



A new approach to governing GM crops?

Global lessons from the rising powers

A working paper by Durham University

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Executive summary

Background

- Although the rise of genetically modified (GM) crops has been dramatic, their uptake has not been the smooth nor universal transition predicted by its advocates. Controversy has been marked even in those countries where approvals have been impressively rapid. All too commonly the regulation of GM crops has been challenged as inadequate, even biased.
- The present study was undertaken by Durham University, in partnership with local research teams and advisors in Mexico, Brazil and India. The research was funded by The John Templeton Foundation under the banner 'Can GM crops help to feed the world?'
- Our strategic question was that unless we examine why GM crops have not been universally accepted as a public good, we will fail to understand the conditions under which 'GM crops can help to feed the world'.

The study

- Current approaches to the regulation and governance of GM crops has been dominated by risk-based assessment methodologies, the assumption being that the key criterion mediating the release of GMOs into the environment should be an independent case-by-case risk assessment of its impacts on human health and the environment.
- One consequence is that the public debate surrounding GM crops has tended to be funneled down to one of (bio)safety: are GM crops safe? Are they safe to eat? Are they safe to the environment? Do they have adverse impacts on biodiversity? Do they have cumulative or long-term effects?
- In relation to these questions we remain agnostic. Our argument is otherwise. Our argument is that if we are to govern GM crops in a socially robust fashion, we need to engage with the issue within the terms of the debate as it is considered by an inclusive array of actors, including publics, scientists and farmers.
- The fieldwork was undertaken in three of the global 'rising powers': Mexico, Brazil and India. The rationale was threefold: due to the strategic importance of these countries to debates on global food security, to add to existing scholarship on the socio-political dimensions of GM crops in developing world contexts, and the importance of working in those countries to help build capacity. In addition, there are important distinctions between India, Brazil and Mexico that warrant comparative analysis.

The methodology

- A set of research activities was developed for each of the three case study sites (Brazil, India and Mexico). The in-country field research took place in each national setting over a nine-month period and was conducted by local researchers, overseen by Durham University.
- The research included: a review of the debate over GM crops in each country, a nine week ethnography with farmers and other actors in a rural setting, a set of interviews and a questionnaire with stakeholders, a series of focus groups with mostly urban consumers, a participation observation study in a public or nonprofit national research laboratory and a deliberative workshop with stakeholders asking how to advance the debate on GM crops.

Findings: Mexico

- In Mexico, the controversy over GM maize came to prominence in 2001/2002, following a highly publicised article in the journal *Nature*, reporting the flow of transgenes into wild maize populations (the paper was later retracted). This set the scene for subsequent widespread and continuous protest.
- Maize is highly culturally resonant in Mexico, and protests against GM maize came to signify the defence of Mexican culture and identity in the face of an unwanted form of imposed globalization.
- The decisions by regulatory bodies have been seen as compromised and lacking in transparency. They have been contested vocally by NGOs and questions have been raised about their legality. There has been little sustained effort by institutional actors, including the Mexican State, to engage the public.
- The ethnographic fieldwork was conducted with smallholder farmers and other stakeholders in the Pátzcuaro Lake region in the State of Michoacán. We found that debates on GM maize were situated within the context of an on-going crisis in rural agriculture. We found strong and enduring social relations around maize agriculture.
- Within this context GM maize was seen as a likely intrusion into traditional practices, with unknown and likely negative impacts. Suspicion was exacerbated by deep patterns of mistrust expressed in the motivations of key actors, including the government and the seed companies.
- In the stakeholder interviews we found a clear division between the views of smallholders, consumers, environmental NGOs and social scientists and those of large producers and representatives of seed companies. For the former, traditional maize agriculture was perceived as highly significant for Mexican culture, GM maize was perceived as an imposition and transgression, and regulatory bodies and laws were seen as largely compromised and ineffective. For the latter, GM maize was seen as part of a modernity that would help transform the Mexican countryside from its current malaise.
- In a laboratory ethnography conducted at the National Laboratory of Genomics for Biodiversity (LANGEBIO) in Guanajuato, we found a clear distinction between senior and older researchers who tended to be uniformly in favour of GM crops, including GM maize, and younger and more junior researchers who were more cautious and nuanced. For the latter, any attempt to restructure the maize genome was treated with caution, with preference not to introduce foreign genetic material from other species, so as to help safeguard maize's integrity.
- In the public focus group research we found a deep appreciation of maize products and cooking. We identified a general negative reaction to GM foods and crops, especially to GM maize but to other GM crops too. This was exacerbated by various factors: the sensed lack of reliable information, the absence of labelling, mistrust in the motives of seed companies, the unknown dangers that GM foods may bring and the lack of proven necessity. The government, the seed companies and regulatory bodies all lacked credibility.
- In the deliberative workshops, we found broad agreement on the need to reopen up the public debate on GM crops: to give more voice to small farmers, to rekindle the debate on native maize and food security, to develop more rigorous policies on maize, and to develop agricultural research that secures genuine sustainable development.

Findings: Brazil

- In Brazil, we found that the debate over GM crops had been noisy and divisive, with strong coalitions both for and against GM crops active until 2005, but without widespread public engagement.
- Following the adoption of the Biosafety Law in 2005 the coalition against GMOs lost momentum. GM crops in Brazil then increased dramatically, especially GM soya and maize. By 2012, the coverage of GM crops in Brazil had risen to 36.6 million hectares or 21% of the global biotech crop, the world's second producer of GM crops behind the US.
- By 2008, a new alliance had developed, between Embrapa and big soya producers, acting in both GM crop markets and non GM crop markets. Concerns started to mount over weed resistance to glyphosate and its implications for increased herbicide use.
- The ethnographic research was conducted with mainly family farmers in the western region of Santa Catarina. GM crops tended to be seen as an inevitable part of the future. We found that while GM crops were perceived to have certain technical advantages (e.g. ease of working the land), they were adopted mainly on pragmatic terms. We found evidence of a conflict between farmers and technical experts from the seed companies, each blaming each other for the growing problem of weed resistance to glyphosate.
- In the stakeholder interviews we found predominantly negative views: that GM agriculture was creating dependency on seed companies, threatening traditional forms of life and generating potential risks to human health and the environment. We found that while most respondents agreed that the debate had receded, that it had been thus far dominated by a few powerful voices – namely large farmers, scientists and the seed companies – with limited involvement of the public or access to quality information.
- In the laboratory ethnography, conducted at the soya division of the agricultural research organisation Embrapa, we found clear and unqualified optimism amongst scientists that GM technologies would provide significant future agricultural improvement. The arguments deployed tended to be instrumental and nationalistic, emphasising economic benefits, the apparent unparalleled ability of GM technologies to provide 'improvements' and the necessity for GM research to have a strong national base. We found little evidence of a structured and sustained debate with wider society, which was represented, by and large, as uninformed. Non-scientific actors were seen as equally unqualified for entering the debate on GM crops.
- In the public focus groups we found an apparently growing interest in food quality and safety from the middle classes and from women, with a fairly intense concern with the industrialization of foods, and, for at least the better off, a desire to consume foods as organic and local as possible. When introduced to the topic of GM crops and foods, we found little knowledge or awareness and genuine surprise about the extent of their adoption. Through the discussions, participants adopted largely negative opinions, not least because the technology was seen as benefiting the producer (not the consumer) and because they had not been consulted. Participants called for wider responsibility, particularly from government and educational institutions, for assuring more robust regulation and oversight, for raising consciousness and for promoting the public interest.
- In the deliberative workshop, we found a clear majority of participants calling for the debate on GM crops on its regulation to be reopened, for concerted action to communicate reliable information, and for new channels of citizen participation in strategic decisions, although there remained a widespread feeling of impotence in facing the power of the alliance between scientists, seed companies and politicians.

Findings: India

- In India the debate over GM crops has been equally divisive. National media attention began in 1998 with fears that Monsanto's importation of Bt Cotton would include a terminator gene that would make farmers dependent on seed companies. Despite Monsanto's protestations, Bt cotton became a symbol of a struggle against multinationals, neoliberal logics, the US and globalization. In 2001, Bt cotton was found to be grown illegally; in 2002, this was approved retrospectively.
- The regulatory body, the Genetic Engineering and Approval Committee (GEAC), has been routinely criticized as having inadequate procedures for the approval of GM crops. In 2009, the introduction of Bt brinjal – a type of aubergine indigenous to India – was approved for commercial release by GEAC following field trials in 2008. This was later rescinded. In 2013, the Indian Supreme Court issued what appeared to be an indefinite moratorium on food crops (with the exception of Bt cotton which is widely cultivated).
- The ethnographic fieldwork was conducted with small family farmers – both in organic and conventional farming villages – in the Kalahandi district in the west of Odisha. We found an increasing prevalence towards the cultivation of Bt cotton in the conventional village, which now accounts for over 95% of cotton cultivation in India, due to higher yields and increased incomes. We saw that BT cotton was being aggressively marketed by seed companies.
- This was seen as having positive and negative impacts. As well as increasing incomes, the increased coverage of Bt cotton was making it difficult for the farming community to access traditional varieties of food crops. In recent years Bt cotton crops had become affected by increased pest attacks and had led farmers to consider previously available seed varieties. However, farmers find themselves often 'locked-in' to using Bt cotton with indigenous seeds no longer so easily available.
- In the stakeholder interviews we found that the two consistent negative views on GM crops in India were dependency on seed companies, and the possible risk or danger to human health and environment. We found that both stakeholders in favour of GM crops and those against tended to use a similar argument from science: that science, in principle, when conducted in an unbiased manner, would settle the issue.
- In the laboratory ethnography conducted at the New Delhi branch of the International Centre for Genetics and Biotechnology (ICGEB), we found that scientists were opposed to the moratorium and that they tended to construct and perceive the position of anti-GMO actors as 'ignorant' or aimed at 'publicity' seeking. Scientists' critique of the moratorium was often framed in terms of post-colonial discourse, as they argued that India could not afford the risk of 'falling behind' in the development of biotechnology.
- In the public focus group research the majority of our participants developed negative opinions on GM crops and foods. Urban consumers pointed out that they did not trust the government and the local authorities to provide a reliable regulatory system for the production of GM crops and therefore would prefer to avoid the consumption of GM food. They suggested that information provided by the Indian media on GMOs was confusing. Rural consumers also argued that GM seeds were interfering with the preservation of indigenous seeds.
- In the deliberative workshop, we found that participants from different categories of stakeholder were eager to engage in a dialogue and emphasised the importance of considering diverse points of views in deciding the future of GM crops in India.

A comparative analysis

- We found that in all three cases the technical regulatory bodies charged with approvals for the release of GMOs had not provided 'authoritative governance'. Across all three jurisdictions, decisions had been rejected as biased, unlawful, unconstitutional and lacking in transparency.
- We offered a typology aimed at explaining why the controversy surrounding GM crops had taken different forms in different national settings. Factors that were relevant included: the perceived authority of the regulatory agencies, the cultural resonance of the crop in question, the level of intensity of protest movements, the extent to which the GM crop can become represented as a symbol of wider struggle and the degree of sustained effort by institutional actors to engage the public.
- Using this typology, the authority of the regulatory bodies across all three national contexts can be characterised as weak. The cultural resonance of the GM crop in question can be seen as high in the case of cotton (in India) and maize (in Mexico) but less so in the case of soya (in Brazil). The protest movements against GM crops were sustained in India and Mexico but petered out in Brazil since 2005. Across all cases, GM crops have been represented as a symbol against globalization and neoliberal policies. Across all sites, there has been little attempt by institutional actors to engage the public.
- Comparing the field ethnographies, we found that GM maize in Mexico represents a unique case. The cultural resonances surrounding maize suggest that any introduction of GM maize would likely be perceived as a threat both to traditional practices and to a national sense of identity.
- We also found on the ground evidence in India and Brazil of the prevalence of glyphosate-resistant weed species. In both cases, we found that seed companies and farmers were tending to blame each other, with farmers finding that they had become increasingly 'locked-in' to GM agriculture, finding it hard to revert to previously available indigenous seeds.
- Comparing the stakeholder interviews, we found a divide between those who also represented GM crops as part of a gradual and continuous path of science working towards agricultural improvement (mostly representatives from seed companies and some natural scientists), and those who saw GM crops as a rupture or break with conventional breeding practices (mostly smallholder farmers, environmental and consumer NGOs, women's associations and indigenous groups). For the latter, GM crops tended to be perceived as engendering further dependency on seed companies, as presenting novel and unknown risks, and as disrupting traditional farming practices and lifestyles. There was near consensus from the latter constituency that decision-making thus far had lacked transparency and broad participation.
- Comparing the research laboratory ethnographies, we found that the research culture of each was lacking in broad '*reflexivity*' and '*inclusiveness*'. Researchers were not encouraged to work with other disciplines, including social scientists. And even through each of the laboratories operated with a strategic context, what constituted the national or public interest tended to be taken as a given, with little opportunity for deliberation with external actors in public forums.
- Comparing the consumer focus group research, we found that lay people were able to engage in meaningful debate on GM crop technologies. Across the board, we found little public enthusiasm for GM crops and foods and a hardening of response as the discussions developed. People adopted negative views partly because they felt they had

not been consulted, partly because GM foods were perceived to be unnecessary and potentially harmful, and partly because regulatory agencies and seed companies were not trusted to operate in the public interest.

- There were some specifics: in Mexico GM maize was represented as a symbol for the apparent collusion between the political class and large corporations at the expense of the wider public interest. While for some of our Indian participants, particularly from rural areas, the actual gene used in the genetic modification of plants was seen as relevant. Insertion of animal genes into plants was seen generally as less acceptable as this would transgress religious taboos.
- Finally, we compared the stakeholder deliberative workshops. We found, generally, that the attempt to develop a new kind of conversation on GM crops and their governance was welcomed across all three national contexts, with a surprising degree of consensus between participants. Stakeholders tended to prioritise the call for novel forms of public engagement, for the production of high quality and reliable information, for educational establishments to foster the development of critical citizens and for governments to govern in the public interest.

A framework for governance

- The key factors that explain the controversy over GM crops were found to be social and institutional in nature, and transcend beyond the question of technical risk: i.e. the extent to which GM crops would (or would not) pose a risk to human health and the environment. There is little capacity and few rules or norms within current policy arrangements to respond to these matters of concern. Such considerations thus tend to become hidden from public accountability and influence.
- Responding to this 'institutional void' we propose a novel way to govern GM crops informed by recent debates on responsible innovation. The 'anticipation', 'inclusion', 'reflexivity', 'responsiveness' dimensions are proposed – the AIRR framework – as offering potential for informing governance deliberation. The responsible innovation framework is being implemented in the UK by the research councils and across the synthetic biology research landscape, with wider implementation in Europe.
- The anticipation dimension responds to the need to describe and analyse the impacts, intended or otherwise (e.g. economic, social, environmental), that may arise through the development of a technology. It does not seek to predict but rather to support an exploration of possible impacts and implications that may otherwise remain uncovered and little discussed. The reflexivity dimension calls on scientists to reflect on the purposes of, motivations for and potential implications of their research, and the associated uncertainties, areas of ignorance, assumptions, framings, questions, dilemmas and social transformations these may bring. The inclusion dimension calls on scientists to open up such visions, impacts and questioning to broader deliberation and debate in an inclusive way with public and stakeholder groups. The responsiveness dimension calls on institutional actors to use these processes to influence the direction and trajectory of the research and innovation process itself.

Chapter 1 Introduction

1.1 Context for project

This working paper reports on a John Templeton Foundation funded project titled: 'Understanding the social, cultural and religious factors that shape the acceptance, use and resistance to GM crops'. The project responds to a call for proposals under the banner 'Can GM crops help to feed the world?' Approximately 15 projects were funded, this one included, from across the social and life sciences. Our strategic question was that unless we examine why GM crops have not been universally accepted as a public good, we will fail to understand the conditions under which 'GM crops can help to feed the world'.

The regulation and governance of GM crops has been dominated by risk-based assessment methodologies. Different approaches to regulation have emerged between the United States and the UK/Europe, between broadly product-based approaches which assume that genetic engineering as a process presents no special risks that could not be addressed by existing product-oriented legislation, and process-based regulation which assume that the potential risks of GM crops require additional forms of control and regulation that can not be accommodated with existing regulatory structures. Nevertheless, the assumption remains, that the key criterion mediating the release of GMOs into the environment should be an independent case-by-case risk assessment of its impacts on human health and the environment.

For this reason, it is perhaps not surprising that the public debate surrounding GM crops has too often been funneled down to one of (bio)safety: are GM crops safe? Are they safe to eat? Are they safe to the environment? Do they have adverse impacts on biodiversity? Do they have cumulative or long-term effects? Are risk assessment methodologies sufficiently robust to answer these questions? What does the application of the precautionary principle mean in relation to these questions? And is it being applied appropriately?

In relation to these questions we remain agnostic. While we agree that there is little definitive evidence of harms directly attributable to the introduction of GM crops, we can also point to research that provides evidence of potential harm, both to human health and to the environment, and that at least warrants further research and the application of additional public resource. Nevertheless, our argument is otherwise. Our argument is that if we are to govern GM crops in a socially robust fashion, we need to engage with the issue within the terms of the debate as it is considered by an inclusive array of actors, including publics and farmers.

1.2 The project questions

Our long-term vision is to develop a model of social science that engages with and contributes to policy and scientific debates on GM crop technology assessment and appraisal.

In the project we asked three big questions:

Q1) What intellectual innovations are required to enrich the debate on GM crops and foods at the level of culture and ontology, alongside considerations of risks to human health and the environment, and to inquire on the spirit in which GM crops can and should be developed, if at all?

