. The findings of an activist-initiated study may help to prove that an environmental or public health problem exists when authorities have been reluctant to acknowledge it. In a more general sense, participatory research destabilizes scientists' claims to authority in producing useful knowledge of the natural world. Ordinary people prove themselves capable of carrying out research and contributing to scientific debates. Furthermore, the research process may help to mobilize greater support for a social movement and build confidence among those who participate. However, research produced by activists may not always be taken seriously by political authorities or the scientific community.

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Table 1 Tactics to confront the political authority of science

Tactic	Example	Potential impacts
Using scientific information	Farmworkers use scientific studies and expert allies to show the toxic effects of agrichemicals.	Counters opponents' claims; damages public perception of science as neutral, apolitical and trustworthy.
Participating in scientific research	An NGO tests food products for unapproved substances.	Fills knowledge gaps; destabilizes scientists' claims to authority in producing useful knowledge of the natural world.
Reframing the problem	Farmer-activists shift attention from health impacts to economic consequences of bovine growth hormone.	Expands range of relevant experts and stakeholders; makes social conflict and political issues explicit

Scientific knowledge can be highly useful in political activism, and is often what forces authorities to pay attention to a social problem. However, activists often fight to ensure that expert discourse does not overshadow citizens' perspectives on social, economic, and moral issues in debates and decisions about scientific and technological developments. This is the third social movement tactic to confront the political authority of science. When a social problem is defined as narrowly technical, groups of citizens may attempt to persuade authorities to redefine the problem to encompass a broader range of issues. For instance, in anti-dam movements around the world, grassroots activists and their transnational allies have called attention to the human rights abuses associated with big dam projects, in the process challenging the very premise of "development" (Khagram 2004). Similarly, indigenous peoples around the world have fought for access to clean water, demanding that the international community recognize that water is not only a health and environmental matter, as it is commonly understood, but is also sacred to indigenous people (Espeland 1998; Norrell 2006). And across the US, community struggles against environmental racism have examined the racial injustice at the root of environmental pollution, bringing issues of inequality to the forefront of conflicts over the environment (Bullard 2005).

The impact of this type of effort, when successful, is to reverse the scientization of social problems, reopening the possibility for democratic deliberation about the value preferences and power relations that were previously obscured. This process differs in important ways from what Weingart (1999) refers to as the "politicization of science," which results from the escalating use of competing expertise. In contrast, when citizens mobilize to challenge the narrowly technical definition of a policy issue, they politicize (and potentially democratize) decision-making processes. Belief in science as an objective, non-partisan source of knowledge may remain unscathed—but the relative importance of science in making policy and regulatory decisions is diminished, as social values gain a more central role the political process.

The controversy over GE maize in Mexico provides a rich and complex source of insights about the impacts and pitfalls of each of these activities. An extensive network of non-governmental organizations (NGOs), activist groups, rural community groups, farmers and scholars have protested biotechnology by simultaneously using scientific knowledge and challenging the political authority of experts. These critics of GE maize have advanced their position by using scientific data, by filling in knowledge gaps by conducting scientific studies themselves, and by seeking out venues in which it is possible to redefine transgene flow as a cultural and economic crisis. They clash with promoters of the technology over what sort of evidence and expertise are required in order to credibly establish that native maize plants have become "contaminated" with transgenic material. In addition, those who view GE maize as a cultural, economic, ecological or safety threat have fought to increase their involvement in decisions about the regulation of biotechnology, despite the fact that state decision makers do not welcome their ("unscientific") perspectives.

Conflict over Mexican maize

As of 2006, Mexico was among the 22 countries of the world that cultivate GE crops (James 2006). GE tomatoes, cotton and soybeans have been grown on a large scale, and a variety of other transgenic crops, including maize, have undergone field trials. However, the Mexican government has not approved the commercial cultivation of GE maize. Mexico is the "center of origin" of maize and is home to a remarkably high level of maize genetic diversity, which is valued by plant breeders, ecologists and environmentalists—not to mention the small-scale producers who rely on local varieties for food. Furthermore, maize has important cultural meanings in Mexico as a staple food, a national symbol, and as a part of many indigenous religious traditions (González 2001; Esteva and Marielle 2003). For these reasons, the potential introduction of GE maize has been

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much more contentious than any other GE crop. Opponents of GE maize in Mexico include international civil society organizations, urban Mexican environmentalists and intellectuals, an assortment of intermediary organizations promoting sustainable rural livelihoods, and associations of rural and indigenous communities. Their efforts include not only attempts to shape government policy at the federal level, but also grassroots work to promote sustainable agricultural practices within local communities. GE maize in Mexico has also been the topic of numerous scientific conferences, research articles, public forums and policy debates.

Official policy regarding GE crops, particularly GE maize, has focused on avoiding threats to biological diversity through scientific risk assessment and risk management. Mexico began to actively participate in the deliberations for the UN Protocol on Biosafety in June 1997 (González Aguirre 2004, p. 193). By putting the issue of biosafety on the political agenda, these international negotiations were an important stimulus to the further development of regulations to protect biological diversity (Gupta and Falkner 2006). From 1999 to 2005, Mexico's federal elected officials debated the creation of a new Biosafety Law for Genetically Modified Organisms (Ley de Bioseguridad de Organismos Genéticamente Modificados, LBOGM). NGOs, scientists and even some well-known celebrities protested the proposed law, saying it would serve only to promote the interests of the biotechnology industry and did not sufficiently protect biodiversity or the rights of peasant farmers and indigenous people (Massieu Trigo and San Vicente Tello 2006). Massive *campesino* (peasant farmer) protests in 2003 led to the signing of the National Accord for the Countryside, which, among many other points related to Mexican agricultural policy, resolved that *campesino* organizations and producers be consulted about the biosafety law (Massieu Trigo and San Vicente Tello 2006, p. 44). In 2004, Oaxacan farmers and activists took a stand against GE maize, writing a manifesto that emphasized the social, economic and cultural importance of maize, called on the Mexican government to stop the importation of transgenic maize, and demanded a law on ag-biotech regulation that would support both biological and cultural diversity.[1] Despite these and other protests, a version of the LBOGM dubbed by activists the "Monsanto Law," because of its promotional stance on biotechnology, was ratified in February 2005. The law creates a process for testing and approving transgenic crops for commercial release. Since the law's passage, the Mexican government has indicated its willingness to permit field trials of transgenic maize in certain regions. This is the first step toward commercialization and widespread cultivation.