Intellectual innovation is needed to move beyond risk-based analyses. Risk-based approaches are not equipped to understand the meanings of GM crops and foods from the perspectives and practices of actors themselves, and ignore that societal goals are not decided on a purely technical basis. New approaches are required that seek to understand the far-reaching dilemmas GM crop technologies raise concerning the meaning and purpose of the natural and the human. Our assumption is that social scientific treatments of culture and religion may provide more appropriate vocabularies for examining issues such as knowledge, right to life, identity, the relationship between humanity and the globe, and the sacred. In this we are fully aware of the worldviews and values that move billions of human beings in the planet; we wish to make a strong case for taking them on board. We believe that by exploring and deploying both vocabulary and meanings within GM debates we may be able to stimulate a change in the way GM crops are seen by key actors (regulators, scientists, politicians), and thus help reconfigure GM debates to allow for cultural and spiritual dimensions to be considered in more equal terms. Such ambitions are important if we are to comply with the requirements of democracy and pluralism in a globalized world.

Q2) What methodological innovations are required to enable dialogue and engagement aimed at giving due consideration to issues of truth, vision, tradition and human flourishing; at securing voice and space for diverse actors across different contexts; at embedding the ensuing results in community practices; and at reflecting them in policy debates?

Methodological innovation is required to develop deep cultural understanding of public and stakeholder attitudes, and to build on existing analyses (including in our three target countries) which have tended to be largely quantitative in nature. Our assumption is that ethnographic and in-depth qualitative methodologies may help capture the complexity of understandings and practices surrounding GM crops and foods, and thus help clarify the reasons behind the ambivalence of actors towards them. By unpacking and communicating this complexity in its socio-cultural dimensions we expect to generate a rich public and stakeholder understanding of how GM perspectives are permeated by and embedded in specific socio-cultural and religious beliefs and practices, and to initiate a process of inclusion of actors' voices traditionally excluded from GM debates. Ethnographic and qualitative research strategies also help to direct attention to unheard or dismissed voices in their own forms of articulation and reasoning.

Q3) What innovations in policy are required to institutionalise creative interaction between regulators, scientists, farmers and publics, in which views and interests can be shared, debated and negotiated with sensitivity and fairness, and in which a set of comprehensive policy options and narratives can be developed?

The divisive rows over GM crops present a cautionary tale of the dangers of relying on a model of policy deliberation that remains technocratic, risk-based and with little scope for citizen involvement. In the context where radical technological change is required to face the challenges of global food security, this project proposes new deliberative policy innovations in which plant scientists, regulators, farmers and publics can share and negotiate their views with empathetic sensitivity, through deep culture-sensitive conversation. Our assumption is that these deliberative mechanisms, as developed and tested throughout the research, may provide a setting for stakeholders and regulators to experiment in the deployment and embedding of new and more democratic deliberative and regulatory practices.

1.3 The case studies

The fieldwork was undertaken within and across three of the global 'rising powers': Mexico, Brazil and India. The rationale for focusing on three non-Western settings was threefold: the strategic importance of these national settings to debates on global food security; to add to existing scholarship on the socio-political dimensions of GM crops in developing world contexts; and the importance of working with local actors within each of these countries to help build capacity. In addition, there are important distinctions between India, Brazil and Mexico that warrant comparative analysis.

As will become evident in Chapter 2, the debate surrounding GM crops in Mexico has been dominated by social and cultural sensitivities surrounding maize. Mexico is the Centre of Origin of maize and traditional maize agriculture continues to be practiced by over 2 million farmers. In addition, maize is and has been a fundamental part of the Mexican diet and of its culture and society, for millennia. This specificity provides thus a case study to examine how cultural arguments are accommodated (or not) within regulatory frameworks on GM crops hitherto dominated by risk science. It also represents an opportunity to examine how the voices of diverse stakeholders – notably smallholders, indigenous groups and religious organisations – are heard (or not) within a macro-economic context of increasingly neoliberal policy-making.

Brazil represents a different case. As we will see in Chapter 3, following an period of intense confrontation involving broad coalitions both for and against the technology, Brazil's approval and application of GM crops since 2005 has been rapid and to some sense remarkable. The Brazil case offers the opportunity to examine the factors that contributed to this rapid growth of application by farmers, while taking into account the manner in which various actors and coalitions have been resistant. It also offers an opportunity to examine the ways in which GM crop technologies have been adopted into local agricultural practices, with a particular focus on GM soya. Finally, it offers an opportunity to explore how lay people feel about eating GM foods (which they now have been doing for a decade, even if many are unaware of this) as well as their responses to the wider public debate.

India represents a different case once more, as evidenced in Chapter 4. With the exception of GM cotton, India has established in recent years a moratorium on GM crops, a response to the perceived limitations of its regulatory system as well as a reflection of widespread cultural sensitivities. India offers an opportunity to diagnose why the debate has not been settled (as might on the surface appear to be the case in Brazil), and to understand how by key stakeholders, including scientists comprehend this uncertainty. Given the size of the country, India further offers the opportunity to understand how the public interest has been represented: whose voices have been seen to count and whose have not, as well as how scientists are framing the 'public value' of GM technologies and their relationship to Indian society.

1.4 The strategic opportunity

There now exists a body of social science scholarship on the GM crop and food controversy, using a range of intellectual resources and traditions. These include: actor network theory, bioethics, Christian ethics, cultural theory, democratization theory, discourse analysis, globalization theory, media analysis, mobilization theory, political culture, public engagement studies, regulatory science, resource mobilization theory, political economy, reflexive modernisation, science and technology studies, social amplification of risk theory, social representation theory and the sociology of expectations, amongst others. This

considerable literature on biotechnology and GM crops includes detailed analyses of the controversy and its unfolding, from the perspectives of particular nation states as well as from a comparative perspective.

From the extant literature one can highlight six dynamics that help explain how the controversy emerged and the forms that it took in the UK and Europe. First, there is the argument that early and revolutionary promises from the promoters of the technology – that GM technology would help the poor, alleviate poverty and hunger, address nutritional deficiencies, help feed the world, contribute towards sustainability and provide better quality foods – while perhaps plausible from a technological perspective, and while constitutive of a pervasive technoscientific imaginary (Marcus 1995), were not reflected in practice, at least as regards the outcomes of the first generation of GM crops (Conway 1999; Lipton 2001). The two main types of GM crops that currently exist – (a) crops that have been rendered herbicide resistant (HR) through the insertion of novel genes that code for resistance to the toxic effects of a herbicide (most often Roundup or Liberty herbicides), and (b) crops that have been rendered insect resistant through the insertion of novel genes that code for insect resistance (usually from the soil bacterium *Bacillus thuringiensis*, or 'Bt') – were not designed explicitly with the aim of producing environmental or health/ consumer benefits (Conway 2000, ESRC 1999). Both technologies were aimed to help the producer, not the consumer or the environment, and can be considered to be mechanization technologies, enabling farmers to reduce labour costs and to farm larger acreages of crops, such as soya and maize (Buttel 2005). These technologies were aimed at affecting practices of food production, not the quality of the food produced.

A second consideration concerns the very restricted scope for public stakeholder involvement in the innovation R&D trajectory of GM crop technologies and in processes of regulation and oversight. Wider appreciation of, or sensitivity towards, public values was not regarded a relevant variable. Technologies were promoted on economic grounds, with the market as the arbiter, while regulation was viewed as a technical consideration, conducted by case-by-case scientific risk assessment addressing specific harms to health and the environment (Grove-White et al. 1997). Thus, from the onset, questions concerning the ecological, social and ethical impacts of the technology – including how they would be distributed and how they might create public sensitivities - were excluded as *bona fide* questions within a risk-based approach (Jasanoff 2000). Assessments were conducted using tightly focused, product-specific methodologies, focusing on possible impacts (to human health and the environment) rather than on the complex economic, social and environmental contexts in which GM would be commercialized. Furthermore, this discursive construction implicitly served as the institutional representation of public concerns themselves, which regulation was taken to be addressing (Kearnes et al. 2006).

The third observation concerns the evolution of different approaches to regulation in the United States and UK/ Europe. In the United States a regulatory regime emerged that considered genetic engineering as a process that presented no special risks that could not be addressed by existing product-oriented legislation (National Research Council 1989). This led to the principle of 'substantial equivalence' that came to govern international trade policy, including that of the WTO (Murphy and Levidow 2006). In Britain a more expansive view of the potential for GM technologies to generate harm developed, including those surrounding the industrial production of GMOs and their deliberative release. These were seen to require control and regulation that could not be accommodated with existing regulatory structures. Following a timely report from the Royal Commission on Environmental Pollution (1989), in which emphasis was drawn to how much was still unknown about the impacts of GM technology, a specific regulatory committee was set up in 1990, the Advisory Committee on

Releases to the Environment (ACRE). Thus, a regulatory system developed in which the process of genetic modification became an appropriate basis for determining policy (Jasanoff 1995). This was complemented at the European level, starting in 1990, where GMOs were regulated under the Deliberate Release Directive 90/220, requiring member states to ensure that GMOs would not cause 'adverse effects' (Wynne 2001).

The fourth observation is that the UK and European regulatory framework provided an 'opportunity structure' for NGOs – and later other actors including the media – to help define the issue as a public issue. While arguing within the parameters of risk and precaution to governments and regulatory bodies (this was the only discourse available), they mobilized public support through a range of broader arguments: that GM foods would lead to an inevitable loss of consumer choice, that decisions had already been taken outside the public sphere, that GM would lead to the corporate control of food systems, that the technology was 'unnatural' and that there would be probably unpredicted effects beyond the reach of risk science. Importantly, these arguments, which were identified as 'latent' and cross-cutting public concerns even before the controversy took hold (Grove-White et al. 1997), were simply not captured by the formal and technical language of safety and risk. One effect of this deletion was to make debates over the risk and safety of GM crops stand-in for a host of other unacknowledged concerns (Frewer et al. 2004; Gaskell et al. 2004). Yet the intensity of these wider concerns was reinforced by the lack of any official assurances of the adequacy of current regulatory assessment mechanisms (Kearnes et al. 2006).

While the analysis of the GMO controversy in the UK and Europe is reasonably mature, there is considerably less social scientific analysis in other countries, including Mexico, Brazil and India (for notable exceptions, see Bauer 2006; Fitting 2006, 2011; Guivant 2002, 2006, 2009; Leite 2000; Scoones 2008; Stone 2010; Toke 2004). In particular, in relation to each of the national settings, we suggest that there exist strategic gaps in current literatures.

First, there is a lack of in-depth research examining the impacts of GM crops on farmers' communities and their culturally-specific farming and related practices: how have GM crops been embedded into everyday life contexts; how have benefits and risks been assessed from diverse cultural perspectives; how have GM crops affected farmers' social situations, their religious beliefs and practical knowledge, and their relationship with the land and food. Second, there has been little in-depth examination of public perceptions of GM foods, beyond a few superficial surveys, particularly in the context of food practices (including ritual and religious ones). And third, there has been little attempt to engage farmers (particularly female), citizens, regulators and scientists in deliberation, to assess how and under what conditions, if any, GM crops can be developed fully cognizant of social, cultural and spiritual values.

Our strategic promise is to develop a governance framework in which the views and values of an inclusive set of stakeholders (including publics and farmers) can inform and shape the conditions under which GM crops, and other plant science innovations, can be developed responsibly, including their contribution to global food security and social justice.

This is a strategic promise that merits research for at least six reasons. First, there is an indisputable policy imperative for the sustainable intensification of global agriculture over the coming decades. Faced by a growing global population, rapid urbanization, changes in diets including the growing consumption of meat, a need to protect existing ecosystems, scarcity of land and water and a changing climate, food security represents one of this century's key global challenges. This challenge will be met only through radical technological and social innovation, which may include both GM and non-GM technologies (Royal Society 2009). Yet, so far, the global experience of GM has been divisive. We need new

methodologies in which technical innovation can be accompanied by equally radical innovations in socio-cultural assessment and governance. Second, there exists a geopolitical imperative to understand the dynamics in those places which are likely to be the key drivers of global economic and social change in the future. For this reason we have chosen three global 'rising powers': Brazil, India and Mexico. Each of these countries has a particular history with GM crops; each has its own distinctive, yet parallel, set of resistances. Third, there is a need to build capacity within and across each of these countries. Through the research activities, we have gathered together a cohort of scholars who have generated understanding and work in new ways in an international context. Fourth, there is a need for research methodologies that are able to include voices – notably citizens and local farmers, particularly women – that hitherto have been marginal to the debates on GM crops. Fifth, there is a need for novel intellectual resources that promise new ways to frame the debate on GMO governance that transcend existing polemic and largely culturally insensitive frames. Through anthropological research we can attend to the diverse meanings and significance of GM crops and foods and to how they become embedded into socio-cultural practice. And sixth, there is a need for new deliberative methodologies in which stakeholders (regulators, scientists, publics and farmers) can share views and work, with empathetic sensitivity, towards a common understanding of the conditions, if any, under which GM crops should be developed.

1.5 The research team

The project was coordinated by Durham University and included a broad interdisciplinary mix of researchers, with in-house expertise on the governance of emerging technology and public deliberation, skills in ethnography and focus group methodology, country expertise of working in rural areas in Mexico, scholarship on religion, politics and public participation, expert knowledge on molecular biology and on techniques of genetic modification, scholarship on the moral implications of advanced technology with expertise in the USA and Asia, and subject expertise on religious responses to technology in India and Asia.

Local research teams were set up in Mexico and Brazil, each led by a regional expert on the politics and culture of GM crops, while in India we worked directly with a qualified research assistant. Local partner Guivant (Federal University of Santa Catarina) had extensive knowledge of the social organisation of the controversy surrounding GM crops in Brazil; local partners Astier and Bocco (Center for Research in Environmental Geography, UNAM) had a long-standing interest in the debate on GM crops in Mexico with a particular interest in questions of agronomy and cultural identity among rural populations; while in India we worked directly with a research assistant who was equipped to work on the factors that have contributed to the controversy over GM crops in India.

1.6 The research methodology

A set of research activities was developed for each of the three case study sites (Brazil, India and Mexico). The in-country field research took place in each national setting over a nine-month period and was conducted by local researchers, overseen by Durham University.

The research began with a focused literature and policy review that guided and contextualised the research for each of the local case studies, providing a place-based assessment of the existing structures of GM governance, including a detailed evaluation of national policies and strategies. This was followed by a 3-day training workshop, led by the Project Manager, designed to harmonise research questions, methodology and analysis

across all three local research teams and to provide the specific training for the local researchers in the distinct multi-disciplinary methodologies of this project (focus groups, ethnographic fieldwork, participant observation, in-depth interviews).

1.6.1 Ethnographic fieldwork

Ethnographic fieldwork was conducted in local settings over a period of nine weeks: in Brazil, on local farming practices including those surrounding GM soya; in Mexico, on local practices surrounding maize, including GM maize; and in India, on local practices surrounding GM cotton. The ethnography entailed participant observation and unstructured and semi-structured interviews in four settings: with small-scale male and female farmers, with women (and more rarely men) in small scale agricultural contexts in charge of food preparation, with women (and more rarely men) in charge of small food businesses and/or who commercialise such food products (raw and cooked), and end purchasers and consumers of such food products. The ethnography was designed to provide rich multi-sited qualitative data on the socio-cultural practices and experiences of unrepresented groups in relation to GM crops and foods as they happen in everyday contexts. It enabled the mapping of pathways and sets of social relations surrounding the preparation and commercialisation of food produce (GM and non-GM) as well as the identification of those groups' awareness of and degree of engagement with the existing structures of GM governance. A particular focus lay in observing and engaging in daily agricultural and food practices including, where appropriate, food-related festivals and fairs.

1.6.2 Stakeholder interviews and qualitative questionnaires

Stakeholder qualitative questionnaires and interviews were conducted to understand stakeholder views on agricultural biotechnology. Questionnaires were administered by the local researcher to a wide selection of local stakeholders (mostly institutional and organisational representatives) via email before the commencement of fieldwork and after the national workshops.

1.6.3 Focus groups with consumers

Four to five focus groups were carried out in each of the local settings with male and female consumers in urban contexts. The aim of these focus groups was to develop in-depth understanding of public attitudes to GM crops and foods in the three national settings, focusing in particular on the underlying contextual factors that shape their attitudes. Particular attention was paid to socio-cultural, religious and gendered considerations as well as to people's awareness of and degree of engagement with debates on GM crops and foods and structures of GM governance.

1.6.4 Participant observation and interviews in a public research laboratory

A two- to three-week participant observation ethnography was carried out in an agricultural public or nonprofit research laboratory, selected in consultation with local teams. This was designed to provide rich qualitative data on the culture and dynamics of public research laboratories, and allowed for the contextualisation of scientific voices in the day-to-day socio-cultural contexts of research practice. It provided insights into how laboratory scientists engage with existing structures of GM governance and with wider society. This element of research included between five and ten interviews with practicing laboratory scientists.

1.6.5 National deliberative workshop

Following the fieldwork, each local team organized a national deliberative workshop in collaboration with Durham University. Key local stakeholders (including specifically excluded groups and voices) were invited to each of the workshops to discuss their positions with respect to GM crops and foods and to respond to a presentation of the case study results. These multi-purposed workshops were: a platform for the presentation and discussion of those findings; a privileged arena to observe and analyse discourses, narratives, rhetorical deployments and socio-political and cultural positioning of relevant actors; and an open, experimental laboratory to design, test and promote new forms of dialogue. A dialogic methodology was employed to elicit dialogue and debate to meet these objectives. This resulted in a national report setting out the social and cultural factors that shape local responses to GM crops.

1.7 The structure of the working paper

In Chapter 2, the key findings from the Mexico case study are summarized. There then follow, in Chapters 3 and 4, a summary of findings from the Brazil case and India case, respectively. Subsequently, in Chapter 5, a comparative analysis is offered, with discussion of points of interest and of consequence. Finally, in Chapter 6, we offer a policy framework for the responsible innovation of GM crop technologies.

Chapter 2 Mexico

Susana Carro-Ripalda, Martha Astier-Calderón and Patricia Artia

2.1. A review of the debate in Mexico

Timeline

- 1970s: Agricultural policy in Mexico is governed by a dominant policy narrative of seeking self-sufficiency in basic food grains.
- 1982: Following the debt crisis, a new policy narrative is developed, centred on trade liberalization, privatisation, and the reduction of subsidies for small-scale agriculture. These changes are consolidated under Salinas de Gortari's presidency when a series of neoliberal reforms are introduced: NAFTA (signed in 1993 and introduced in 1994), changes to communal land tenure, and a drastic reduction in agricultural sector investment and subsidies.
- 1988: The General Directorate of Plant Health (DGSV), at the Ministry of Agriculture, begins to grant permits for scientific field trials of GM crops, advised by an *ad-hoc* committee of scientists and government agencies.
- 1998: DGSV imposes a *de facto* moratorium on GM maize field trials, arguing that GM maize trials are of little benefit to Mexico, amid growing concerns of GM maize mixing with landraces.
- 1999: Greenpeace discovers GM maize in a cargo of maize being shipped from the US to Veracruz leading to a vociferous anti-GM campaign. A group of concerned scientists calls for more effective regulation of GMOs, leading to the creation of the Inter-Ministerial Committee on Biosafety (CIBIOGEM) in 2002.
- 2001: Berkeley scientists Ignacio Quist and David Chapela publish an article in the journal *Nature* in 2001, stating that they had discovered the cauliflower mosaic virus, which is used in most transgenic crops, in native maize fields in Oaxaca. The article receives much criticism from certain sectors of the scientific community, and the journal withdraws its support for it.
- 2002: In 2002 the first broad anti-GM maize coalition is formed, comprising hundreds of activists, farmers, academics, indigenous groups and NGOs, all attending the forum *En Defensa del Maiz* in Mexico City. The debate on GM shifts away from technical considerations of gene flow to wider social issues.
- 2005: The Mexican Biosafety Law is approved. Three different agencies are responsible for Mexico's biotechnology policies, while the CIBIOGEM coordinates Mexico's biotechnology activities. This bill is opposed by NGOs due to a perceived lack of transparency in the deliberation process.
- 2006: The first round of applications for GM field trials are submitted, although they are immediately suspended because of questions about their legality. Government institutions declare that GM crops cannot be implemented until Centres of Origin of native crops are identified. The biotechnology companies start a more active campaign of public engagement around maize.
- 2009: The Regime for the Special Protection for Maize becomes active, and the creation of a dedicated public laboratory is required by law to detect, identify and quantify GM maize in Mexico. The Centre of Reference in Detection of Genetic Modified

Organisms (CNRDOGM) is established in 2010, and gains national and international certification from Genetic-ID, Iowa, USA in 2011.

- 2012: A new Agreement for the Centres of Origin and Genetic Biodiversity of Maize is approved, revoking a previous agreement which saw the whole of Mexico as Centre of Origin and biodiversity for this crop, and establishing that large areas in eight Northern states can legitimately be planted with GM maize, as they lie outside the specific zones declared by the new agreement. Phi Mexico, Dow and Monsanto submit six applications for commercial cultivation of GM maize in the states of Tamaulipas and Sinaloa, covering around 2.5 million hectares.
- 2013: A judge in Mexico City, responding to a collective lawsuit, issues a provisional court order to the Ministries of Environment (SEMARNAT) and Agriculture (SAGARPA) to stop processing new permits for commercial cultivation of GM maize in the country. However, new applications for experimental and pilot cultivation of GM maize continue to be received by those ministries, and many other GM crops continue to be approved.
- 2014: Another judge in the Southern state of Campeche grants an injunction against the commercial cultivation of GM soya bean in the Yucatan Peninsula, responding to a lawsuit promoted by Maya communities and local beekeeper associations exporting organic honey to the EU.

2.1.1. The trajectory of the controversy

a) Background – In order to understand the present GM controversy in Mexico, we need to look back to the 1940's and 1950's, at the time of the Green Revolution. The Green Revolution had its origin in Mexico, supported by the Rockefeller Foundation and the national government, and its main aim was the development of high yield seeds for basic crops which were presented as critical in the battle to end world hunger (Massieu 2009). The International Centre for Improvement of Maize and Wheat (CIMMYT – its Spanish acronym) concentrated its efforts on the improvement of seeds for those two crops. However, it soon became evident that those new seeds required an expensive technological package (including irrigation, machinery and agro-chemicals) which was not affordable for smallholder producers. Some Mexican scientists defended the need to create appropriate technologies for poor subsistence farmers, and many of them joined forces to fund the first school of ethnobotany in the country, at the Universidad Autonoma Chapingo, which has trained thousands of agro-ecologists ever since. These facts are key to the understanding of two underlying conditions in the Mexican GM controversy:

- (a) the still relevant polarisation between largeholder producers (many of them in the northern states), who have benefited from new agricultural technologies and resource capitalisation; and smallholder producers (mostly in central and southern states), who practice subsistence, rainfed agriculture (Massieu, 2009, Hewitt de Alcántara 1985, 1999). This division is reflected also in a *de facto* situation in which development operates at two speeds in Mexican rural society.
- (b) the notional division between scientists who work on the development of advanced agricultural technologies (including biotechnologies) with the aim of increasing yield and production for market-oriented purposes, and those who work with smallholder farmers with the aim of promoting sustainable and appropriate rural technologies for the improvement of rural local production.

The other fundamental aspect of the GM Mexican controversy is that, in essence, it focuses almost entirely on maize, with other plants excluded from the main debate to a large extent. This rather unusual focus on one particular crop has multiple explanations. First, Mexico is the Centre of Origin and Diversity of maize, and hosts around 60 landraces and thousands of native varieties, as well as wild varieties such as *teosinte* (thought to be the precursor of domesticated maize). Much of native or *criollo* maize biodiversity is conserved *in situ* by smallholder traditional producers (Soleri et al. 2006). Traditional maize agriculture (small-scale, rainfed, mainly for subsistence) is practised by more than two million farmers, and dominates some regions, particularly those with large indigenous populations in the centre and south of the country. This type of agriculture is arguably vital for many rural areas. Second, and in addition to having been domesticated by early inhabitants over 9,000 years ago, maize has always been a fundamental part of the Mexican diet, of its economy and politics, and of its society and culture. There is much evidence about the social and cultural significance of maize in pre-Hispanic societies, and of its central place in their cosmology. In present day Mexico, maize is still consumed by most of the Mexican population from all social and geographical backgrounds on a daily basis and in a variety of forms: from *tortillas* (flat maize pancakes) to *tamales* (maize dough cooked in maize leaves) to *atole* (maize sweet drink) or *pozole* (maize and meat soup). 53% of caloric intake and 39% of protein intake is claimed to come from direct consumption of maize in Mexico (Toledo et al. 2013). Most importantly, maize holds a special place in Mexican people's hearts, and is linked by many to a Mexican sense of national identity.

b) The origin of the controversy: scientific and regulatory debates and the GM maize moratorium – Until the 1970s, agricultural policy in Mexico was governed by a dominant policy narrative of seeking self-sufficiency in basic food grains. Following the 1982 debt crisis, a new policy narrative has been developed, centred on trade liberalization, privatisation, and the reduction of subsidies for small-scale agriculture. This narrative was consolidated through Mexico's participation in the GATT treaty (in 1986), in the NAFTA trade agreement (signed in 1993 and implemented in 1994) and in OECD discussions (which Mexico joined in 1994). Agricultural biotechnology policy thus became tied to broader policy discourses surrounding trade liberalization and global integration. The development of GM crops took place within this macro-economic context. Thus, in 1988 when the moratorium on GM crops was withdrawn, private companies (including Monsanto and others) were able to develop field trials on GM maize, canola, cotton and soya, leading to significant increases in GM cultivation (in 2012 Mexico had 160,000 hectares under biotech crops, mainly Bt Cotton and HT Soya bean; see James 2012). In addition, GM maize from the United States was imported, to much controversy.

The scientific and regulatory debate started when the General Directorate of Plant Health (DGSV), at the Ministry of Agriculture, began to grant permits for scientific field trials of GM crops, advised by an *ad-hoc* committee of scientists and government agencies. This committee was first named the National Agricultural Biosafety Committee (CNBA) in 1992 (Fitting 2006: 18-19), and was reorganised as CIBIOGEM (Inter-Ministerial Committee on Biosecurity and Genetically Modified Organisms) in 2002. Applications were received both from universities and corporations, with a particular focus on GM maize (CONACYT-CONABIO 1999). However, in 1998 the Directorate imposed a *de facto* moratorium on GM maize trials for two reasons: because of the realisation that GM maize would be of limited benefit to Mexico and because of growing concerns about GM maize mixing with landraces and displacing *criollos* and *teosinte* (Fitting 2006: 19).

c) The controversy goes public: polarisation, coalitions and divisions – In 1999, two events took place which had the effect both of polarising the debate and of transferring it from the

enclosed confines of the scientific and regulatory community to the public arena. First, Greenpeace (2000) discovered GM maize in a cargo of maize being shipped from the United States to Veracruz, as permitted within the framework of the NAFTA free trade treaty. They launched a vociferous anti-GM maize campaign with high profile partners from universities and international NGOs (Fitting 2006). In parallel, a group of concerned scientists sent a letter to the then president Ernesto Zedillo asking for more effective regulation of GMOs. Zedillo responded by creating the Inter-Ministerial Committee on Biosecurity and Genetically Modified Organisms (CIBIOGEM) in 2002. However, this body was surrounded by controversy from the beginning, as one of its original members, a former academic at the Mexican National University (UNAM), changed employment to AgroBio Mexico – an influential consortium of biotechnology companies that includes Monsanto, Novartis, Dupont and Savia as partners – and started promoting GM crops actively (Massieu 2009). These national events occurred with the signing of the Cartagena Protocol on Biosafety as an international backdrop. This protocol, although purportedly based on the precautionary principle, continues to defend the pre-eminence of international trade treaties over national jurisdiction.

Another turning point, which contributed to the increasing polarisation of the controversy, occurred when Berkeley scientists Ignacio Quist and David Chapela published an article in the journal *Nature* in 2001, stating that they had discovered the cauliflower mosaic virus, which is used in most transgenic crops, in native maize fields in Oaxaca (Quist and Chapela 2001). The article received much criticism from certain sectors of the scientific community, and the journal withdrew its support for it; CIBIOGEM however did not react (Massieu 2009). Later, studies in Oaxaca and Puebla funded by two governmental agencies, the National Institute of Ecology (INE) and CONABIO (National Committee for the Study and Use of Biodiversity) corroborated Quist and Chapela's findings. At this point the controversy centred not only on the reliability of scientific evidence pointing to the flow of transgenes to native maize, but on whether a transgene flow might signify a natural and desirable process, beneficial for the plant (a thesis supported by SAGARPA, the Ministry of Agriculture, among others) or, to the contrary, whether it constituted genetic contamination, and thus a threat to native maize biodiversity (Fitting 2011). By now the issue had jumped into the political arena, and the first debates about the necessity of a biosafety law took place at the Mexican Congress.

In 2002, the first broad anti-GM maize coalition came into formation, comprising hundreds of activists, farmers, academics, indigenous groups and NGOs who attended the forum *En Defensa del Maíz* in Mexico City. This forum was organised by the Centre for Studies for Change in the Mexican Countryside (CECCAM) and its participants aimed to shift the debate on GM crops away from a government and industry focus on technical considerations of gene flow to wider social issues. According to Fitting (2011), this was the point at which the emergent anti-GM coalition ceased to refer to 'risk' as exclusively 'genetic risk', and began to portray this notion within an expanded frame of meaning which encompassed political economy and socio-cultural readings. Thus the narrative of risk came to be understood and represented in debates as the threat posed by GMOs to traditional smallholders and indigenous agriculture, and to the diversity of rural society and economy; *criollo* maize and its protection came to signify the defence of Mexican culture and identity on the face of unwanted and imposed globalisation. Also, in 2002, another campaign developed, *El campo no aguanta más* ('The Countryside Cannot Take It Anymore'), set up by a coalition of 14 peasant groups. They organized an event attended by 100,000 protesters, opposed to NAFTA and neo-liberal policies (Fitting 2006: 24). They demanded the halting of GM imports. Meanwhile, the Ministry of Agriculture (together with the biotechnology industry) continued to reject studies commissioned by NGOs which reported GM maize presence or

contamination in Mexico, suggesting that the debate was contested at both a technical and a social level, reflecting disputes over whose knowledge counts and on what authority.

The GM issue was gathering complexity and divisions between groups and actors in the GM debate were not obvious and simple. For instance, the rift between scientists who advised the government on GM matters on the one hand, and technocrats and politicians who sought to accelerate GM implementation in Mexico on economic grounds on the other, was made explicit in 2003 when the Consultative Council of the recently created CIBIOGEM resigned in full, arguing that their recommendations had not been adequately taken into account by the executive. In 2004, and whilst further debates regarding a future Biosafety Law were proceeding in Parliament, the CCA (Committee for Environmental Cooperation in North America, connected to NAFTA) issued a report about transgenic contamination in maize in Oaxaca (which had been commissioned by a coalition of NGOs and farmers) recommending the need for caution and for further research to be undertaken before the release of any GM maize in the country (CCA 2004). At this point, the Mexican Academy of Sciences proposed a bill for a Biosafety Law, which was approved by the Mexican Senate. This bill was opposed by NGOs due to a perceived lack of transparency in the deliberation process, and things were made worse when the Undersecretary for Agriculture signed an agreement with USA and Canada related to GM content in imported crops, which did not conform to existing laws on the matter (Massieu 2009). In the meantime, other studies appeared which corroborated Serratos' research (1998) regarding the reduced benefits of Bt GM maize for Mexican agricultural conditions.

d) The Biosafety Law and the situation of maize – The Mexican Biosafety Law was finally approved in March 2005. Its approval was immediately followed by public protests, and the law was quickly nicknamed 'Monsanto Law'. In the same year the public forum *Sin Maiz no hay País* ('Without Maize, There Is No Country'), was organised at the National Museum of Popular Cultures with a wide and varied audience. The following year witnessed the creation of the *Unión de Científicos Comprometidos con la Sociedad* ('Union of Socially Concerned Scientists'), a group headlined by respected and well-known scientists, 'who defended a critical position to withstand the pressure of multinationals who are promoting the introduction of commercial varieties of GM maize in Mexico' (Massieu 2009: 235; translation is the authors'). This group has held a number of public forums on the issue of maize, which were well attended by scientists, intellectuals, NGOs and the general public.

The first round of applications for GM field trials were submitted in 2006¹, although they were immediately suspended because of questions about their legality. A coalition of academics, NGOs, smallholder farmers and indigenous organisations continued public activities against the impending implementation of GM maize in Mexico, and maintained a presence in the national press. The biotech companies also started a more active campaign of public engagement, more specifically around the issue of maize; for instance in 2007 Monsanto signed an agreement with the CNC, the National Peasant Confederation, in order to investigate the genetic diversity of this plant (Massieu 2009). However, the CNC is affiliated with the PRI (the party which held the presidency in Mexico from 1929 to 2000, and regained it in 2012 with Peña Nieto) and has been involved in a number of high profile corruption scandals, and thus its neutrality on the issue of GM maize has been doubted by many.

Although the involvement of individual states and regions in the GM maize controversy in Mexico has been limited, in 2008 the PRD (the left-wing opposition party) government of

¹ The procedure for the release of GM crops must begin with an experimental phase, proceed with a pilot phase, and after both, comes the commercial phase. This procedure must be iterated for every GMO event.

Mexico City (a federal entity with a population of over 22 million people and with a large peri-urban agricultural area), declared the city a GM-free zone. Also the state government of Oaxaca and some communities in the Sierra Tarahumara in the north have followed this path. 2008 was also a crucial year as the special protection for maize in the NAFTA agreement came to an end, a fact which ignited a new wave of social protest in the country.

2.1.2. Current state of the art

The controversy has remained active in the past few years, and many anti-GM stakeholders feel that, within the new contexts facilitated by the Biosafety Law, the developments in regulation aimed at facilitating the entry of GM maize in Mexico have accelerated and have run in parallel (although largely unrelated) to public debates. On the other hand, many scientists, regulators, politicians and the biotechnology companies, who defend the need and benefits of GM maize for the development of Mexican agriculture, feel that the issue is unnecessarily slow, and that there are too many impediments in the implementation of the law.

In 2009, the Regime for the Special Protection for Maize became active, and a dedicated public laboratory was created to detect, identify and quantify GM maize in the country. However in 2012 a new Agreement for the Centres of Origin and Genetic Biodiversity of Maize was approved, which annulled a previous agreement (which had seen the whole country as the Centre of Origin) and declared that large areas of the eight northern states could legitimately be planted with GM maize. It is interesting to note that those chosen states are those with an already established form of largeholder industrialised agriculture based on hybrid maize.

The controversy at the public level has seen a resurgence in 2013, when the first permits for commercial cultivation in GM maize in the northern states of Sinaloa and Tamaulipas were about to be processed. There were complaints from many scientists, NGOs and other public organisations within the loose anti-GM maize coalition about the opacity of the application and complaint procedures, and about the lack of information on the outcomes. Within this climate, new civil society actors joined the anti-GM campaign, such as *YoSoy123 Ambiental*, a student movement which began to protest about the lack of democracy in the media during the Peña Nieto presidential campaign. The *Unión de Científicos Comprometidos con la Sociedad* also presented the newly elected president Enrique Peña Nieto (PRI) with a letter bearing over 3,000 signatures from scientists and experts against the introduction of GM maize in Mexico.

The last acts in the story of the GM maize controversy in Mexico occurred very recently, and are symptomatic of: (a) the deep divisions that permeate different state institutions with regards to the issue of GM maize; (b) the spill-over of the issue of GM maize to other GM crops and products; and (c) the continuing lack of a long-demanded wide social and political agreement between the government, the scientific community, and the general public on this issue.

In June 2012, SENASICA (National Office for Agricultural and Food Health, Safety and Quality) granted authorization for Monsanto to plant 253,500 hectares of GM soya bean in 7 states of Mexico, 60,000 hectares within the Yucatán peninsula. This approval was contested by an amalgamation of associations of honey producers and NGOs, arguing that the resultant honey would violate the European Union's rule for GM-free honey. Legal permission was suspended although 10,000 hectares were eventually cultivated in 2012, mixed with non-transgenic soya bean and sorghum. Such a precautionary move was

vindicated in research undertaken by Villanueva-Gutiérrez et al. (2014) that found evidence of GM soya bean pollen in Yucatan honey.