Activists have continually, and largely successfully, fought the initiation of experimental trials of GE maize by pointing to one provision of the law that calls for the creation of a "special regimen" for the protection of maize biodiversity. For some critics of GE maize, these short-term victories, based on arguments about environmental risk, offer a "window of opportunity to rethink the role of the countryside and agriculture in our country, based on new principles" such as sustainable agriculture and the value of small scale production (Nadal 2006b). Yet, in a context where arguments based on expert evaluations of environmental risk are clearly more in keeping with the government's priorities, advocates of such alternatives find limited institutional and discursive opportunities for advancing them at the federal level. Thus, opponents of GE maize confront the scientization of politics in the three ways outlined above. They use scientific information, organize participatory research, and attempt to redefine the problem of GE maize not simply as a matter of biodiversity protection, but also as an issue with great social, economic and cultural importance.

Using scientific information

In Mexico, Greenpeace activists and other environmentalists began to draw attention to the introduction of GE maize to Mexico through grain imports in the late 1990s. However, the key event that propelled Mexican activists' concerns about GE maize into the public spotlight was a study by David Quist and Ignacio Chapela, published in the journal *Nature,* on November 29, 2001. The scientists claimed to have found signs of transgenes in samples of native maize taken from the Sierra Juarez region of Oaxaca. Before the article was actually published, activists transformed the discovery into a massive public scandal.[2] Greenpeace Mexico, along with over fifty Mexican NGOs, scholars and activists, called for an "emergency plan" to deal with the contamination (Greenpeace Mexico 2001a; Greenpeace Mexico et al. 2001). The scandal reached international proportions when it was reported in *Nature* (Dalton 2001) and the *New York Times* (Yoon 2001) in late September and early October of 2001.

A coalition of organizations began the process of composing a "public denouncement" (*denuncia popular*), a formal legal complaint submitted to the section of

[1] English translation of the manifesto, "Defender nuestro maíz, cuidar la vida," available online at http://weblog.greenpeace.org/ge/archives/Oaxaca%20MANIFIESTO.pdf.

[2] While Quist and Chapela's findings were awaiting publication in Nature, Chapela shared the findings confidentially with regulatory officials in Mexico. In early September 2001, these officials broke their pledge of confidentiality and made the findings public.

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Mexico's environment ministry in charge of applying environmental legislation (Procuraduría Federal de Protección al Ambiente, PROFEPA). The 19-page document, signed by representatives of several civil society organizations[3] and Professor Alejandro Nadal of El Colegio de Mexico, compiled all known scientific data and outlined in detail each step in the discovery and announcement of transgenic contamination in Mexican maize. On the basis of that factual information and Mexican environmental law, the authors denounced PROFEPA for its failure to act to prevent the contamination and called for a ban on the import of GE corn from the US. The public denouncement was submitted to PROFEPA on December 6, 2001, barely a week after Quist and Chapela's research findings were officially published in *Nature*.

A Greenpeace Mexico e-bulletin on the day that Quist and Chapela's (2001) article was published points to the perceived weight of published scientific reports in this dispute. The announcement pointed out that the previous month, the Secretary of Agriculture, Javier Usabiaga, said that there was no scientific evidence of maize contamination. Greenpeace said, "Now we ask him if he thinks this article, published in one of the most important scientific journals in the world, seems like enough evidence to him" (Greenpeace Mexico 2001b, my translation). Almost immediately, however, critics attacked the credibility of Quist and Chapela's (2001) study (Delborne 2008). A variety of scientists submitted technical critiques of the study to *Nature*, two of which were published in April 2002. The study's methodology and analysis were also attacked in an editorial in *Transgenic Research* (Christou 2002, as cited in Delborne 2008). Furthermore, nearly one hundred pro-biotech scientists tried to diminish any sense of alarm raised by the study by signing a letter asserting that the kind of gene flow Quist and Chapela claimed to find was harmless, even welcomed (AgBioWorld Foundation 2002, as cited in Delborne 2008). Finally, in an unprecedented act, *Nature* published a statement withdrawing support from the Quist and Chapela (2001) article that the journal had originally published (*Nature* editor 2002, as cited in Delborne 2008).

With the evidence of maize contamination in question, anti-GE activists were in need of further scientific studies to support their positions. However, such studies remained "undone" (Woodhouse et al. 2002), and the one study that seemed to confirm Quist and Chapela's (2001) findings did not make it through the peer review process. From the time that Ignacio Chapela informed the Mexican government that he had found transgenes in maize growing in Oaxaca, Sol Ortiz-Garcia of Mexico's National Institute of Ecology (a government agency) began monitoring the presence of transgenes in that region. In 2002, Ortiz-Garcia and her colleagues announced that they possessed data to confirm Quist and Chapela's findings of low levels of transgenes in samples of native maize (Ezcurra and Soberón Mainero 2002). However, their report was not accepted for publication in *Nature*, and the results were never published in any other peer-reviewed journal. Thus, the finding that genetic contamination of native maize had occurred remained officially unreplicated.