In September 2013 a judge in Mexico City responded to the lawsuit brought by Acción Colectiva, an NGO encompassing 53 scientists and 22 civil organisations, and ordered that the Ministries of Agriculture (SAGARPA) and the Environment (SEMARNAT) suspend immediately the granting of permits for commercial cultivation of GM maize in the whole country. In his ruling he cited UN's Global Compact Principle 7, which states that 'Businesses should support a precautionary approach to environmental challenges' (UN Global Compact 2013). This ruling is being hotly debated, and both the Mexican government and Monsanto have challenged the court decision through more than 48 lawsuits to date.

More recently, in March 2014, a judge in the State of Campeche, in southern Mexico, granted an injunction to Maya communities and to honey producers against permits given by SAGARPA and SEMARNAT for the commercial cultivation of GM soya in their territories. The ruling was based on the violation of legal procedures on the part of both SAGARPA and SEMARNAT, as (1) SAGARPA did not hold a free and informed consultation among indigenous communities prior to the issuing of permits for the planting of GM soya in their lands; and (2) SEMARNAT ignored binding reports by CONABIO, CONANP (National Commission for Protected Natural Areas) and INE which advised against the cultivation of GM soya in the area.

2.2 Ethnographic fieldwork

2.2.1. Introduction to fieldwork

The ethnographic fieldwork in Mexico was conducted in the Pátzcuaro Lake area, in the State of Michoacán. The research was carried out by our research assistant, Dr Patricia Artia, an experienced fieldworker with a PhD in Anthropology, who lived in an indigenous community between September and December 2012. During her stay in the community, she carried out participant observation among male and female smallholder farmers and women who made and sold maize *tortillas*. In addition, she participated in community and agricultural activities, and interviewed local authorities. She followed the *tortilla* sellers to their distribution points at the regional market towns, where she interviewed local customers. She also identified other maize-related activities in the region (such as religious festivals or political meetings) in which she participated and carried out informal interviews. Interviews were structured, semi-structured or informal, depending on the context.

The Pátzcuaro Lake region is home to a number of strongly interconnected indigenous Purhépecha and non-indigenous rural communities, connected both economically and socially to the regional urban centre of Pátzcuaro. Many people in the rural communities practise smallholder rainfed native maize agriculture through the *milpa* system. *Milpa* is the term used to designate both a plot of land and the specific system of cultivation which takes place in it. This system of pre-Hispanic origin consists in combining up to 60 different plants, including maize, beans, squash, chilli, and tomato, in the same small plot (Toledo et al. 2013), in order to produce enough food to fulfil the nutritional needs of the kin group, whilst conserving the soil properties from season to season. Smallholder farmers also plant some hybrid maize in some of their plots. Maize production is mainly for home consumption, but excess is sold to neighbours or at local markets. Farmers own their seed and exchange it within their community for seed improvement. Most agricultural land in the area is communal, either in the form of *ejidos* (rural properties for collective use, originally owned

by the state, established after the Mexican revolution) or *bienes comunales*, collectively owned land attached to the indigenous communities.

Michoacán is suffering the effects of the same crisis that has affected all rural areas in the centre and south of Mexico, made worse by changing global economic conditions. Less and less people are practicing agriculture, as young men and women move increasingly to cities, or migrate to the Northern states or to the USA for work. The demise of rural subsidies, the increase in input prices, as well as competition from imported cheap grains, impoverished soil conditions and climate change are impacting strongly on smallholder farmers. Thus agriculture is rarely nowadays the sole source of income for people in the region: households increasingly develop hybrid economic strategies that include the commercialisation of handmade crafts (such as straw hats or embroidered clothing) and temporary paid labour (construction work for men, or house cleaning or childcare for women). In addition, in the last 30 years, there has been a significant increase in out-migration to the United States. This is also an area where drug trafficking has had an impact at the local level, as especially young people are recruited by regional mafias, mainly to act as business intermediaries.

2.2.2. Meanings and practices surrounding maize

a) Social relations around maize agriculture – In small rural communities around Lake Pátzcuaro, smallholder, rain-fed maize agriculture, practiced by both indigenous and non-indigenous communities, continues to be an important activity around which social life is organised. People within the community practise the exchange of *criollo* maize seeds, sharing and swapping seeds between relatives and neighbours in relationships of 'trust'. Maize is commonly 'borrowed' from family or friends in times of scarcity, and returned the following year, when it is others who are most in need. In most life-cycle and community celebrations, maize food, specific for each occasion, is collectively prepared by the women, and exchanged between households as a form of expressing and maintaining relationships between kin groups or neighbourhoods. Certain types of special maize foods are prepared to care for people at particular moments of their lives: for instance, thick *tortillas* are given to children to make them grow strong, and white *atole* is prepared for first time mothers to help them breastfeed their newborn babies. In many religious festivals, maize is offered to the saints in thanks for a good harvest, or cobs are gifted to the attending public, to signify the pride in the agricultural occupation of the village's inhabitants. Thus it could be argued that maize fuels and sustains networks of social relations of trust, support and exchange, in communities where a key form of 'social security' comes from these forms of networking and relating, and where many other components of community life (knowledge and information, but also money and goods) also flow through these networks.

b) The importance of seeds and land – In rural communities in the area of our study, as in many other parts of rural Mexico, native maize seeds are very special items. They belong to the household, but most specifically to the farming team, commonly of husband and wife, who tend to make joint decisions about what to grow each year. They are considered family heirlooms, passed down year on year from parents to children, and identified by and referred to as 'my father's' or even 'my grandfather's' seeds. Seeds are exchanged between relatives and neighbours each year, but seed exchanges only occur between farmers in relationships of trust, in the sense that they trust each others' good farming practices, the quality and strength of their seeds, and their honourable intentions within the exchange. In short, seeds are important and valued properties, which carry traditional family knowledge and good practice from one generation to the next; they are also, together with land, the main agricultural capital of smallholder farmers, the assets which guarantee that they will be able to plant and grow maize from year to year and thus survive. In addition, it is now widely

accepted that seed exchange is one of the best forms of *in situ* agricultural biodiversity conservation.

Land is the other type of agricultural resource which holds a special significance among smallholder farmers who continue to practice traditional maize agriculture. Like seeds, the *milpa* is passed down from parent to child, and is linked to a specific family or household. The family *milpa* is not just seen as an agricultural asset in terms of production, but is connected with memories from childhood, with kin and village identity, with work but also with leisure. Local people still consider that selling one's *milpa*, particularly to outsiders who will (probably) not use it for its traditional purpose, is morally wrong. Even nowadays, when the importance of maize agriculture has receded in economic terms, when the benefits of what a *milpa* produces are not enough to sustain a whole household, and when young people are migrating, those household members who remain in the communities (grandparents, parents, wives, siblings and children) still keep and cultivate the family *milpa*. One example of this practice found in our study is that of a qualified nurse in one of the indigenous communities: her two daughters held university degrees and lived in the nearby state capital, but she still preserved her family land and cultivated native maize with the help of paid workers.

c) Milpa and maize as important parts of the local economic strategies – Despite the fact that the *milpa* is rarely able anymore to sustain economically a whole family, it does in many cases produce enough maize and other vegetables (squash, beans, and chillies) to feed the household for most of the year, with any excess production sold on to neighbours or at regional markets for cash. In the riverine communities of Pátzcuaro Lake area, where agricultural land is scarce, the *milpa* has never been the sole source of income for families. Traditionally, people also fished or hunted duck in the lake, kept small animals such as chicken or pigs, and produced different types of crafts for sale (from pottery to wooden masks) since the times of the Colony. Nowadays, paid labour and the remittances from migrants might even subsidise the keeping and running of the household's *milpa*.

However, and despite the fact that these days it might be cheaper to buy hybrid maize in the shop than to grow your own criollo varieties, maize continues to be seen by rural people as a sort of insurance against hunger (Fitting 2011), and native maize from the family *milpa* is nearly always the preferred choice for household consumption. Many people in our study reported that in times of scarcity, their only food was '*tortillas with a bit of salt and chilli*'. Furthermore, for vulnerable sectors of the rural population (such as old people or single mothers) cultivating one's own maize on one's own land, and cooking associated maize food products for sale, has become often a much needed viable strategy for economic survival. In the region, many women who made native maize food products for sale were organised in a small cooperative known as Red Tsiri (*tsiri* means maize in Purhépecha) which commercialised traditional and organic foodstuffs at the nearby urban centres with reasonable success, helped by the rising interest in organic and traditional foods among the Mexican urban middle classes.

d) Maize agriculture as craft and career – Many of the smallholder farmers interviewed in the study (mostly men but also women), reported experiencing a sense of pride and pleasure in the conduct of their agricultural practices. They spoke about cultivating *criollo* maize 'for pleasure' or 'enjoyment' and not (simply) for 'business', and described the activity more like a craft than a simple pecuniary set of exchanges:

'For me, growing maize is a pleasure, holding the cobs, beautiful cobs make one happy, gathering the seed, looking at well-formed plants, at the harvest....'

(Smallholder maize farmer, Tzurumútaró)

They also talked about the experimental dimension of their agricultural labour, which is often driven by an amateur scientific curiosity:

'I had some seed of mine, but I did not plant that because I wanted to see how this other one worked. I had spent a couple of years without planting anything, and now I wanted to see if it was true that this one yielded much more maize and of better quality. I would like to experiment more to see how it goes. I only have one hectare, but we are few, so that is enough [maize] and sometimes we even have some to sell'

(Smallholder maize farmer, Puácuaro)

Good, dedicated, successful farmers are recognised and respected in their communities, and they are the ones who are most sought after for seed exchange. In addition, different farming styles are attributed to different communities, thus linking forms of maize agriculture to local and regional identities.

In short, what became highly evident as a research finding, is that the social practices involved and invested in *milpa* agriculture and know-how, in people's experience, were highly related to moral, ethical and aesthetic notions about what constitutes a good life. Agricultural practice goes beyond mere task to embrace an artisan's dedication, providing people with a strong sense of personal and social identity, as well as enabling farmers in very restricted economic circumstances to experience aesthetic and spiritual pleasures and the satisfaction of a job well done.

2.2.3 Factors mediating concerns over GM maize

Smallholder producers in the Pátzcuaro Lake area reported a lack of knowledge regarding both GM crops and the technological processes involved in genetic modification, something they shared with many other sectors of the population. They complained about the absence of neutral and reliable information on GMOs in general and GM maize in particular. Furthermore, many people in rural areas had the suspicion that this lack of information may be a deliberate strategy on the part of the government to keep them oblivious of their real intentions, which many perceived as that of quietly introducing GM maize without public consultation or consent. It is necessary to note that commercial cultivation of GM maize has not yet taken place in Mexico (see section 2.1.2), although there have been some experimental field trials. There are, however, other GM crops already authorised and grown extensively in Mexico, mainly soya and cotton: these also are cultivated in the Southern states, and are beginning to generate some degree of public controversy, although not comparable to that of maize.

Despite the fact that GM maize is not yet cultivated, or even authorised in the area, many smallholder producers, both male and female, had heard about a 'new' maize which is '*made in laboratories*'. They reported some understandings, ideas and concerns about what they felt could be an impending reality. These were:

a) GM maize is unknown and suspicious – Farmers expressed concern with new proposed varieties of GM maize seed – which were seen as likely to be coming their way – over what precisely GM maize is and how it would work in agricultural terms. They expressed the view that this new type of seed could bring them some unknown problems, and that it could force undesired changes in the way they practise agriculture. This suspicion of 'trouble' hinged upon two factors: first, that GM seeds would originate entirely from 'outside' the communities and the rural farming environment which they know and trust. Second, that they would be researched, developed, regulated and distributed by organisations and

institutions towards which there has been a historical lack of trust, such as multinational seed companies and the federal government.

b) GM interpreted within political economy framings – Smallholder producers conveyed an implicit lack of trust in those they saw as the main proponents of GM maize: the government as an institution, politicians as a social group, and the agricultural and biotech industries as interested parties. They suspected that GM maize may not be grown for human consumption or even animal feed, but for bio-fuels for developed countries. They also deduced that the maize seeds would not be exchangeable, as they are now, but would need to be bought from the seed companies each year, something they suggested would be outside their economic possibilities. Moreover they suspected that the real reason behind the drive for GM maize is the promise of benefit for the usual constituencies, that is, according to our respondents, the national and multinationals companies owned by or operating in the interests of the rich and powerful, and the corrupt politicians which favour them often in exchange for money. Both points a) and b) clearly relate to a comprehensive, experientially felt and historically informed lack of trust in the national government, which was nearly universally perceived as incapable of defending citizens' interests and which was presumed to operate almost exclusively in favour of global economic actors.

c) Ontological rejection – Many farmers perceived GM maize as an artificial, man-made construct:

'[...] In a public talk, I heard about that maize which is made in laboratories, transgenesis or something like that [...]'

(Smallholder maize farmer, Uricho)

They communicated a sense of mistrust in the processes and forms of intervention that are used to create GM maize in the labs, which they expressed through the often-quoted question: *'what are they going to do to our maize?'.* Some of the smallholder producers reported telling their neighbours not to give away native maize seed to unknown people (presumed to be scientists from the government or from seed companies), who had visited their communities asking for it, assuming their intentions were not to be trusted nor for the common good. Their preoccupation was not only about the fate of maize seeds in research laboratories, but also more generally about the long-term fate of 'their' maize.

d) What is GM maize for? How can we defend ourselves? – These are two fundamental questions that appeared often in exchanges with farmers. The first one refers yet again to widespread suspicions on GM maize and whether it was truly needed within the frame of traditional smallholder agriculture:

'Why change our seed? We are using and benefiting from our grandparents maize, and it is that same maize that we can continue planting....'

(Smallholder maize farmer, Napízaro)

The second question is linked to the fear of what was perceived to be as yet another 'imposition from above', which could have negative consequences not only for the preservation of their *criollo* maize and for their ownership of that resource, but, more generally, for their present ways of life and agricultural practices.

2.3. Structured interviews

2.3.1. Introduction to data set

Twelve in-depth qualitative structured interviews were conducted with key stakeholders. These included representatives from the following categories: multinational seed companies, indigenous organisations, women's associations, environmental groups and other NGOs, religious organisations, smallholder farmers, medium and largeholder producers, social scientists, natural scientists, consumer associations and regulators. We interviewed two natural scientists, both molecular biologists, who held different positions with respect to GM maize. These last two interviews are analysed in Section 2.4.

The structured interviews were conducted following a fixed set of 19 questions. The interviews were carried out in Spanish by the Mexican Research Assistant at different locations in Morelia, Lake Pátzcuaro, Irapuato, and Mexico City. Interviews were then analysed qualitatively by the Mexican Leads.

2.3.2. Analysis of questions

a) *The state of the Mexican countryside* – Most stakeholders agreed that the Mexican countryside is in crisis. Respondents offered various explanations that included: processes of out-migration, abandonment of traditional agriculture in favour of lowly paid urban employment, increasing poverty among smallholder farmers, and lack of opportunities for young people in rural areas.

'[The Mexican countryside] needs attention, so that it produces food, not migrants'
(Religious stakeholder)

Most interviewees also agreed on some of the conditions that have caused, or at least exacerbated, this situation. Many stakeholders identified the Mexican government as responsible for 'abandoning' the countryside and its smallholder populations. They believed this has arisen not least through the implementation of national policies including reductions in agricultural subsidies, and through the changes in land ownership laws, especially the abrogation of Article 27 of the Constitution, which protected forms of communal land property from passing to private hands. Many also blamed international policy and treaties such as NAFTA for this situation; they argued that global economic models are pushing Mexican agriculture towards increasing industrialisation and monetisation. International policy and treaties have also caused a situation of dependency with respect to food imports, which is not conducive to food security or food sovereignty. The majority of stakeholders thought this was the result of an increasing move on the part of previous Mexican governments towards a neoliberal economic and political model, something which they see continuing – even exacerbated – in the present 6-year presidential period.

Interestingly, there are some stakeholders who placed the origins of this rural crisis not on neoliberal policy, but precisely on a lack of sufficient policies of this type. Representatives of seed companies and of largeholder farmers' associations adopted a developmentalist perspective towards rural areas: they considered the problem in the countryside as one of 'backwardness', as having arisen from a lack of access to technologies and education, and from inadequate infrastructure. They highlighted the need for an increase in grain production, in terms of volume, in order for Mexico to be more competitive in international markets. They also blamed the federal government for being 'slow' in catching up with agricultural biotechnology.

One final aspect to note is the generalised vision of a country divided in two distinct areas: the North (states of Sonora, Sinaloa, Chihuahua, Coahuila, Durango and Nuevo León in particular) versus the Centre and the South (roughly the rest of the states). Those two areas tend towards different forms of agriculture (large, intensive, and export-oriented in the North; small, traditional and to a large extent for local consumption in the South), which are accompanied with what stakeholders see as ideological differences at state-level governments, policies and populations (conservative and neoliberal in the North, and more liberal and socially aware in the South). This division can be seen in the ways in which Mexican government policy has been developed with respect to debates on native maize and Centres of Origin.

b) Opinion about GMOs – Most people interviewed (with the exception of the representatives of smallholder farmers and of women's associations) were reasonably knowledgeable about GM technologies. It is worth noting that 8 out of 12 interviewed stakeholders held science degrees in different disciplines. Smallholder farmers and women's associations reported having heard about GMOs, and having some knowledge about their provenance (*'seeds genetically modified in labs'*) but also reported other ideas about them which would not be identified as scientifically accurate by other actors, but which were very significant for these groups:

'Foreign maize, not for human consumption [...] We do not know it [...] it is contaminated with products [...] there is the danger that it can contaminate land, maize, fruit, and this passes to the human food chain'
(Smallholder producer)

Moreover, smallholder farmers and women's associations' opinions about GMOs reflected more their understanding of the political economy surrounding GM development and implementation in Mexico. They considered that GMOs are produced by big companies which are only concerned with sales and not with contamination. They believed these companies are not worried about whether the product is good or bad; they just want to sell.

'GM favours big groups and their economic interests, and harms rural communities'
(Women's association representative)

One aspect to note here is that most stakeholders differentiated between the case of GM maize and other GM crops in Mexico. There are various reasons for this distinction. First, most people recognise the fact that Mexico is the Centre of Origin of maize, and that this represents a serious and collective responsibility in terms of biodiversity conservation, not least because of the biological characteristics of maize as a species (for instance, open pollination). This concern with the preservation of native maize biodiversity was linked to a distrust in current regulatory systems and capacities to guarantee biosafety; many stakeholders were of the opinion that GM maize cannot coexist with non-GM at present, because of the clear (and not successfully refuted) risk of contamination.

'It is not by chance that it [maize] is the only species which is specifically mentioned in the Biosafety Law.'
(Regulator)

Second, stakeholders highlighted the significance of maize for rural economies and for traditional forms of agriculture (in Mexico, communally owned land still represents over 50% of the total acreage). Many of them spoke of the lack of benefits for smallholder producers from GM maize due, for instance, to the impossibility of keeping and exchanging seeds, which was seen as both an economic and a cultural loss (*'it goes against the Mexican culture*

of maize', religious stakeholder). Some interviewees spoke that the pressure to introduce GM maize had a purely economic rationale, and that it would benefit only largeholder farmers, multinational seed companies, and other large-scale agricultural farming and food consortiums (such as Mexican maize flour company MASECA). A few even point out that there are studies which point to a decrease of productivity over time.

Third, native maize was not perceived as simply a commodity or a crop: it is recognised, even by scientists and regulators, as having a far broader impact and significance in Mexican history, society and culture:

'Maize is basic in Mexican food and culture.'
(Social Scientist)

'Maize should not be modified in its nutritional properties because of the way we consume it, and the way we use it on a daily basis.'
(Regulator)

Aside from the specific concerns relating to GM maize, one stakeholder revealed a set of ontological arguments against agricultural GMOs, which are also implicit in other stakeholders' arguments (particularly among consumers and scientists): they felt they are different from medical GMOs because the latter stay in the laboratory, whilst the former are unleashed in the fields, and thus are more difficult to control or contain. Agricultural GMOs, and particularly those which involve the insertion of genes from other species, were rejected on an ontological and ethical basis, and arguments contained a critique of certain forms of science which were seen to change humans' relation with nature:

'I think human beings have a very arrogant attitude towards nature, they want to control it to the last resort. [GM] technology can break barriers that nature has imposed for over millions of years. It was created so that there was not genetic recombination from different groups, kingdoms and genera. [...] This has to be for a reason, an evolutionary reason for species conservation. The moment human beings break those barriers, we are attempting to move against evolutionary dynamics.'
(Consumer association's representative)

Seed companies and large-scale farmers' representatives shared a more positive vision of GM maize. They considered that it could be beneficial for certain parts of the country (i.e. the North) and that it could contribute towards improved food security as well as helping to resolving the crisis in agriculture. In contrast to the ontological concerns reported by many other stakeholders, the representatives of seed companies defended the argument, shared by many scientists, that GM represents a continuum from traditional forms of plant breeding, rather than a qualitative change:

'We have domesticated plants and they depend on us. [...] But there's a point in which we find [genetic] limitations within the same species, we cannot find genes to introduce. [...] So the possibility of incorporating biological functions through genetic modification is a great discovery. [...] It is possible to make human proteins within bacteria, which means that bacteria keep the same fundamental mechanisms of gene expression as humans, and vice versa'
(Seed company representative)

c) *GM policies and debates* – The majority of stakeholders believed that the GM maize debate in Mexico was not resolved, yet was somewhat foreclosed by certain recent decisions of Mexican Deputies (MPs):

'Deputies closed the debate, passed over agreements they had themselves approved, and accelerated the process to pass the law'
(NGO representative)

'[The debate] was curtailed by Federal Government decisions, as we found out at Davos in 2010.[...] We spoke to the Coordinator for Advisers to the Presidency [...] and he told us that President Calderón had just spoken to Monsanto's President and that [Calderón] had promised him to open the possibility of growing GM maize in Mexico. Whilst we are here debating, the Mexican government is taking a political decision which responds to financial interests.'
(Religious organisations' representative).

There was a generalised agreement from certain actors that the current Biosafety law (which was approved in 2005) does not adequately protect GM maize, but rather favours GMO approvals in general. This law is popularly known in Mexico as 'Monsanto Law'.

By contrast, seed companies saw the Biosafety Law as a good instrument for regulation, and as opening the path for GM maize approvals. One argument that seed companies share with regulators is that GM maize is already in Mexico in the form of imported grain from the States and Canada as permitted by the NAFTA agreement, and that properly regulated Mexican-grown GM maize would be a better and safer option.

Most interviewees reported a series of shared complaints about the nature and dynamics of the GM maize debate in Mexico: they spoke of the lack of reliable, unbiased information, of the lack of transparency in deliberation and policy making, and of the lack of meaningful public participation. They commonly blamed the federal government for this situation, and considered the GMO debate as emblematic of wider problems of political culture: of a government that is generally corrupt, that bases its decisions on the economic interests for a few, and that has little sense of the public interest. It was these considerations, according to a majority of our participants, that were driving the debate on GM maize implementation in Mexico. Many stakeholders believed that the lack of transparency and public participation are in fact governmental tactics to 'pass in silence' GM approvals which would work in their interests, narrowly defined. Most stakeholders shared a sense of impotence in this respect, as they sensed that so-called debates are not genuine or meaningful, since actors are not really listened to. Even when participation is seemingly allowed, the results of consultation appear to be ignored:

'Maize's Special Protection Regime was consulted, thousands of opinions were received online, but they [the Government] never took them into account. There are thousands of expressed opinions when permits [are about to be issued], but they do not take them into account. So why participate, what for? There is no real debate, no real participation, which has an impact and where you can see results.'
(NGO representative)

The seed companies' representative also felt that debates were one-sided, but in the opposite sense, and reported that 'there is not debate, but controversy'. There are, according to this stakeholder, three significant aspects to the debate on GM in Mexico: maize, cotton and soya. GM soya was represented as a silent issue until 'the business about honey' (when honey producers from Yucatán found that their honey was not accepted as organic in the EU market anymore):

‘Europeans were happily eating honey and they did not care, but then they developed an “absurd regulation” saying that pollen is an item that has to be analysed as if it was a GMO, even if it did not represent a problem of biosafety’.
(Seed companies’ representative)

Around a third of interviewees stated that indigenous groups should have special rights on the issue of GM maize, on account of questions of human rights, sovereignty over resources, biosafety and political economy:

‘[Indigenous peoples have the] right to preserve biological integrity, the purity of the (maize) landraces, to avoid mechanisms of IP control, to keep their genetic resources, their seeds and their crops away from transgenes.’
(Indigenous groups representative)

In a similar vein, a number of stakeholders argued that the GM maize debates in Mexico has been dominated by scientific reductionism, and that in the particular case of maize, not enough attention has been given to social or cultural aspects. The regulator, for example, remarked that there should be more concern with the ways in which traditional agricultural practices contribute to maize biodiversity conservation. Moreover, this stakeholder argued that the debate should not only be centred upon the loss of genetic diversity, but ought to incorporate in the discussion issues such as loss of knowledge, practices and skills among rural populations.

d) *Voices* – There was a general agreement that voices that are ‘least heard’ in GM debates in Mexico are those of consumers, smallholder farmers and indigenous groups. Consumers are seen as a heterogeneous group which lack a unified voice or a strong presence. According to the seed companies’ representative, the reason for this lack of voice is that:

‘they do not have a militant attitude, they want to have quality products which are more accessible, safer, and they want to know that the relevant authorities who generate that safety and certainty, such as COFEPRIS, do their job properly’.
(Seed companies’ representative)

Other stakeholders preferred to talk of ‘citizens’, or ‘civil society’, to refer to the majority of the population, who might not have a clear for or against position with regards to GM, or who may not have a scientifically informed perspective of the issue, yet who nonetheless have a stake in it.

Smallholder farmers are widely recognised as an absent voice in GM debates, although people think they should be included because ‘they are the ones who grow the maize’. The category ‘smallholder farmers’ is often identified with that of ‘indigenous groups’, as rural indigenous populations are strongly associated with traditional maize agriculture in Mexico.

Indigenous people represent 14.9 % of Mexico’s total population (15.7 million out of 118 million inhabitants in 2013; source CONAPO). They are perceived as key voices with respect to genetic resources and biodiversity conservation, yet according to a number of our stakeholders that they generally are not consulted on issues regarding GM maize and their opinions generally are not heard.

Another voice that was reported as absent in debates, is that of the independent, neutral scientist, who is contrasted with those scientists who are seen as collaborating with the biotechnology industry. It is interesting to note what independence and neutrality mean in this context: independent scientists are viewed as those who work for a public academic institution, who have a professional reputation, who are not funded by the GM seed

companies, who follow the precautionary principle in GM matters, who do not actively participate in 'militant' environmental NGOs such as Greenpeace, but who nevertheless are aware of the wider social, cultural, economic and political dimensions of GM crops. Those who want to implement GM maize in Mexico tend to argue that the 'sound science' which needs to be heard in GM debates should not take other factors into consideration outside the 'scientific facts' (i.e. political, cultural or ethical considerations), and they firmly believe that this sound science has provided sufficient evidence to prove (in the absence of evidence to the contrary) that GM maize is innocuous and bio-safe.

Other voices, noted as relevant in stakeholders' interviews, were those of the Government, which is seen as largely inactive in debates on regulation. In addition, the voices of certain NGOs (such as Greenpeace) are perceived as problematic, and variably described as 'a caricature, contrary', 'too militant', and 'lacking solid arguments'; most stakeholders (even anti-GM actors) do not think these types of voices have helped to move the debate forward.

As to who were the most vocally heard voices in the debate, the majority of stakeholders presented the view that the biotechnology industry has been most successful in making its voice heard and in actively shaping GM policy and regulation. Even the seed companies' representative recognised the validity of this perception, agreeing that large companies and consortiums have made themselves heard at governmental and Congress level, and 'have achieved regulation' [sic] which opens up the development of agricultural biotechnology. Whilst the seed companies see this as a positive step, the other stakeholders were overtly critical of these methods:

'They want to get things changed by putting pressure on the regulatory system. It is sad that companies that could be more organised, more responsible, want to get to the commercial phases in a hurry, and do not assume responsibility about their management'.

(Regulator)

The clear majority of stakeholders shared the opinion that the Mexican media tended to follow and support the agri-food and biotechnology industries and their associated discourses ('*we are following behind in technology; it is necessary for Mexico to join international agreements and adopt GM; the Mexican countryside needs biotechnology*'). Yet, these stakeholders viewed these media arguments as far too simplistic.

Large-scale agricultural producers viewed themselves as absent in the debate and as being insufficiently consulted. Their claim was that their voice, advocating that GM maize should be allowed to be grown, should be heard and respected:

'We need to act a bit stronger from the legislative perspective, from the regulation of national budget, they should take producers opinions into account'.

(Large-scale farmers' representative)

In conclusion, all stakeholders recognised the need for wider and more inclusive consultation, yet most also agreed that this would require complex procedures, and that this lack of consultation is not the preserve of the GM issue, but permeates many aspects of government decision-making and practice.

e) Decision making – Most interviewees perceived a distinct lack of formal and institutional spaces for citizens' participation in decision-making. According to some interviewees, civil society is presently advocating extended spaces for dialogue and participation in Mexico, specifically with regards to proposals for the implementation of GM maize. Public

participation, they say, should be enshrined in policy, and citizen movements should demand participation and democracy.

It is interesting to note that the majority of interviewed stakeholders considered that decisions about GM crops should continue to be made in forums where they currently are made at present; the problem, they suggested, concerns the manner in which those decisions are being taken:

‘The place [where decisions] are being made is fine, the problem is how those decisions are taken, and who is being taken into account. [...] The problem is that only one side is being listened to, because of their economic and political power’.

(Regulator)

Most stakeholders agreed that GM policymaking and regulation *‘is not a process of real, participative, representative democracy’* (Social Scientist). Many see corruption as taking place both in the process and in the people who are implicated in the law and in policy-making, who are seen as looking after their own individual and corporate interests *‘even if they say it’s for the good of the people’* (Women’s association representative). For this reason, a large proportion of our interviewees suggested that economically powerful consortiums should not be included in decision-making processes at a governmental level, as they can (and do) influence political decisions through their economic power.

Stakeholders, however, recognised the complexity of existing GM regulatory systems and frameworks in Mexico. The interviewed regulator pointed out that there is a lack of capacity and resources, and that there are serious differences of opinion even within the very governmental departments and agencies that take the decisions regarding GM maize. According to this insiders’ perspective, SAGARPA (the Ministry of Agriculture) supports the interests of large-scale farmers, whilst SEMARNAT (the Ministry for the Environment) adopts a more precautionary position, as they are concerned with the preservation of agricultural biodiversity in relation to the conservation of genetic resources. Even though SEMARNAT’s reports are meant to be binding within the internal consultation process about GM permits, decisions are taken at other levels even within this same organisation, and many times those decisions are taken for political, not technical, reasons.

Finally, there was a generalised call for the implementation of more and better methods of public consultation and participation, particularly for those groups which have been marginalised in the whole GM maize debate and policy process:

‘In the last presidential period, there was an initiative for a consultation law for indigenous peoples. We participated with comments, saying “we should consult and respect their practices” – they should express whatever they have to say, it is very legitimate to say I want that, or I don’t want that [this law was not passed]’.

(Regulator)

Seed company representatives, however, suggested that existing consultations mechanisms are more than sufficient. They referred to the present mechanism of public consultation for GM permits, which gives the public 20 days to present evidence of harms, which have to be scientifically and technically substantiated to be legitimate.

2.4. Participant observation at a research laboratory

2.4.1. Social organization of the laboratory and its objectives/ mission

Participant observation and semi-structured interviews were conducted at LANGEBIO, the National Laboratory of Genomics for Biodiversity, in Guanajuato, Mexico. LANGEBIO was created in 2005 as part of CINVESTAV, the Centre for Research and Advanced Studies of the National Polytechnic Institute (IPN), a respected public university in Mexico. The aim of LANGEBIO is, according to its director, Dr. Luis Herrera-Estrella, 'to bring together interdisciplinary groups to carry out cutting-edge research and to generate genetic knowledge about Mexican biodiversity that could lead to its sustainable use' (Herrera-Estrella no date). LANGEBIO has been financed through an agreement between the Federal Ministry of Education (SEP), the Ministry of Agriculture (SAGARPA), the National Research and Technology Council (CONACyT), the Government of the State of Guanajuato and CINVESTAV.

Within LANGEBIO, our research assistant worked particularly with Dr Ruairidh Sawers' team, the Maize Genetics and Genomics group, who are undertaking research on maize's landrace germplasm. The broad aim of the research is to offer new insights and possibilities for conferring tolerance to both biotic and abiotic stress, the major focus being tolerance of maize to phosphate stress. Led by Dr. Sawers, the team consisted of various post-doctoral, doctoral and masters' researchers, all of whom agreed to participate in our research. In addition to this team, our research assistant also interviewed the Laboratory's director and another of the research team leaders, who specifically requested an interview so that he could express his views on GMOs. A total of 16 senior and junior researchers participated in our study, and 5 of them were interviewed in depth.

Participant observation and interviews were carried out following research guides which had been created by the Project Manager, and which were followed as a resource to guide observation and interviewing. Each guide referred to a different domain of investigation (the work at the laboratory; relations and hierarchies; science and society; GMOs; and GM debates and voices). Equivalent guides were followed in the three national case studies.

2.4.2. Perceptions of GMOs within the laboratory: Arguments and narrative resources

Opinions about GMOs in general and GM maize in particular varied greatly within the laboratory and within each of the different research groups. These differences could be broadly mapped onto age groups and the hierarchical position that people occupied in the laboratory: generally speaking, and with some exceptions, younger and more junior researchers expressed more caution in their opinion about GMOs and about the viability of different processes of genetic manipulation compared to their older and more senior counterparts, who tended to be more openly in favour. It is also interesting to note that the Maize Genetics and Genomics group was not working on the development of GM maize at the time of our research, and that most researchers in this group expressed scruples and doubts about the suitability for maize to be genetically modified, a principle they seemed to share with the rest of Mexican society.

A number of more junior scientists made a clear distinction between two different ways in which maize could be genetically modified: either modifying the maize with transgenes from the same species or from other species. When it came to the idea of inserting genetic material from other species into the maize plant, they reported reticence:

'We do not insert pieces of one jigsaw into another jigsaw. We use the natural tools which exist in maize's genome.'

(Doctoral researcher)

Their distinction was in part justified by the conceptual continuity they perceived between the conventional breeding farmers undertake in the fields and the research GM researchers undertake in the laboratory. They believed this continuity was abruptly interrupted in processes which required the insertion of genes from another species:

'Here we work with crossbreeds, so that we learn about the pieces of the jigsaw, but they are crossbreeds which have been made for a long, long time, since the ancestral collectors were doing crossbreeds.... It is a very artisanal work that we do here. We want to make improved seeds with desirable characteristics'

(Post-doctoral researcher)

Junior scientists thus made distinctions between what is 'natural' (e.g. to use genes of the same species) and what is 'not natural' (e.g. to use genes from other species) in research processes that involve the direct genetic manipulation of plant life. In addition to these ontological distinctions, junior researchers also raised a few (mild) ethical questions with respect to the practices and products of maize biotechnology:

'We need to ask: what kind of maize do they want to introduce? Where are those genes coming from and why do they want to use them? What benefits will they bring, and in what ways are they improving maize?'

(Post-doctoral researcher)

Their cautious position concerning the genetic manipulation of maize and the use of GM maize in open cultivation was also linked to a perception of the limits of current scientific knowledge, which they felt is still imperfect and incomplete:

'We still do not know maize well enough to think about transforming it. We need to invest more time and effort in getting to know it, to know its genomics. It is terrible to think that we can modify it genetically'

(Doctoral researcher)

This expressed caution became was transformed in some of the exchanges into a sense of danger and a fear of unexpected consequences, which they believed could affect maize's integrity as a plant and threaten its future genetic diversity:

'[...] We do not want for that genetic diversity to be lost. GMOs could spell the end of maize's genetic diversity, because in cross-pollinisation they exchange genetic material and cross among them. Everyone knows that if you cultivate GM varieties in the field, they will mix with the landraces.'