Three years later, Ortiz-Garcia and her colleagues (2005) succeeded in publishing their most recent findings in the *Proceedings of the National Academy of Sciences*, a US scientific journal. Rather than a useful resource to anti-GE activists, however, the study undermined the movements' claims of irreversible contamination. The study reported that transgenes were no longer present in native maize in Oaxaca, since they found no evidence of transgenes in samples of maize over the course of 2 years (Ortiz-Garcia et al. 2005). The authors did not mention their earlier, positive findings, perhaps because of methodological questions raised in their earlier, unsuccessful attempt to publish them. The authors did not dispute Quist and Chapela's (2001) earlier findings, but rather argued that any previous contamination had been reduced to undetectable levels. This could have occurred, the authors indicated, because maize producers had become more careful about not planting seeds imported from the US. The authors also acknowledged that the study was limited to a narrow geographical area. When the Ortiz-Garcia et al. study was published, critics of Quist and Chapela's study used it to argue that previous findings of transgenes were simply the result of sloppy research, and that there had *never* been GE contamination. Despite the careful wording of the report by Ortiz-Garcia et al., it was widely reported in the press that it proved that Quist and Chapela had been wrong all along, and that there was no basis for claims of contamination. This view was promoted vehemently by *AgBioView*, a pro-biotech listserv (Morton 2005; Prakash 2005).

While the scientific debate has continued, with new findings of contamination published in a prominent journal (Pineyro-Nelson et al. 2009), it seems to have little effect on the regulation of GE maize imports and cultivation. The Mexican government decided to proceed with experimental cultivation of GE maize in 2009, just a few short months after the most recent study was published.

As this series of events illustrates, the use of science as a resource for collective action is hardly a reliable tactic.

[3] The organizations that signed were Greenpeace Mexico, the National Association of Marketing Organizations of Rural Producers (Asociación Nacional de Empresas Comercializadoras de Productores del Campo, ANEC), the Center for the Study of Change in the Mexican Countryside (Centro de Estudios para el Cambio en el Campo Mexicano, CECCAM), the National Union of Regional Autonomous *Campesino* Organizations (Unión Nacional de Organizaciones Regionales Campesinas Autónomas, UNORCA), and Environmental Studies Group (Grupo de Estudios Ambientales, GEA).

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Certainly, citizens' grievances are more likely to be heard in a context of scientized politics if scientists can speak on their behalf, so scientists have become crucial allies to citizens organizing for political change. However, as Yearley (1992) insightfully observes, science is an "unreliable ally," in part because scientists "accept in principle that their knowledge is revocable and incomplete" (Yearley 1992, p. 517). Science rarely provides the certainty that activists would like to rely upon, as this case illustrates. Furthermore, "members of the public may look for authoritative judgments and may be dismayed by factlessness," since the research that activists need may simply not be done (p. 518, 529).

Despite these obvious drawbacks, activists still may find that using scientific expertise as a resource has positive outcomes. Here, without the scientific controversy initiated by David Quist and Ignacio Chapela's discovery of transgenes in native Mexican maize, and continued by other scientists concerned about Mexican biodiversity, it seems unlikely that the Mexican anti-GE movement—prior to the publication of the study, consisting only of a small network of urban activists—would have grown into the more diverse and extensive network that is active today. There is also the possibility of more profound long-term impacts on the political authority of science, akin to the "politicization of science" discussed by Weingart (1999), which damages public perception of science as neutral, apolitical and trustworthy. Signs of distrust in science are particularly evident in the efforts of anti-GE activists to take research into their own hands.

Participating in scientific research

Responding to the limitations of the existing scientific knowledge about transgenic contamination of native maize, Mexican activists and farmers made a remarkable effort to generate new data. In January 2002, at a national forum on the topic of maize contamination, small-scale maize producers from many regions of the country said that they wanted to know whether the maize growing in their own communities was contaminated. It became evident, however, that neither the government nor academic scientists were about to undertake such a massive study. Therefore, in the months and years that followed, a coalition of organizations based in Mexico City responded to this need for further investigation by seeking funding for independent tests for contamination. Several grassroots and intermediary support organizations[4] jointly coordinated the research in collaboration with numerous rural communities.

In the first phase of the participatory study, maize samples were collected from 138 communities in nine different states of Mexico. Most of the samples were collected by farmers themselves and then tested by professionals in a commercial laboratory. Transgenes were found in maize samples taken from nine Mexican states—an important finding, since official studies had only focused on Oaxaca and Puebla (ETC Group 2003a). In 2003, the activists announced the findings internationally and circulated an "open letter" to the Mexican government and the international community, demanding that immediate action be taken to address the widespread contamination (ETC Group 2003b). The letter gained hundreds of signatures from organizations around the world. However, the Mexican government disregarded the findings and the petition. One reason for this may be that the scientific community did not recognize the findings. In interviews, a number of academic researchers who were critical of biotechnology said they were not even aware of the study—a sign that there was little communication between activists and the scientific community with respect to this investigation. It appears that the highly polarized and politically contentious nature of the issue led many scientists to fear reprisals if they were seen to be collaborating with anti-GE activists. Indeed, while some scientists aided the activists in certain aspects of the study, they wished to remain anonymous, and activists guarded the scientists' identities carefully.

Despite being ignored by authorities, the activists and farmers involved in the study remained confident in their findings, which permitted them to directly challenge those who claimed that contamination had gone away or never occurred. For example, when the study by Ortiz-Garcia and her colleagues (2005) put forth the argument that there was no longer any detectable maize contamination in Oaxaca, Mexican activists used their own findings to counter the scientists' claims. In a press release, the nonprofit ETC Group criticized "the biotech industry's self-serving interpretation of the study" and minimized the significance of the Ortiz-Garcia investigation (ETC Group 2005). The activists argued that the negative findings were not surprising, because some of the samples were taken in communities where the activist network had already done testing and found negative results. The press release quotes Baldemar Mendoza of UNOSJO: "We took samples in three of the 18 communities that the new report mentions

[4] The coordinators of the study were the Center for the Study of Change in the Mexican Countryside (Centro de Estudios para el Cambio en el Campo Mexicano, CECCAM), the National Center to Support Indigenous Missions (Centro Nacional de Apoyo a Misiones Indígenas, CENAMI), Action Group on Erosion, Technology and Concentration (ETC Group); the Center for Social Analysis, Information, and Popular Training (Centro de Análisis Social, Información y Formación Popular, CASIFOP); the Union of Organizations of the Sierra Juarez of Oaxaca (Unión de Organización de la Sierra Juárez de Oaxaca, UNOSJO); and the Jaliscan Association for Support to Indigenous Groups (Asociación Jalisciense de Apoyo a Grupos Indígenas, AJAGI).

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(San Juan Ev. Analco, Ixtlan, and Santa Maria Jaltianguis) and our results were also negative in those three communities" (ETC Group 2005). However, they suggested that contamination was widespread in other areas that had not been studied by Ortiz-Garcia and her colleagues.

Earlier, I hypothesized that participatory research not only produces new information; it may also undermine scientists' unique claims to produce useful knowledge of the natural world. That is, laypeople may also come to be seen as producing authoritative knowledge. In the example discussed above, the information that activists produced through their independent studies of maize contamination has been extremely useful to those opposing transgenic maize, particularly when faced with contradictory claims from scientific authorities. Certainly, among those involved in the movement, the unique authority of scientists to produce knowledge has been undermined. However, these efforts do not appear to have affected perceptions of the authority of experts or the contributions of laypeople in any broader sense. Unlike cases in which activist-led studies lead to collaborative efforts with scientists and are accepted as legitimate sources of scientific knowledge (for example, Corburn 2003, 2007), this instance of participatory research had little to no impact outside of the activist community itself. This observation points to a need for more research on the factors that lead authorities to accept some studies produced by laypeople as credible and legitimate sources of knowledge, while other participatory studies are ignored or discredited.

Reframing the problem

Social, economic and cultural issues associated with GE maize have not been on the national policy agenda. However, opponents of GE maize repeatedly argue that the problem is a matter of cultural and economic importance in addition to being a biosafety issue. The broadly social dimensions of the problem of GE maize in Mexico have been brought to the forefront in several ways. For example, there have been efforts to promote appreciation of traditional foods and diverse varieties of maize, both among maize producers and urban consumers. Such efforts include a restaurant in the city of Oaxaca, called Itanoní, run by an agronomist who wanted to create a market for locally-produced maize and traditional recipes. In addition, small NGOs and promoters of sustainable agriculture have organized multiple rural "maize celebrations." Another way that Mexican activists have attempted to steer the risk-oriented agenda toward a broader consideration of social issues has been to appeal to the international community. In one of these efforts, Mexico's National Council for Culture and the Arts (Consejo Nacional para la Cultura y las Artes, CNCA) applied (unsuccessfully) to the United Nations Education, Science and Culture Organization (UNESCO) to have Mexican cuisine recognized as "patrimony of humankind" (AFP y Notimex 2005; Cruz Bárcenas 2005). In a news report on the effort, Jaime Nulart of CNCA expressed his hopes that such a designation would provide a way to confront the "grave risks" to Mexico's traditional food system, referring to GE maize as one of those threats (AFP y Notimex 2005).

Of all the efforts to expand the narrowly technical definition of the problem of GE maize contamination, the most successful was waged through the Commission for Environmental Cooperation (CEC), a tri-national agency created through an environmental "side agreement" to the North American Free Trade Agreement. The CEC investigates complaints about environmental issues associated with trade between Canada, the US, and Mexico. In 2002, a group of organizations and rural communities successfully petitioned the CEC, asking the commission to study the issue of GE maize in Mexico and generate a set of recommendations. The CEC process brought together scientists and other experts with a wide range of views on the risks and benefits of GE crops. A public symposium was held in Oaxaca in March 2004. Farmers and anti-GE activists hoped that the process would lead to pressure on the Mexican state, ultimately forcing the government to stop the introduction of GE maize. Through colorful demonstrations and sometimes heated testimony to the CEC, farmers and activists urged the expert advisory group to consider a much wider range of issues than those that are normally addressed in scientific risk assessment of biotechnology—such as indigenous belief systems and the value of traditional agricultural practices.

Remarkably, despite their surprise and discomfort with the protests, the CEC experts responded positively. In a victory for activists, the expert report explicitly recognized the multiplicity of concerns about GE maize—mentioning even the spiritual significance of maize—and recommended a variety of steps to keep GE maize out of Mexican fields (Secretariat CEC 2004). The CEC report also echoed concerns that ordinary people have not been included in decision-making processes about transgenic crops, and called for more democratic processes of deliberation. However, the US and Canadian governments rejected the CEC report, saying that its recommendations did not follow from the scientific data. In other words, the CEC's emphasis on socioeconomic and cultural issues, including its assertion of the relevance of the knowledge and perspectives of rural people, deviated from the expectation for science-based decision making. With the US and Canada against the CEC recommendations, the Mexican government had little incentive to implement them.