(Post-Doctoral researcher)

The ethical and ontological concerns expressed by Mexican scientists working with maize could be explained in part by their special relationship with maize, as the quintessential Mexican plant. When asked about whether this was the case in particular, they tended to abandon scientific explanations and revert to well-known public rhetorics on the significance of maize in Mexican culture and identity – a rhetoric which so often informs anti-GM arguments and protests:

'Maize is my land, it is my mother, and it gives me the food that sustains me'

(Post-doctoral researcher)

'It is not about being attached to the actual plant with which we work, but is about feeling affection for the product, which is our main food and the basis of many people's economy in many areas. We feel affection for it because it is a food we have seen since we were kids, tamales, tortillas... We would die if we could not eat tortillas! It is very important for our identity; we are made of maize, as the story goes about the origins of the Mexican race. Ultimately, every Mexican eats tacos.'

(Academic technician)

Despite their expressed concerns about GM maize, most junior scientists did not question GM as a technology: on the contrary, they quietly defended the technology as a useful research tool which had helped them to advance their studies and to further their knowledge, even of maize. At the same time, a few of the junior scientists and most of the senior ones were less reserved or nuanced about GM technologies, declaring themselves openly in favour of them of all kinds. It is curious to note that, in order to explain their support of both the technology and its products, these GM enthusiasts used many of the same arguments that junior scientists had used to illustrate their ontological misgivings. For instance, the direct manipulation of genes, and in particular the insertion of new genetic material into the host genome through laboratory practice, was not considered an interruption of natural biological processes but rather a continuation of them. In this sense, these scientists conceptualised direct genetic manipulation on plants as a natural and legitimate part of existing agricultural processes, where the manipulating human enters a chain of natural causality by virtue of the naturalness of its own humanity:

'It is not a question of whether we have the right or not. Our human nature means we want to understand why things happen, we want to know, and we came across genetic modifications [...] Evolution is about modification'

(Master's researcher).

2.4.3. Reflections on science in society

All the interviewed scientists made a clear distinction between the practice of doing basic science and its subsequent application, use and commercialisation. However, this distinction led to two different positions towards scientific responsibility and the ethical dimensions of scientific research.

One group at the laboratory, including some of the more senior and influential scientists working with GM technologies, argued that their job is to 'do science', and that they do not have the time or the capacity to evaluate how their results are used downstream – neither it is their responsibility to know or justify the possible perverse application of their discoveries and inventions. Some defended the neutrality of science, a fact that for them meant that nobody (not even the public who is supposed to benefit from scientific advances) has the right to demand responsibility from scientists, nor has anyone the right to question scientific work in ethical terms:

'Science is neutral, and can be used to create equality or inequality. We do not all benefit in the same way, but this a social decision, a governmental decision, not the scientist's decision. If I worried about that, I would do nothing. Why would I bother to do agricultural studies? I know that those who are going to adopt [GM technology] are the largeholder, industrialised farmers, so what should I do? Then I better not do agriculture, or medicine, or electronics...'

(GM scientist)

However, other scientists at the laboratory considered that their work does and must entail a sense of social and moral responsibility towards how their research is used downstream. These scientists believed that questions about impacts and costs of technologies should be embedded in the very design of research projects, and they suggested that there should be a discussion about ethics at the outset of any scientific investigation, something they say does not happen at present.

2.5. Focus groups with urban consumers

2.5.1 Introduction to research

Focus groups were conducted with urban consumers in the city of Morelia, the capital of the State of Michoacán, in November and December 2012. Dr. Artía, our Research Assistant for Mexico, conducted four separate focus groups: (1) one with young women aged 29 to 38, who took their children to the same local school, and who were either professionally engaged or worked at home; (2) another with professional women, aged 26 to 45, who worked in the academic environment of UNAM; (3) a third with students at UNAM aged 25 to 30; and (4) and a fourth with people aged 22 to 39 who defined themselves as religious practicers of different faiths (Catholic, Pentecostal, Christian and Maya).

Each focus group was organised around a similar script and set of questions: after a brief introduction to the activity, participants were asked to talk about food practices and their meanings; then, they were introduced to a brief definition of genetically modified crops and foods, and were invited to speak about their knowledge and opinion on the matter, and in particular about GM maize; they were then questioned about their ideas regarding the benefits and risks of GM products for human health and nutrition; and finally they were encouraged to express their feelings about GM maize through writing their comments on a large sheet of paper.

2.5.2 Food and daily practices

All participants in the focus groups said they consumed maize products on a regular basis, ranging from the most traditional and local, such as *uchepos* (maize paste made from young corn and boiled inside a maize leaf), to the most recently introduced, such as popcorn. Maize tortillas were consumed daily by all respondents, and although some of them bought industrially produced tortillas whilst others bought hand-made ones, everyone said they preferred tortillas made with creole maize and in the traditional way, which they said they could distinguish by their look, consistency, colour, smell, taste and durability.

Some maize foods were prepared and consumed on special occasions and were linked by participants to particular festivities, rituals and places:

‘Sometimes I cook tlacoyos [a thick oval blue maize tortilla filled with beans, cheese or potato], everytime there is a festival. Last time I made them for the 15th of September [Mexican Independence Day] and everyone had to cook a typical food from their region, and I come from Tlaxcala, so I cooked tlacoyos’
(Male PhD student).

Maize cookery tended to be highly appreciated by participants, and associated not only with food and nutrition, but also with emotional nourishment and care, including the constitution and maintenance of social relations and diverse identities (gender, family, regional, national):

'My granny knows how to cook many things, her own mother-in-law taught her, and she in turn taught my mum, and there is always an exchange of recipies going on'
(Master's Degree student)

'When women are breastfeeding, they are given atole [white maize drink] so that they produce more milk'
(Female Communications graduate)

'Tamales are very special in my family. We prepare them when the whole family is together, we make them to eat them together. We keep a few aside, and then we take those to work the following day, to your other social sphere, and you give them away to your colleagues'.
(Female University lecturer)

However, the maize food which elicits more and richer responses from participants in terms of meanings and significances are the *tortillas*. *Tortillas* are identified with land and belonging and with being Mexican (*'the base of our food', 'the maize from our land', a part of us'*), with but also with relations and affection (*'home, love, pleasure'*) and with health and wellbeing.

Criollo maize and its cooked products were also brought into conversations by participants to signify the memory of people's childhoods, which in many cases were either spent in the countryside or included relatives who cultivated maize, such as grandparents. This clearly indicated the inter-generational proximity of rural and urban worlds in the Mexican imaginary and experience, and the connection with traditional agriculture and home grown native maize which transcended the 'symbolic' to enter the realm of real and remembered meanings and values:

'[Tortillas] mean a great deal to me, because my maternal grandparents live in the countryside, and my granny was a farmer. I remember how, during my childhood, I would go to my granny's house at five in the morning to grind the nixtamal (boiled criollo maize) and she made the tortillas in an earthenware comal [flat plate used to cook the tortillas]. It was such a rural and rich way of making tortillas, they tasted like heaven....All my siblings and cousins waited beside the comal for my granny's tortillas. And that is how days started in the countryside. We also went to the milpa, and we helped my grandfather to thresh the cobs, and the stalks were used for the fire, and were also fed to the pigs. It brings me to a world that does not exist anymore: my grandparents are dead, and nobody carried on working their land, my uncles migrated, and my mum came to the city'.
(Female Excutive Secretary)

Most participants admitted they do not cook their own maize products anymore, due to the pressures and lack of time of urban living, and to the loss of know-how with respect to traditional maize cookery. However, they still bought maize foodstuffs, mostly from women known to them who still cook in the traditional hand-made manner and using native maize. It is interesting to note how our selected consumers chose this type of product not only because of the perceived sensorial qualities of the ingredients, but also because of the artisanal, careful manner in which they were made:

'The taste, the care... in hand-made tortillas, all the love from the woman who prepares them is embedded into the tortillas. I feel they are more nutritious than the industrial ones just because of this'
(Female Communications graduate)

2.5.3 Responses to genetically modified foods and products

Most of the participants stated that they did not have a clear understanding of what GMOs are and what GM maize in particular entails. Many said they had heard about the issue vaguely; they complained it had been presented to them in a 'very abstract' manner, and called for unambiguous, neutral information. They admitted a lack of familiarity with the topic, felt intimidated by the subject and expressed an attitude of caution towards GM maize.

'I know [GMOs] are modifications which are made to the species in order to give it specific characteristics, which are supposed to be better than the original. But perhaps if it is food which is genetically altered it is not necessarily good'
(Female PhD in Geophysics)

Most respondents were unaware as to whether they were consuming GMOs or not, as they did not know which foods included them, not least due to the absence of GM labelling legislation in Mexico. Whilst consumers expressed concern over GM foods, the lack of information made it difficult for them to make decisions, which caused frustration. Many expressed support for labelling not only because they felt this was their right to be informed, but also because the food companies' opposition to labelling made them suspicious.

Our participants expressed concern about the unknown dangers GM foods could bring, and their potential long-term impact to human health and the environment. They also questioned the science that is claiming that GM foods are safe. They expressed unease not so much about the technology, but about the partisan reasons that consumers felt underpinned its promotion and development:

'Fear, folly that the food shortage is going to be more and more acute. There is fear of the unknown, ... that they are doing things that will harm or will cause problems, and we cannot stop them, and it is not in my power to tell the shop owner not to do such and such, or tell the company guy not to do such and such; it is not in my power.'
(Female Administrative Assistant)

Some of the participants in the focus groups also raised the question as to whether we genuinely need GM foods, and distinguished GM foods from other applications of biotechnology, such as medicines. They did not doubt the good intentions of scientists, but questioned science's capacity to predict harm:

'Obviously, we believe that all [scientific] research has a good end, a charitable purpose. The intention is never to cause harm. But you cannot control all the variables. Experiments have apparently a good objective, but we really cannot know exactly what is going to happen.'
(Female Physican)

'When we talk about biotechnology, it is not bad. If I was told that a family member is sick and through biotechnology a cure can be found; of course, I'll say yes. When it comes to food I disagree; in terms of environmental and health risks, we do not know.'
(Female Master's Student)

The most commonly used words to describe people's feelings towards GM foods were: anger, sadness, worry, distrust, deception, abuse, indignation, confusion, suspicion, fear and impotence. Ontological arguments also were voiced, with GM crops and foods represented as artificial, unnatural, false and manipulated.

People also tended to situate their views on GMOs within broader political economy considerations. People expressed scepticism in the claimed benefits of GM crops, because many people fundamentally mistrusted the intentions of seed companies and government actors, particularly on GM maize:

'I do not believe in Monsanto's social commitment, I do not believe they will bring a solution to the Mexican countryside'

'I believe that with this issue, as with many others, the political class is in collusion with the big corporations.'

'I do not believe in Monsanto's declarations; its interests are only economic, they want to appropriate all seeds that mother earth naturally produces and in such a way, to control all seed production and all consumption too, damaging those most in need, as usual.'

(Anonymous writings on paper)

2.5.4. Responses to public debates

Many of our participants perceived the debate on GM crops and particularly on GM maize as 'enclosed', restricted only to 'experts', namely scientists and regulators. People did not feel included in the debate, and they did not think their voices had been heard or taken into account. Nevertheless, they believed that they should be included in discussions about GM agriculture, together with smallholder farmers and citizens in general.

Most people did have a positive image of traditional maize farmers ('they look after the environment') and called for an alliance between scientists, farmers and universities to open up the debate on GM maize, and for these actors and institutions to be more involved in decision-making processes, since they were regarded to 'have the [necessary] knowledge'. Our respondents suggested there are two kinds of scientists involved in the debate, those who are concerned about possible risks and involved with the smallholder farmers and with society in general, and those who align themselves with power:

'[GM] Scientists use their discourse to sell; their arguments are for obtaining profit and money. Politicians want to sell to society the idea that GM will benefit us. Meanwhile, traditions, land, jobs and lives are being lost.'

(Anonymous writings on paper)

2.5.5 Governance and responsibility

In discussions on the decision-making process, consumers tended to question the credibility of the regulatory bodies responsible for safeguarding food. They expressed concern as to whether regulations on GM crops were being properly implemented, as well as concern about the lack of public consultation. And, in those cases where public consultation had taken place, many of our participants found them restricted and opaque:

'There has just been no consultation. ... They appear in the newspapers, tiny and hidden, so nobody finds out, legally going through the motions. But most people are in obscurity.'

(PhD Student)

Our respondents pointed out the difficulties of making decisions in the absence of reliable information. Information about GMOs, in their experience, tended to be incomplete. For example, companies tend not to publish the transgenic origin of their products and there is

no compulsory labelling in Mexico. Consumers called for a system of labelling, for more transparent and rigorous regulation and monitoring, and for reliable information on risks and benefits. There was little confidence expressed in government and in CIBIOGEM. Government data on this subject also tended to be mistrusted, given its sensed proximity to large multinationals and their interests.

‘Transnational companies are the great powers behind the national governments. In formal terms, the executive and legislative bodies are the ones who define regulation and legislation, but there is a great deal of lobbying behind the scenes. It is in those lobbies, which happen in ‘obscurity’, where decisions are made about maintaining or giving preference to economic interests above social interests’.

(Female with a Masters Degree in Public Policy)

2.6. Deliberative workshop

2.6.1 Introduction to workshop

The Mexican workshop took place in Mexico City at the National Autonomous University of Mexico (UNAM) campus, and was held over two days in April 2013. On the first day, a deliberative session was organised focusing on presentations of preliminary results of the field research conducted in Mexico, followed by plenary discussion, and small group and plenary work among participants. The presentations included three aspects covered by the field research on maize: ethnographic work with small farmers, indigenous communities and women, ethnographic work within LANGEPIO, and focus groups with urban consumers. The deliberative activity was divided into small group work and a plenary presentation of each group's conclusions followed by plenary discussion. This was aimed at eliciting reflection and at generating an informal group deliberation on the research preliminary outcomes and the current ‘political economy’ of GM crops in Mexico. Both the small groups’ and the final plenary activities were facilitated by members of the project's local team under the guidance of two of the main project team members.

Nearly 40 participants attended the first day's activities, drawn from a range of governmental, civic and private organisations representing scientists and academics, traders, social and religious activists, indigenous communities and small farmers. The following governmental organisations were represented: the Ministry of the Environment and Natural Resources (SEMARNAT); the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA); the Inter-Ministerial Committee on GMO Biosafety (CIBIOGEM). As a result of detailed discussions held on the second day, involving a smaller number of mainly academic participants to the workshop, a summary statement was prepared for a press release, which was published a few months later in *‘La Jornada del Campo’*, an agricultural supplement of the daily newspaper *La Jornada*. The statement, titled *‘Necesarios, nuevos debates sobre el maíz transgénico y la soberanía alimentaria’*, called for new public debates on GM maize and food sovereignty, and was signed by seventeen of the workshop participants.²

2.6.2 Analysis of findings

The group and plenary discussions during the workshop stressed a broad agreement on the need to open a new cycle of public debate on the issue. This was not a consensual position,

² The article was published on 19 October 2013 and can be accessed at <http://www.jornada.unam.mx/2013/10/19/cam-nuevos.html>.

as several scientists – including those who worked for biotechnology companies – argued that on the basis of evidence, the argument had been settled in favour of GM. Others expressed doubts about whether it was feasible to have an open public debate. But overall, a clear predominant view developed that, in principle, it would be relevant and necessary to instigate a series of transparent, inclusive and democratic debates involving a range of social actors.

Asked to consider priority issues and an agenda for this new round of proposed public debates, virtually all participants agreed that specific public policies on maize were needed which comply with the national legal framework for the region and that give due consideration to the interests and perspectives of small farmers. The latter were seen as particularly misrepresented in existing arrangements. Other priority areas were identified as information provision and social participation.

Regarding concrete actions, after discussing the small group contributions, and engaging in some negotiation on how to articulate them, the plenary agreed on the following two points: a) the need for an active moratorium on the release of GM maize. Alongside the moratorium the initiative should promote an informed debate, with society at large (not just interest groups), based on an agenda with clear deadlines and aims, and refrain from restricting scientific and technological research in the country, provided that the latter is oriented towards securing genuine sustainable development at all levels; and b) the reopening of a national debate on the production and conservation of native maize and food security, with effective sharing of reliable and verifiable information on biosafety and GMOs, involving active and inclusive consultation with all citizens, in view of promoting a democratic and transparent debate on where Mexican agriculture should be heading towards.

2.7 Conclusions

We now briefly summarise the key findings from the Mexico case study. First, we reviewed the debate on GM maize in Mexico. We found that the controversy over GM maize came to prominence in 2001/2002, following a highly published article in the journal *Nature* reporting the flow of transgenes into wild maize populations (the paper was later retracted), setting the scene for subsequent widespread and continuous protest. Maize is highly culturally resonant in Mexico, and protests against GM maize came to signify the defence of Mexican culture and identity in the face of the unwanted form of imposed globalization. Decisions by regulatory bodies have been seen as compromised and lacking in transparency. They have been contested vocally by NGOs and questions have been raised about their legality. And there has been little sustained effort by institutional actors, including the Mexican State, to engage the public.

Second, we presented fieldwork research with mainly smallholder farmers and other stakeholders in the Pátzcuaro Lake region in the State of Michoacán. We found that debates on GM maize were situated within the context of an on-going crisis in rural agriculture. Within this context we found strong and enduring social relations around maize agriculture, reproduced by systems of local community exchange and day-to-day food and religious practices. Within this context GM maize was seen as a felt intrusion into traditional practices, with unknown and likely negative impacts. Suspicion was exacerbated by deep patterns of mistrust expressed in the motivations of key actors, including the government and the seed companies. Small farmers tended to be ontologically opposed to GM maize, seeing it as artificial, unnecessary and a threat to traditional smallholder agriculture.