Efforts to reframe narrowly technical definitions of policy problems in order to make political conflicts explicit

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are perhaps the most radical of the three tactics examined in this study. The use of scientific expertise as a resource and participatory research both leave intact the assumption that science is of utmost importance in resolving conflicts over GE crops; however, activists who bring cultural and economic issues to the forefront challenge the dominant approach to political decision making. In this case, the outcomes of activists' struggles to politicize the GE maize debate are somewhat mixed. On one hand, citizens' groups successfully expanded the CEC's definition of the GE maize "problem" to include cultural, economic and even spiritual dimensions. The CEC report lent international legitimacy to the movement in defense of maize and may serve as important political leverage in the future. On the other hand, at the national level, these efforts produced no tangible policy outcomes. In part, CEC's failure to generate policy changes in Mexico should be attributed to a structural shortcoming: all CEC recommendations are non-binding. But this episode also points to the resilience of scientized decision-making institutions, even when confronted with highly visible and disruptive citizen protests.

Conclusion

The forms of collective action discussed above contrast with the mainstream model of the citizen who lacks "understanding" of technical issues and passively interacts with expert institutions. Indeed, the farmers and activists involved in the defense of maize enacted practices that deeply questioned the privilege of experts in political decision making. This model of citizen engagement is particularly relevant to conflicts over agricultural biotechnology because, as in many contemporary conflicts over science and technology, at least some of the risks involved are invisible and difficult to comprehend without scientific investigation. Awareness of transgene flow, or genetic contamination, is particularly dependent on analysis at the molecular level. Yet opposition to GE crops, while necessarily informed by scientific knowledge, stems from a diverse array of political solidarities and organizations, including environmental movements, peasant alliances, and anti-hunger groups. Anti-GE activists thus combine scientific knowledge with knowledge of social problems derived from lived experiences and affiliations. It should not be seen as a contradiction, therefore, that opponents of GE crops use scientific knowledge to advance their claims while also asserting the relevance of other forms of knowledge.

In the case of anti-GE activism discussed here, three main tactics brought ordinary citizens into domains previously reserved for scientific authorities and other experts. These efforts led to some notable shifts toward the democratization of decision making about biotechnology. The first tactic was to use scientific expertise as a resource. The highly public controversy over Quist and Chapela's (2001) report of transgenic contamination of native maize, fueled in part by activist groups who raised the profile of the study even before it was published in *Nature*, became the basis for many observers to question whether science can truly provide nonpartisan, objective policy advice. The second tactic was to engage in participatory research, filling gaps in knowledge by collecting and analyzing data that experts neglected to study themselves. Here, activist-led participatory science was especially important, since so little scientific information was available about the extent of transgene flow in native maize. Farmers and other ordinary citizens gained confidence in their own knowledge and developed a strong foundation on which to base doubts about the published claims of some scientific experts.

The third tactic was to redefine the problem at hand in such a way that it no longer appeared appropriate to leave decision-making power in experts' hands alone. Maize activists challenged the framing of biotechnology in terms amenable only to scientific analysis, such as "risk" and "safety." In their interactions with the state and supranational bodies on the topic of biotechnology policy, farmers and other concerned citizens questioned the assumption that decisions about genetic engineering were merely technical matters. Resulting from this activism, the CEC moved away from dominant conceptions of risk assessment, asserting that farmers' and other citizens' perspectives should be included in the evaluation of GE maize. The CEC's endorsement of a more democratic and less scientized approach to decision making about biotechnology did not lead to the outcomes activists desired—such as halting the introduction of GE crops or creating policies that hold biotechnology companies responsible for genetic contamination. However, the process served as an important reminder that another approach to decision making was possible. It set a precedent and provides a source of legitimacy for future demands for multidimensional and participatory assessment of GE crops.

Despite the aforementioned accomplishments, the Mexican farmers and activists discussed in this study have achieved few political victories in their mobilization in defense of maize. When citizens confronted authorities with the findings of scientific experts, their opponents quickly attacked the credibility of the information. When activists conducted their own participatory research project, gathering data about the widespread contamination of native maize, authorities simply ignored the findings. And when protesters succeeded in convincing an international environmental commission to recommend a more multidimensional approach to evaluating the suitability of GE

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maize for Mexican agriculture, the Mexican government disregarded the commission's advice. Indeed, the Mexican government remains largely unresponsive to citizens' multiple concerns about transgenic crops.

The obstacles that maize activists faced in carrying out each of these efforts indicate that despite diverse and sophisticated engagements between social movements and the scientific field, scientization remains a significant institutional barrier to democratizing agricultural governance. In this context, theories of science and social movements may be useful in agri-food studies, but they must address the institutional barriers to democratizing agricultural governance. One potential way forward may be found in an emerging literature in sociology that considers the structures of power and inequality that shape the production and dissemination of knowledge (Frickel and Moore 2006). There are fruitful points of intersection between this "new political sociology of science" and studies of agricultural science, technology, and policy that focus on points of conflict, the construction of knowledge, and processes of rulemaking, such as standards-setting (e.g., Busch 2000; Hatanaka and Busch 2008). Additional case studies of agricultural governance and social movements should focus on the institutions that structure the possibilities for public participation in highly technical policy debates. Comparative analyses would be particularly useful in advancing this area of social theory. Such research would make welcomed contributions not only to the study of agricultural governance and agri-food systems, but also to the sociology of science and technology.

A research program on the scientization and democratization of agricultural governance must break with assumptions about the "neutral" role of scientific experts. In the present case study, the venue most willing to question the scientization of ag-biotech politics was a body made up of experts—primarily natural scientists: the Advisory Group of the CEC. This would seem to suggest that, while states may attempt to restrict citizen input into decisions by defining the issues in narrowly technical terms, scientists do not necessarily share the view that difficult problems can be solved on the basis of their expertise alone, a finding suggested in other studies of scientists whose work is relevant to environmental policy (Kinchy and Kleinman 2003). Furthermore, the CEC example signals that the scientization of biotech politics is double-edged. Scientization may limit broad debate if the science is fairly straightforward or has been determined to be a closed debate. But when scientific knowledge itself is controversial, contested, and offers no clear answers, as in the question of the effects of GE maize on biodiversity, (ostensibly) scientific processes may generate opportunities to insert social issues and lay perspectives into the debate.

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References

Abels, G. 2002. Experts, citizens, and Eurocrats: Towards a policy shift in the governance of biopolitics in the EU. *European Integration online Papers (EIoP)* 6. http://eiop.or.at/eiop/texte/2002-019a.htm. Accessed 14 Oct 2008.

AFP y Notimex. 2005. Pide México oficialmente reconocer su cocina como patrimonio universal. *La Jornada* (Mexico City), 20 September. http://www.jornada.unam.mx/2005/09/20/a03n1gas.php. Accessed 5 June 2007.

Beck, U. 1992. *Risk society: Towards a new modernity* (Trans: Ritter, M.). London: Sage (Originally published in 1986).

Bellon, M.R., and J. Berthaud. 2006. Traditional Mexican agricultural systems and the potential impacts of transgenic varieties on maize diversity. *Agriculture and Human Values* 23: 3–14.

Benveniste, G. 1973. *The politics of expertise*. London: Glendessary Press.

Brown, P., and E.J. Mikkelsen. 1990. *No safe place: Toxic waste, leukemia, and community action*. Berkeley: University of California Press.

Brown, P., S. Zavestoski, S. McCormick, B. Mayer, R. Morello-Frosch, and R.G. Altman. 2004. Embodied health movements: New approaches to social movements in health. *Sociology of Health & Illness* 26(1): 50–80.

Bullard, R.D. (ed.). 2005. *The quest for environmental justice: Human rights and the politics of pollution*. San Francisco, CA: Sierra Club Books.

Busch, L. 2000. The moral economy of grades and standards. *Journal of Rural Studies* 16: 273–283.

Buttel, F.H. 2005. The environmental and post-environmental politics of genetically modified crops and foods. *Environmental Politics* 14(3): 309–323.

Christou, P. 2002. Editorial: No credible scientific evidence is presented to support claims that transgenic DNA was introgressed into traditional maize landraces in Oaxaca, Mexico. *Transgenic Research* 11(1): iii–v.

Corburn, J. 2003. Bringing local knowledge into environmental decision making—improving urban planning for communities at risk. *Journal of Planning Education and Research* 22(4): 420–433.

Corburn, J. 2005. *Street science: Community knowledge and environmental health justice*. Cambridge, MA: MIT Press.

Corburn, J. 2007. Community knowledge in environmental health science: Co-producing policy expertise. *Environmental Science and Policy* 10(2): 150–161.

Couch, S.R., and S. Kroll-Smith. 2000. Environmental movements and expert knowledge: Evidence for a new populism. In *Illness and the environment: A reader in contested medicine*. New York: New York University Press.

Cruz Bárcenas, A. 2005. Fallo en contra de la comida mexicana como patrimonio de la humanidad, *La Jornada* (Mexico City), 26 November. http://www.jornada.unam.mx/2005/11/26/a10n1gas.php. Accessed 5 June 2007.

Dalton, R. 2001. Transgenic corn found growing in Mexico. *Nature* 413(6854): 337.

Delborne, J.A. 2008. Transgenes and transgressions: Scientific dissent as heterogeneous practice. *Social Studies of Science* 38(4): 509–541.

Author's personal copy

Driedger, S.M., and J. Eyles. 2001. Organochlorines and breast cancer: The uses of scientific evidence in claimsmaking. *Social Science and Medicine* 52(10): 1589–1605.

Dryzek, J.S., and A. Tucker. 2008. Deliberative innovation to different effect: Consensus conferences in Denmark, France, and the United States. *Public Administration Review* 68(5): 864–876.

Einsiedel, E.F., E. Jelsoe, and T. Breck. 2001. Publics at the technology table: The consensus conference in Denmark, Canada, and Australia. *Public Understanding of Science* 10(1): 83–98.

Elam, M., and M. Bertilsson. 2003. Consuming, engaging and confronting science: The emerging dimensions of scientific citizenship. *European Journal of Social Theory* 6(2): 233–251.

Epstein, S. 1996. *Impure science: AIDS, activism, and the politics of knowledge*. Berkeley: University of California Press.

Espeland, W.N. 1998. *The struggle for water: Politics, rationality, and identity in the American Southwest*. Chicago, IL: The University of Chicago Press.

Esteva, G., and C. Marielle. 2003. *Sin maíz no hay país*. Mexico City, Mexico: Museo Nacional de Culturas Populares.

ETC Group. 2003a. Nine Mexican States found to be GM contaminated (News release 9 October) at http://www.etcgroup.org/en/materials/publications.html?id=145. Accessed 28 June 2007.

ETC Group. 2003b. Open letter from international civil society organizations on transgenic contamination in the centers of origin and diversity, to the Mexican government and the international community. 19 November. http://www.etcgroup.org/en/materials/publications.html?pub_id=139. Accessed 24 June 2007.