Third, we reported on the results of interviews and a questionnaire survey with a variety of local stakeholders involved in the debate on GM agriculture. We found a clear division between the views of some of the respondents (smallholders, consumers, environmental NGOs, social scientists) and those of others (large producers and seed companies). For the former, traditional maize agriculture was perceived as highly significant for Mexican history, society and culture; GM maize was perceived as an imposition and transgression; and regulatory bodies and laws (e.g. the Biosafety Law) were seen as compromised and ineffective. For the latter, GM maize was seen as part of a modernity that would transform the Mexican countryside from its current malaise.

Fourth, we reported on findings from a laboratory ethnography conducted at the National Laboratory of Genomics for Biodiversity (LANGEBIO) in Guanajuato. We found a clear distinction within the laboratory, between senior and older researchers who were more avowedly in favour of the application of GM agricultural technologies *tout court*, including GM maize, and younger and more junior researchers who were more cautious and nuanced. For the latter, extreme care was advocated in any attempt to restructure the maize genome, with a strong preference not to use genetic material from other species, and to minimise any risk that could affect maize's integrity.

Fifth, we presented research with predominantly middle class urban consumers on Mexican public responses to GM crops and foods. We found an appreciation of maize products and cooking as a part of Mexican identity and as a medium in the maintenance of diverse social practices. We identified a general negative reaction to GM foods and crops, especially to GM maize but to other GM crops too. This negative perception was compounded by various dynamics: by the sensed lack of unambiguous and reliable information, by the lack of labelling, by mistrust in the motives of those producing them, by the unknown dangers GM foods may bring and by the lack of proven necessity. The government, generally, was seen as in collusion with the large corporations, at the expense of the public interest. Regulatory bodies were similarly lacking in credibility.

Six, we reported on a deliberative workshop, conducted with a range of national stakeholders, set up to explore research findings and how to develop the public debate on GM crops. With some exceptions (mainly the natural scientists and representatives of seed companies who believed that the argument in favour of GM agriculture had already been won) we found broad agreement on the need to open up the public debate. Particular calls were made to develop more rigorous policies on maize, to give more voice to small farmers, to develop agricultural research that aims to secure genuine sustainable development and to reopen a debate on the production and conservation of native maize and food security.

We conclude by making a final observation concerning the model of development model that has tended to be associated with GM crops. At issue here is not simply a technology that involves the genetic modification of plants, but the model of development that this technology supports and fuels. In our research, some of the stakeholders saw promisory images and the defence of GM agriculture as a means of a particular kind of development that would bring increased productivity and yields, reduced usage of agrochemicals and carbon dioxide emissions, and a response to world hunger. However, for the majority of our stakeholders, GM agriculture was part of a different imaginary; in GM agriculture (in particular in the commercialisation of GM maize) they saw a technology that (perhaps unwittingly) would engender more land grabbing, more food insecurity, increased out-migration from the countryside, further social inequalities and the increase in the smallholder farmer's dependence on commercial monopolies.

Chapter 3 Brazil

Julia Guivant and Phil Macnaghten with Adilson Alves, Naira Tomiello and Joanildo Burity

3.1 A review of the debate in Brazil

Timeline

- 1995: The regulatory committee CTNBio is set up to provide technical advice on requests for permission to release genetically modified organisms (GMOs).
- 1998: CTNBio receives its first application from the global biotechnology company Monsanto for approval of its Roundup Ready herbicide-resistant GM soya. Even though this is approved by CTNBio, the Brazilian Federal Court upholds a case brought by Greenpeace and the consumer group Instituto Brasileiro de Defesa do Consumidor (IDEC), arguing that GM crops should undergo a local environmental impact assessment (EIA) prior to commercial application. This effectively establishes a judicial moratorium that continued until October 2003.
- 1999: A noisy confrontation takes place, and is sustained for the next five years between coalitions of actors arguing for and against the introduction of GM crops. The debate lacks widespread public engagement,
- 2003: Following widespread use of illegal GM soya in the southern states, President Lula issues a presidential decree that permits the temporary sale and distribution of illegally grown transgenic soya bean and later the use of the GM seeds on an annual basis.
- 2005: The Biosafety law is approved. The Law determines that regulations and licenses for experimental crop commercialization should be permitted so long as they comply with the principle of maximum precaution and the evaluation of national economic interests, food security and environmental impacts. It also established labelling as mandatory.
- 2005: Following the adoption of the law, the coalition against GM crops begins to lose momentum. The rate of growth of GM crops in Brazil increases exponentially, especially GM soya and GM Maize. By 2012, the coverage of GM crops in Brazil had risen to 36.6 million hectares or 21% of the global biotech crop, now the worlds second largest producer of GM crops, behind the US.
- 2008: A new alliance develops promoting non-GMO agriculture, centred on the Brazilian Association of Non-Genetically Modified Grain Producers (Abrange), acting in both GM and non GM markets. Concerns with weed resistance to glyphosate begin to mount, with implications for increased herbicide use. The GMO-free campaign changes its name to the Campaign for a Transgenic and Pesticide Free Ecological Brazil.

3.1.1 The trajectory of the controversy

Despite the controversy that has raged over the introduction of the technology since the 1990s internationally, Brazil's approval and application of GM crops since 2005 has been rapid and to some sense remarkable. In this section we analyse the factors that contributed

to this rapid growth of application by farmers, while taking into account the manner in which various actors and coalitions have been resistant.

Following a period of intense contestation, involving diverse coalitions of actors both for and against the introduction of GM crops – and involving a succession of high profile media campaigns, court injunctions, NGO campaigns, illegal smuggling of GM seeds into Brazil, presidential decrees and inter-ministerial conflict – the Brazilian government eventually approved the Biosafety Law in 2005, establishing the rules of engagement for GM approval and diffusion. This included: the ratification of the 2003 Cartagena Protocol on Biosafety, the creation of the National Biosafety Council as the supreme body responsible for executive decisions on GMOs (a cross-ministerial body), and the restructuring of the National Technical Committee on Biosafety (CTNBio) as the key scientific and multilateral agency responsible for approvals.

Before examining the ways in which these processes facilitated the rapid application and diffusion of GM agriculture, it is necessary to look in some more detail at earlier patterns of resistance. In 1998, the regulatory committee CTNBio, which had been set up in 1995, received its first application from the global biotechnology company Monsanto for approval of its Roundup Ready herbicide-resistant GM soya. Even though Monsanto's application had been approved by CTNBio, there remained dissonant voices – both inside the committee and in and across different ministries – that diminished the authority of the decision (Bauer 2006). Indeed, a few days before the CTNBio decision, the Federal Court had upheld a case brought by Greenpeace and the consumer group Instituto Brasileiro de Defesa do Consumidor (IDEC), arguing that GM crops should undergo a local environmental impact assessment (EIA) prior to commercial application. Drawing on an interpretation of the precautionary principle in the 1988 Brazil constitution, the ruling required crop segregation, labelling and EIAs even for field trials, effectively establishing a judicial moratorium that continued until October 2003, when a presidential decree legalised GM crops on an annual basis until the Biosafety Law was ratified in April 2005.

The above judicial dynamics created a set of conditions in which GMOs came to occupy a place at the centre of a national debate. A political coalition began to consolidate against the widespread (yet illegal until 2005) adoption of GM crops, consisting of various NGOs, political parties, social movements, learned bodies and parts of the judiciary. Key members included: (parts of) the Workers Party (*Partido dos Trabalhadores* – PT), the Landless Workers Movement (*Movimento dos Trabalhadores Sem Terra* – MST), the Brazilian Society for the Progress of Science (SBPC), the Federal Prosecutor's Office, IDEC, Greenpeace, the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), and state programmes of the Bureau of Consumer Protection (PROCON). This was a heterogeneous coalition that opened a political space for action against GMOs. The mix of social actors can be understood as a 'discourse coalition' (Hajer 1995), and included coalitions of scientists, politicians, activists and consumer organizations, who while sharing divergent interests, nevertheless adopted a common set of storylines, in this case against the widespread adoption of GM agricultural technologies. For example, one set of 'conventional' social actors, including the PT and MST, incorporated the issue of GM agriculture within a leftist discourse against globalization, imperialism, multinational corporations, the USA, the International Monetary Fund, etc. (Guivant 2002). While another set of actors, including Greenpeace, IDEC and federal public prosecutors, adopted a more internationally defined agenda, focusing on legal actions, with the objective of redefining CTNBio duties and decisions, while at the same time advocating food labelling and an active application of the precautionary principle (Guivant 2009).

The coalition in favour of GM adoption was composed of four main groups: scientists who

sought to defend the authority and decisions of CTNBio, biotechnology company representatives (such as those of Monsanto), farmers associations, and, after 2002, some representatives and ministries of the Lula government. Key advocates included some prominent researchers, mainly from public universities and from Embrapa (Brazil's state-owned agricultural research organisation affiliated with the Ministry of Agriculture). Their argument had an orthodox scientific and technocratic character, identifying the positions of the oppositional groups as unreasonable, uninformed, catastrophist and against progress. A key claim was that opposition to GMOs was not based on the facts of the matter (or at least those facts derived from current risk science). The risk assessments of GMOs and their derivatives, according to this group, had established that there was no evidence of risk in the production or consumption of GM crops (Lajolo and Nutti 2005; Guivant et al. 2009a, 2009b).

3.1.2 *The road to closure*

Up until 2003, the coalition against GMOs had retained its strength and profile, with high profile initiatives and campaigns, including in the media, in Congress and in international arenas. However, once Lula da Silva had begun his presidency in 2003, matters began to change direction. In March 2003, in response to strong pressure from Monsanto, farmers associations, scientists and politicians, and in the context of widespread smuggled GM seed being grown in the south of the country, President Lula issued two provisional executive orders³, in March and September 2003, that permitted the temporary sale and distribution of illegally grown GM soya and later the use of the GM seeds. This meant in effect the practical end of the moratorium on GMOs that had been in place since 1998.

Later, in 2004, contestations and conflicts of interests surrounding the adoption of the proposed Biosafety Law took much of the attention of both coalitions. In the Senate, Marina Silva, at that time the Minister of Environment and a strong critic of GM crops (including the formal position of her government), and her allies, were comprehensively defeated when the Biosafety Law was approved in 2005. The Law determined that regulations and licenses for experimental crop commercialization should be permitted so long as they complied with the principle of maximum precaution and the evaluation of national economic interests, food security and environmental impacts, as provided for in national legislation and in accordance with current international agreements (see Pinto Vieira and Viera Jr 2005, for details of the Law). It also established labelling as mandatory.

Following the adoption of the Biosafety Law in 2005, and the subsequent raft of applications that were approved by CNTBio subsequent to adoption, the coalition against GMOs began to lose momentum. The claims of international environmental organisations such as Greenpeace began to lose purchase, not least because their campaign had never effectively mobilized wider Brazilian society, or had engaged with the lived and material concerns of ordinary Brazilians (Guivant 2002, 2006; Hochstetler 2007; Hochstetler and Keck 2007). Indeed, attempts aimed by the coalition to mobilise wider publics, or engage in broad public dialogue, have been analysed as relatively superficial attempts that reached mainly militants already engaged in the cause (Guivant 2009). Indeed, Greenpeace eventually withdrew its campaign against GMOs in Brazil in 2011, a function of its inability to mobilise opposition and debate following the approval of the Biosafety Law.

³ Provisional executive orders (*medidas provisórias*) are issued directly by the President and have immediate effect, but must go through Parliament's vote within sixty days (extendable for the same duration) or lose legal force. They are meant to provide the government with effective decision-making powers but must be grounded on two criteria: urgency and relevance.

3.1.3 The changing structure of the alliance against GMOs

One of the main remaining actors from the coalition against GM crops is the NGO Family Agriculture and Agroecology (AS-PTA) that, since 1983, has sought to promote family farming and sustainable rural development in Brazil⁴. Following the approval of the Biosafety Law, AS-PTA argued (successfully) that the GMO-free Brazil campaign change its name to the Campaign for a Transgenic and Pesticide Free Ecological Brazil⁵. This attempt to merge two hitherto relatively unrelated issues can be seen as an innovative attempt to connect an issue on which there exists strong public concerns in Brazilian society (pesticide overuse) to the newer issue of GM crops and foods, in the hope that this association might be important for future mobilization and in the construction of alternative notions of scientific citizenship (Jasanoff 2011; Callon et al. 2010; Guivant and Macnaghten 2011). AS-PTA actions include the rescue of native seed for small family farmers (Santilli 2009) and critical positions against the process of approval of CTNBio, usually reported in their newsletter. Among AS-PTA allies, at least at the level of discourse, are the Nucleus of Agrarian Studies and Rural Development (NEAD), the National Council on Food and Nutrition Security (CONSEA) and some professional associations. NEAD, for example, part of the relatively recently created and family farm-oriented Ministry of Agrarian Development (MDA), has produced a number of booklets criticizing the process of GMO approval (Ferment and Zanoni 2007; Zanoni and Ferment 2011).

CONSEA is another member of the new configuration of the alliance. It operates at the interface between government and civil society in the areas of food and nutrition. It has largely a consultancy character and advises the President of the Republic on the formulation of policies and rights. The president of CONSEA, Emilia Maria Pacheco, recently advocated the 'restoration' of the government's concern with genetically modified products. She said: *'We also have great concern with the expansion of the release of GMOs in the country, which is largely associated with increased pesticide consumption, as is the case of soya beans, and we advocate the application of the Precautionary Principle, on issues related to biotechnology'* (Pacheco 2012: 3). In addition, there is the National Nutrition Council (NCC), representing nutritionists, who have supported the coalition since around 2011. The NCC defends agro-ecology and family farming as a counter-weight to agribusiness and monoculture and as one of the conditions necessary for wholesome and nutritional food.

Since 2005, the coalition against GMOs have attempted to influence the approval decisions of CTNBio through the courts, with some successes. In 2007, for example, members of the coalition filed a claim against the Federal Government contesting the decision of CTNBio to authorize the production, marketing and consumption of Bayer's Liberty Link Maize on the grounds that the conditions of coexistence and monitoring post-commercial release had not been met, as embodied in the Biosafety Law. The decision was upheld and CTNBio was obligated to impose stricter biosafety measures to ensure coexistence between organic, conventional and transgenic varieties. Nevertheless, despite some successes to slow down or halt the decision-making process⁶, approvals of GM crops have continued at a

⁴ Stemming from a Project on 'technological alternatives' launched by FASE, one of the oldest Brazilian NGOs, AS-PTA, like so many other Brazilian civil society groups, has its roots in Catholic Church pastoral initiatives and organisational forms (cf. Riffell 2002).

⁵ Another channel and expression of the anti-GM coalition is the *Ecovida* Agroecology Network, set up in 1998 to promote agroecological practices within family farming nationwide. It is originally grounded in, and has been sustained by, church-related NGOs and grassroots organisations (see Rover 2011; De Souza 2011).

⁶ A recent initiative by the Federal Public Prosecutors' Office (*Ministério Público Federal*) in October 2013 was to ask the National Technical Commission on Biosafety (CTNBio) to suspend deliberations on the release of transgenic crops resistant to pesticides 'until public hearings are held and conclusive studies on the impacts on the environment and human health have been carried out' (see Audiência Pública 2013).

considerable pace. As of 2013, approvals have been granted for 5 GM soya cultivars, 19 maize cultivars, 12 cotton cultivars and one black bean (feijão) cultivar (due to be commercialized in the 2014-15 growing season). All the GM plants have been modified to be either herbicide or insect resistant or in some recent cases for both.

3.1.4 The recent growth of GM crops in Brazil

Since 2005, the rate of growth of GM crops in Brazil has been dramatic. According to The International Service for the Acquisition of Agri-biotech Applications (ISAAA, 2013a), an industry body funded by biotechnology companies including Monsanto, Bayer CropScience and CropLife International, the coverage of GM crops in Brazil had risen to 36.6 million hectares in 2012 or 21% of the global biotech crop. This includes 23.9 million hectares devoted to GM soya bean, 12.1 million hectares to GM maize and 0.55 million hectares to GM cotton. Indeed, of the 44.7 million hectares devoted to these 3 crops across Brazil, 36.6 million hectares or 82% was biotech. Notwithstanding questions surrounding the reliability of these figures (for a detailed critique, see IFDP 2010), such statistics nevertheless point to the rapid diffusion and adoption of GM crops.

Notwithstanding such growth, there are signs that we may be witnessing the beginnings of a new alliance promoting non-GMO agriculture. In 2008 a new player emerged on the scene. The Brazilian Association of Non-Genetically Modified Grain Producers (Abrange), representing five of the most important soya bean companies (Grupo André Maggi, Caramuru, Imcopa, Vanguarda and Brejeiro), was set up as a consultative reference centre with a mission 'to institutionally promote [the] market for genetically modified free products, ensuring [that] consumers [are provided with] the right to choose', and 'to offer support to the agriculture business [and supply] chain with technological and innovative solutions, aiming at transparency, quality and safety [aligned] with economic, social, and environmental sustainability' (Abrange 2014). Following active discussion on the strategic need for Brazil to sustain its presence in non-GM markets (notably Europe), Embrapa aligned with Abrange and developed its own GM-free Soya programme.

There are important differences between this new coalition (centred on Abrange) and the previous coalition (centred on NGOs and social movements). While the old coalition campaigned against GMOs as a moral and political crusade, using arguments from bioethics, small farmers' rights, native seeds and so on (Nelkin 1995: 451), the new coalition is more pragmatic, seeing its role as that of extending economic opportunities in the non-GM marketplace, more 'pro non-GMO' than 'anti GMO'. Such an emergent storyline uses a different set of arguments emphasising the rhetoric of accountability, choice and the responsibility and rights of farmers. Nevertheless, on certain issues the 'new' and 'old' coalitions share a common voice, including growing concerns with weed resistance to glyphosate and its implications for increased herbicide use.