ETC Group. 2005. The genetic shell game, or now you see it! Now you don't! (News release 11 August) http://www.etcgroup.org/upload/publication/50/01/etcmaizenrfinal.pdf. Accessed 28 June 2007.

Ezcurra, E., and J. Soberón Mainero. 2002. Evidence of gene flow from transgenic maize to local varieties in Mexico. In *LMOs and the Environment: Proceedings of an International Conference*, ed. OECD, 289–295.

Fischer, F. 2000. *Citizens, experts and the environment*. Durham, NC: Duke University Press.

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.

Frickel, S., and K. Moore (eds.). 2006. *The new political sociology of science: Institutions, networks, and power*. Madison, WI: University of Wisconsin Press.

González, R.J. 2001. *Zapotec science: Farming and food in the Northern Sierra of Oaxaca*. Austin: University of Texas Press.

González Aguirre, R.L. 2004. *La biotecnología agrícola en México: efectos de la propiedad intelectual y la bioseguridad*. Mexico City, Mexico: Universidad Autónoma Metropolitana.

Greenpeace Mexico. 2001a. Boletín 0174: México, primer centro de origen de un cultivo contaminado por maíz transgénico; exige Greenpeace aplicar un plan de emergencia. Mexico City, 11 September.

Greenpeace Mexico. 2001b. Boletín 0194: Científicos de todo el mundo llaman a tomar medidas para detener la contaminación genética del maíz mexicano. Mexico City, 29 November.

Greenpeace Mexico, et al. 2001. *Letter to Javier Usabiaga, Victor Lichtinger, Julio Frenk, Reyes Tamez, Francisco Gil, Luis Ernesto Dérbez, and Fernando Ortiz Monasterio, dated 4 October 2001*. Mexico City: Archive, Grupo de Estudios Ambientales.

Gupta, A., and R. Falkner. 2006. The influence of the Cartagena protocol on biosafety: Comparing Mexico, China and South Africa. *Global Environmental Politics* 6(4): 23–55.

Guston, D.H. 1999. Evaluating the first US consensus conference: The impact of the citizens' panel on telecommunications and the future of democracy. *Science Technology & Human Values* 24(4): 451–482.

Habermas, J. 1970. *Toward a rational society; student protest, science, and politics* (Trans: Shapiro, J. J.). Boston, MA: Beacon Press (Original published 1968).

Hatanaka, M., and L. Busch. 2008. Third-party certification in the global agrifood system: An objective or socially mediated governance mechanism? *Sociologia Ruralis* 48: 73–91.

Heller, C. 2001. From risk to globalization: Discursive shifts in the French debate about GMOs. *Medical Anthropology Quarterly* 15(1): 25–28.

Heller, C. 2004. Risky science and savoir-faire: Peasant expertise in the French Debate over genetically modified crops. In *The politics of food*, ed. B. Lien, and M. Nerlid. New York, NY: Berg.

Hess, D.J. 2009. The potentials and limitations of civil society research: Getting undone science done. *Sociological Inquiry* 79(3): 306–327.

Irwin, A. 1995. *Citizen science: A study of people, expertise and sustainable development*. London: Routledge.

James, C. 2006. *Global status of commercialized biotech/GM crops: 2006*, 35 ed, ISAAA. Ithaca, NY: International Service for the Acquisition of Agri-Biotech Applications.

Jasanoff, S. 1995. *Science at the bar: Law, science, and technology in America*. Cambridge, MA: Harvard University Press.

Jasanoff, S. 2005. Judgment under siege: The three-body problem of expert legitimacy. In *Democratization of expertise? Exploring novel forms of scientific Advice in political decision-making*, ed. S. Maasen, and P. Weingart, 209–224. Dordrecht, The Netherlands: Springer.

Joss, S. 2005. Between policy and politics, or: Whatever do weapons of mass destruction have to do With GM crops? The UK's GM nation debate as an example of participatory governance. In *Democratization of expertise? Exploring novel forms of scientific advice in political decision-making*, ed. S. Maasen, and P. Weingart, 171–187. Dordrecht, The Netherlands: Springer.

Khagram, S. 2004. *Dams and development: Transnational struggles for water and power*. Ithaca, NY: Cornell University Press.

Kinchy, A.J., and D.L. Kleinman. 2003. Organizing credibility: Discursive and organizational orthodoxy on the borders of ecology and politics. *Social Studies of Science* 33(6): 869–896.

Kinchy, A.J., D.L. Kleinman, and R. Autry. 2008. Against free markets, against science? Regulating the socio-economic effects of biotechnology. *Rural Sociology* 73(2): 147–179.

Kleinman, D.L. (ed.). 2000. *Science, technology and democracy*. Albany, NY: SUNY Press.

Kleinman, D.L., and A.J. Kinchy. 2003a. Boundaries in science policy making: Bovine growth hormone in the European Union. *The Sociological Quarterly* 44(4): 577–595.

Kleinman, D.L., and A.J. Kinchy. 2003b. Why ban bovine growth hormone? Science, social welfare, and the divergent biotech policy landscapes in Europe and the United States. *Science as Culture* 12(3): 375–414.

Kleinman, D.L., and A.J. Kinchy. 2007. Against the neoliberal steamroller? The biosafety protocol and the social regulation of agricultural biotechnologies. *Agriculture and Human Values* 24(2): 195–206.

Lapp, R.E. 1965. *The new priesthood: The scientific elite and the uses of power*. New York, NY: Harper and Row.

Leach, M., I. Scoones, and B. Wynne (eds.). 2005. *Science and citizens: Globalization and the challenge of engagement*. London: Zed Books.

Levidow, L. 1998. Democratizing technology—or technologizing democracy? Regulating agricultural biotechnology in Europe. *Technology in Society* 20(2): 211–226.

Author's personal copy

Levidow, L. 2001. The GM crops debate: Utilitarian bioethics? *Capitalism, Nature, Socialism* 12(1(45)): 44–55.

Levidow, L., J. Murphy, and S. Carr. 2007. Recasting "substantial equivalence"—transatlantic governance of GM food. *Science Technology and Human Values* 32(1): 26–64.

Leydesdorff, L., and J. Ward. 2005. Science shops: A kaleidoscope of science-society collaborations in Europe. *Public Understanding of Science* 14(4): 353–372.

Maasen, S., and P. Weingart (eds.). 2005a. *Democratization of expertise? Exploring novel forms of scientific advice in political decision-making*. Sociology of the sciences yearbook, vol. 24. Dordrecht, The Netherlands: Springer.

Maasen, S., and P. Weingart. 2005b. What's new in scientific advice to politics? In *Democratization of expertise? Exploring novel forms of scientific advice in political decision-making*, ed. S. Maasen, and P. Weingart, 1–20. Dordrecht, The Netherlands: Springer.

Massieu Trigo, Y.C., and A. San Vicente Tello. 2006. El proceso de aprobación de la ley de bioseguridad: política a la mexicana e interés nacional. *El Cotidiano* 21(136): 39–51.

McAfee, K. 2008. Beyond techno-science: Transgenic maize in the fight over Mexico's future. *Geoforum* 39: 148–160.

McCormick, S. 2007. Democratizing science movements: A new framework for mobilization and contestation. *Social Studies of Science* 37(4): 609–623.

Moore, K. 2006. Powered by the people: Scientific authority in participatory science. In *The new political sociology of science: Institutions, networks, and power*, ed. S. Frickel, and K. Moore, 299–323. Madison: University of Wisconsin Press.

Morello-Frosch, R., S. Zavestoski, P. Brown, R.G. Altman, S. McCormick, and B. Mayer. 2006. Embodied health movements: Responses to a 'scientized' world. In *The new political sociology of science: Institutions, networks, and power*, ed. S. Frickel, and K. Moore, 244–271. Madison: University of Wisconsin Press.

Morton, R. (2005). Mexican government studies on transgenes in Mexican maize? *AgBioView* 1 November. http://www.agbioworld.org/newsletter_wm/index.php?caseid=archive&newsid=2435. Accessed 14 Oct 2008.

Nadal, A. 2006a. Mexico's corn-producing sector: A commentary. *Agriculture and Human Values* 23: 33–36.

Nadal, A. 2006b. Ventana de oportunidad. *La Jornada* (Mexico City) 18 October. http://www.jornada.unam.mx/2006/10/18/033a1eco.php. Accessed 6 June 2007.

Noble, D. 1977. *America by design*. New York, NY: Knopf.

Norrell, B. (2006). Annual World Water Forum disappointing to indigenous. *Indian Country Today* 10 April. http://www.indiancountry.com/content.cfm?id=1096412796. Accessed 3 June 2007.

Ortiz-Garcia, S., E. Ezcurra, B. Schoel, F. Acevedo, J. Soberon, and A.A. Snow. 2005. Absence of detectable transgenes in local landraces of maize in Oaxaca, Mexico (2003–2004). *Proceedings of the National Academy of Sciences* 102: 12338–12343.

Pineyro-Nelson, A., J. Van Heerwaarden, H.R. Perales, et al. 2009. Transgenes in Mexican maize: Molecular evidence and methodological considerations for GMO detection in landrace populations. *Molecular Ecology* 18: 750–761.

Powell, M.C., and M. Colin. 2008. Meaningful citizen engagement in science and technology—what would it really take? *Science Communication* 30(1): 126–136.

Prakash, C. S. (2005). Duh… No GM genes in Mexican corn. *AgBioView* 9 August. http://www.agbioworld.org/newsletter_wm/index.php?caseid=archive&newsid=2398. Accessed 14 Oct 2008.

Price, D.K. 1965. *The scientific estate*. Cambridge, MA: Harvard University Press.

Quist, D., and I.H. Chapela. 2001. Transgenic DNA introgressed into traditional maize landraces in Oaxaca, Mexico. *Nature* 414: 541–543.

Sarewitz, D. 2004. How science makes environmental controversies worse. *Environmental Science and Policy* 7(5): 385–403.

Sclove, R. 1995. *Democracy and technology, the conduct of science series*. New York, NY: Guilford Press.

Secretariat of the Commission for Environmental Cooperation. 2004. *Maize and biodiversity: The effects of transgenic maize in Mexico*. Montreal, Canada: Communications Department of the Commission for Environmental Cooperation.

Snow, C.P. 1961. *Science and government*. Cambridge, MA: Harvard University Press.

Soleri, D., and D.A. Cleveland. 2006. Transgenic maize and Mexican maize diversity: Risky synergy? *Agriculture and Human Values* 23: 27–31.

Weingart, P. 1999. Scientific expertise and political accountability: Paradoxes of science in politics. *Science and Public Policy* 26: 151–161.

Woodhouse, E., D. Hess, S. Breyman, and B. Martin. 2002. Science studies and activism: Possibilities and problems for reconstructivist agendas. *Social Studies of Science* 32(2): 297–319.

Yearley, S. 1992. Green ambivalence about science: Legal-rational authority and the scientific legitimation of a social movement. *The British Journal of Sociology* 43(4): 511–532.

Yoon, C.K. 2001. Genetic modification taints corn in Mexico. *The New York Times*, October 2, F7.

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