3.2 Ethnographic fieldwork

3.2.1 Introduction to fieldwork

Fieldwork, involving ethnography, informal conversations and semi-structured interviews, was conducted between January and February 2013, with small farmers and their families, with women farmers, and with representatives of organizations that provide technical assistance to farmers. Only small family farmers were included in the research. In Brazil, family farmers and rural family entrepreneurs are defined as individuals who carry out activities in rural areas and meet the following basic criteria: a) own a single property not

larger than four fiscal modules in size (measuring anywhere from 0.5 ha in southern Brazil to 100 ha in the Amazon region): b) mainly use labour provided by the landowner's own family; and c) family income is mainly derived from economic activities associated with their own establishment (FAO, 2012). Family farm establishments represent 84% of the country's farms and occupy 80 million hectares of land, or 24% of total farmland in the country. Thirty-one interviews were conducted and observation visits were undertaken at agricultural product fairs (called 'Field Days'), ran by cooperatives in the region. In addition, research team members participated in meetings of trade unions and family farmers organizations.

The western region of the southern state of Santa Catarina was chosen as the research site for a number of reasons: a) the historical, social, economic and political relevance of its family farming traditions; b) the general pattern of income distribution and land occupation in the region, which is less concentrated than in other regions of the country; c) the fact that the region is one of the original loci of contemporary land reform and women farmers' movements in Brazil; d) the degree of heterogeneity of organisational forms in family farming economic activities (including collective production); and e) the growing adoption of GM soya bean and maize as the main local farming practices.

In recent years, the western region has undergone a serious economic crisis due to falling relative prices of agricultural products, which is having a dramatic impact on rural communities. These problems began in the 1980s and intensified with a concentration of pig farming production, as pork (and to a lesser extent poultry) agro-industries targeted only those producers who were able to increase both the scale of their operations (raising a minimum of 50 sows) and their productivity (on a piglets/sow/year ratio).

Government agencies, the Catholic Church, the Lutheran Church and various NGOs, such as the Association of Western Santa Catarina Small Farmers (APACO)⁷ and the Small Farmer Support Centre (CAPA)⁸, sometimes working together with governmental agencies (such as the Ministry of the Environment or the Ministry of Agrarian Development), have promoted the creation of associations as a way of combating the crisis of agriculture in the region and providing alternative forms of production.

The main option for family farming lies in the production of GM soya, introduced in the region some 15 years ago. Over the last 5 years, GM maize has followed suit to become the second major local crop.

3.2.2 Practices and differentiations surrounding GM and non-GM agriculture

The majority of farmers in the area have adopted GM crop technologies, farming different varieties of GM maize and soya beans. They obtain seeds through the main regional cooperatives and are mostly associated with some of the big pork and poultry companies, such as Aurora and Seara. There are a number of important perceived advantages in the adoption of GM seed: less demand for manual work (relevant in the context of the growing rural exodus of the youngest), more free time, and better productivity and prices. Farmers that have not adopted GM crops have in some ways been pushed to the margins of the productive system, and have sought support for non-GM production from small regional

⁷ One of the most active NGOs in the region, APACO was set up in 1989 with support from the rural labour movement and the Catholic Church, and is aimed at providing both technical and financial assistance to farmers' groups (see www.apaco.org.br).

⁸ CAPA was set up in 1979 by the Evangelical Church of Lutheran Confession in Brazil (IECLB), the main Lutheran strand in the country, and provides technical and financial support to small farming agroecology in the southern states of Rio Grande do Sul, (west of) Santa Catarina and Paraná (see www.capa.org.br).

cooperatives, NGOs and local markets. Many have been involved in the production of organic horticulture and in the sowing of native seeds of maize, both for animal feed and human consumption.

Farmers can be grouped differently with regard to their engagement with GM crops:

a) *Non-GM farming* – small-scale, organic or agro-ecological farming based mainly on horticulture, maize, beans and raising dairy cows. These farmers choose not to adopt GM for at least two main reasons: scarcity in available funding and choosing high quality, healthy foods for the family and the market. These farmers resist transgenic grains because they identify growing them with destroying and polluting nature with pesticides. They show significant concerns about what to eat and the amount of pesticides in food.

b) *Non-GM through organic + creole maize farming* – One advantage of creole maize seeds is that they have been distributed free of cost through regional, state assisted small-scale cooperatives. In addition, Epagri (the rural extension agency of Santa Catarina state government) has provided 'improved' seed varieties that are perceived to be more resilient to pests and resistant to droughts than traditional varieties. However, farmers worry that these seeds are increasingly not a good option because their preferential offer has been reduced, because they remain sensitive to changes in climate, and because they are not as resistant as GM seeds. It is expected that conventional seeds are likely to continue to lose market share because of the predominance of GM seeds. For some, creole maize is used for feeding dairy cows when farmers are concerned that GM maize may contaminate their cows' milk, given the perception of outstanding uncertainties on grounds of safety.

c) *Non-GM through creole + conventional seeds farming* – This grouping of farmers have needed to abandon organic production because of contamination from neighbours' crops. This has been attributed at least in part to the spread of GMOs, which are seen as responsible for spreading pests to their crops, which are very difficult to control. Their neighbours are claimed not to have respected the segregation distances required by law, spreading herbicides using tractors, apparently in total disregard. These farmers are critical of GMOs, and emphasise the environmental and health problems the latter may cause. The land is already seen as 'intoxicated' and as needing to be 'detoxed', just as one would in relation to human health.

d) *GM + Creole seed farming* – Amongst these farmers, many were previously swine producers involved in contract farming. First, they changed to dairy cows and later to GM soya beans. They have a well-organised administration and are market oriented. They keep cropping creole maize because they find it sweeter and richer in proteins than GM varieties. The main reason for keeping it is for family consumption. Production of GM soya beans is for selling to the cooperatives. For them, the main advantage of GM soya is that it is easy to plant and that it reduces costs because pesticides need to be applied only once. With the conventional seed, they need to clean the '*inço*' (weeds), and apply pesticides many times.

e) *GM only* – Again, for these farmers the main advantage of GM soya and maize is that they facilitate working the land. With conventional crops, farmers need to be much more precise about the amount of agro-chemicals used and when to apply them. GM crops, as one of them described, are 'beautiful, grow quickly and are clean'. However, even these producers tend to avoid direct consumption of GM products, reserving some of their subsistence farming for the use of conventional or creole seeds, particularly maize. Practically 100% of animals used in meat products are fed GM soya and maize.

3.2.3 Factors mediating concerns over GM soya

a) *Gender* was a clear mediating factor deriving from a clear division of labour that continues to persist around agricultural practices. Women largely produce vegetables and fruit for family consumption and take care for animals (pigs, cows, and chicken) whereas men are involved in decision-making and in working on grain crops. Choices on seed purchasing, sowing, handling and other related issues are typically made by men. Some women even found it hard to provide specific information on crops, cultivated areas, or types of seed.

Women interviewed can be divided between those who are involved in organic production or creole maize and those who work in GM farming. The former were quite active and speak enthusiastically about their values and engagement in other activities outside the farm (for example, the women farmers' movement). One example is a woman from a farm raising dairy cows and growing creole maize. She was part of a mothers' group that produces seeds of a type of lettuce (*rabicho*), amongst others. They meet once a month and exchange information and seeds. They are also involved with medicinal herbs, something very valuable in the region, given that these are used both in human and animal health care.

For the group of women who work in GM farming, grain crops were represented as 'men's issues'. The women tend to be in charge of growing vegetables and fruit, mainly for family consumption, and in activities related to the care of animals (cows, pigs, chicken). They seem to be largely marginalised from the decision-making processes on whether or not to adopt GM farming.

In both cases, women play a critical role in handling and preserving creole seeds. Although some do not seem to have a problem with consuming GM maize, most associate healthy food consumption with non-GM (and preferably organic) products.

b) *Food practices* – Food practices have changed significantly in the last few decades. Some recipes are still very traditional but ingredients are increasingly bought at local supermarkets. For example, to prepare the traditional *polenta* with maize, they buy the flour from supermarkets. When they speak about how it had been when they were children, everything then was produced at the farm.

Still some farmers produce creole maize using a traditional windmill in their locality to make flour, and keep it frozen for consumption all year round. Mainly organic farmers are careful about keeping this tradition because they consider that they do not know what they are buying as all products seem contaminated by pesticides. Moreover, if they can avoid it, they will 'do their part'. Among farmers that keep creole and conventional maize, they prefer the former for cooking because it is sweeter.

c) *Farmer-experts conflicts* – In a number of interviews with stakeholders in the region, we identified tensions between farmers that adopted GM seeds and technicians from seed companies, as to the cause of the problem of weeds and insect resistance in GM crops. Producers and representatives of major companies operating in the region (Pioneer, Monsanto, etc.) both recognised the problem and tended to blame one another. The increasing resistance of some weeds to glyphosate herbicide used on GM soya is already widespread in crops across the three southern Brazilian states. In most infected crops, the fall in productivity can reach 40%, not counting costs associated with the need for increased herbicide use and the loss of quality of soya bean due to higher grain moisture and impurity.

Technicians from the seed companies complain that farmers do not follow recommendations about keeping a buffer zone between GM and non-GM crops, or doing crop rotation. This would increase weed resistance, among other problems. For them,

farmers are to blame:

'Farmers do not follow the technical recommendations. They do not keep the buffer zone, [they] fail to do crop rotation, and apply more glyphosate than they should. Overdosing is a major problem. All this is bringing many problems to farmers as they are losing their yields... so we put a lot of emphasis on [good] management.'

(RR technician)

From the technical experts' point of view these bad practices are seen as caused by farmers' desire for 'short-term' profit:

'They [farmers] see profit; they only want profit. Soya bean prices are good, and they see no need to rotate [soya] with another product; but they are going against themselves because [subsequent] weed management is complicated and expensive.'

(RR technician)

Farmers who already face the problem of weed resistance, however, feel that they are not the ones responsible for this situation. However, they hope that 'science' will find new alternatives:

'Will there be a day when things will be put right? Because science tries to evolve, but many things were stopped because they did not work. I believe, I hope that with more studies things will work better for us. We depend on it [science], either for our health, the wellbeing of animals, and farming. We depend on researchers and those who are in search of new knowledge.'

(A farmer)

It is interesting by contrast to note the explanation of a representative of a small cooperative, blaming the technicians of the seed industries:

'What we observed was that farmers planted without any recommendation, without even knowing the law. The law requires the use of buffer zones. Farmers are tricked by technicians from seed companies who say that GM is cheaper, that it yields more – which is a lie, because it does not produce more. If you take a variety of Pioneer GM and another non-GM variety, they yield just the same.'

(A farming cooperative representative)

3.3 Structured interviews and questionnaires

3.3.1 Introduction to data-set

Seven individual interviews were conducted in the west of Santa Catarina, using a list of open questions, with representatives from a public research centre, a social movement organisation, a NGO and technicians from seed companies. An electronic survey was also used, identical to what was used in the other national project case studies, sent to over two hundred people, with a 12.5% return. From the sample, nearly 38% of respondents held PhDs, 31% Masters' degrees, 17.2% a postgraduate diploma, and 10.3% a graduate degree. In terms of gender, 65.5% were men and 34.5% women. Over 82% considered themselves 'well' or 'reasonably informed' about debates on GMOs. Only 20% of them expressed positive opinions on how open or how accessible the debate of GM crops and foods had been in Brazil, up until now.

3.3.2 Analysis of questions

a) *Opinion on GMOs* – There were conflicting views on respondents' general opinions on GMOs. When forced to choose only three responses (out of 13 options) a significant number of respondents aligned their opinion with negative claims. A sizeable proportion of respondents agreed with the statement that GM agriculture 'creates dependency on seed industries' (48.3%), with the claim that GM agriculture 'may cause problems to the environment and/or to human health' (44.8%), with the claim that 'GM agriculture actually worsens conditions in rural areas' (31%), with the claim that GM agriculture 'destroys local cultures and traditions'⁹ (31%) and with the claim that 'GM crops are definitively harmful to human health and the environment' (17.2%). In relation to positive claims of GM agriculture, respondents agreed that GM agriculture constitutes a 'beneficial scientific advance' (37.9%), with the claim that GM agriculture 'helps towards feeding the world' (20.7%), with the claim that GM agriculture helps Brazil to become 'economically competitive and to enter global markets' (13.8%) and with the claim that GM crops provides 'benefits for the economic development of the country' (13.8%). Thus, to summarise, the three consistent negative views associated with GM agriculture were 'dependency', 'possible threats to the environment and human health' and 'threats to traditional forms of life'.

b) *Openness and efficacy of the public debate on GM* – Although the large majority (around 70%) agree that the debate has all but receded, respondents were at the same time of the view that access to quality information by the general public was limited (79.3%). They also tended to agree with the view that the debate has been unable to solve the problems around agricultural innovation and food security (44.8%). One reason may refer precisely to the lack of opportunity for widespread participation, as indicated above, which may have been dominated by the presence of a few powerful voices. Indeed, when assessing (on a range of 0–5) how 'loudly' relevant voices have been heard, large farmers, scientists, businesspeople score at least 3.4, whereas small farmers, consumers, women, indigenous and religious groups never scored higher than 1.41. Politicians and NGOs were perceived at an intermediary level, at an average of 3 and 3.3 respectively. Such figures changed slightly when it came to their views on who has real power to effect decisions and norms: politicians, businesspeople and large farmers stand out, in this order, as the most effective actors, though people also know that decisions are taken mostly within technical committees. Indeed, whereas people view scientists as their main source of authority of these issues (over 55% choose scientists as an authoritative source, or an average 4.34 out of 5), decisions were seen as not simply guided by science, in that they demonstrate a particular social and political bias (i.e. towards corporations and large producers). Down the scale, indigenous and religious groups, women and consumers feature lowest in terms of who has power to influence decisions. While businesspeople and large farmers are by far those who are seen to benefit most from GM agriculture, indigenous people, religious groups and women are seen as those who will be the most disadvantaged. Small farmers still clearly lose out, consistently scoring around 1.3 on average.

c) *Who participates? Who decides?* – Various open-ended responses to questions on participation and decision-making processes point to a tension between whether the debate on GM agriculture should be framed by expert and scientific knowledge or whether social dimensions and ethical considerations should also be considered. Although both dimensions are highly valued, they tend to differentiate as one approaches key issues of evaluation and implementation. Responding to an open question on who should take part in decision-

⁹ This rises to 51.7% when projected towards the future of agriculture and of the country in general.

making processes, the majority of respondents approved of the idea of independent, science-based technical committees. However, respondents differed on the latter's composition: whether these should be composed of scientists alone or whether this should include in addition a blend of social scientists, representatives of civil society without political attachments, and social actors affected by the technology. As seen above, this former position points to a certain view of science as apolitical, neutral, and therefore as scientists are crucial actors in decision-making. What the second position adds is a qualification for such blanket legitimacy: scientists must consult with other social and economic sectors and 'filter' their positions in order to reach a robust and fair conclusion.

A related point concerns who should *not* be involved in decision-making processes. A number of respondents suggested that all those who are directly identified with, or who represent political or economic interests, should be excluded, whether these be social movements (seen as tendentially radical), seed industries and scientists working for them 'without ethics'. A few replies focused on social actors that were seen as having inadequate knowledge to be involved, including indigenous groups, who were rarely seen as having a special stake in the issue¹⁰. A similar logic applies to religious groups, who are thought not to be relevant or to be an appropriate voice to be taken on board in the discussion of GM issues¹¹. When asked about which actors should have more influence in the decision-making process, besides scientists, there was a significant stress on the role of consumers.

3.3.3 *Short discussion on results*

The adoption of GM maize and soya is part of a broader set of transformations in local agricultural practices, which have facilitated the widespread adoption of GM crops, reaching up to 100% of large farms in the case of soya in the region, and around 30% of all properties in the case of maize. Maize is an important component of the family farming model, connected as it is to the production of milk and to its consumption by the farmers themselves and their families. Although there is some degree of coexistence of GM seeds with creole and hybrid varieties, alternatives are being increasingly narrowed.

The scale of adoption of GM seeds, and the compounded impact of the considerable 'rural exodus' of farmers and younger generations towards urban areas, alongside pressures coming from cooperatives and larger producers, have led to a situation in which few questions are raised about GM technologies. GM crops have tended to be accepted on pragmatic terms – whether as survival for small farmers, as market rationale for cooperatives, large agribusiness companies and governments, or as competitive innovation for scientists and technicians. Scientists and anti-GM activists have tended to adopt more principled arguments in their opposition to GM crops. In the Brazilian context, where some debate exists, it tends to be framed around the opposition between 'modern' and 'backward' agricultural practices. But virtually everyone is well aware of one dynamic: the increased operation of major multinational farming companies in the region (such as Pioneer, Monsanto and Dow), heavily impacting on the local economy.

Indeed, notwithstanding the views of some hard-core scientists, there is often some sensitivity from actors of the potential for GM crops, and the more intensive agricultural systems of which they are part, to pose negative and long-term impacts on traditional forms

¹⁰ The apparent indifferent attitude towards indigenous peoples among respondents should not, we suggest, be taken at face value, given that there exists in various regions of western Santa Catarina state a historical struggle to reclaim ancestral land, with some degree of success.

¹¹ This again contrasts with the role that some religious organisations – especially Catholic and Lutheran – have adopted, providing grassroots support to small farmers, landless workers and indigenous communities in the region.

of life and local cultures. It also seems quite clear that despite the lack of momentum of public debate on GM crops, many people feel that a host of relevant issues have not been tackled, that a good deal of relevant information has not been presented and discussed, and that some relevant stakeholders have been either unnecessarily neglected or disregarded in the process. This all raises questions about the (lack of) participation in technical decisions and the disregard of social actors affected by them.

3.4 Participant observation at a research laboratory

3.4.1 Social organization of the laboratory and its objectives/ mission

The laboratory ethnography was conducted at the soya research division of the Brazilian Agricultural Research Company (Embrapa), located in Londrina, in the southern state of Paraná. The research took place on two separate occasions: a) *in loco* application of a questionnaire and secondary data collection on the operation of the unit, and b) a 20-day period of direct on-site ethnographic observation.

Embrapa is a state-owned agricultural research organisation set up by the Brazilian government in 1972, organised as a distributed network composed of 47 relatively autonomous decentralised centres, distributed across several regions and working across six Brazilian biomes (Amazon, Cerrado, Atlantic Forest, Caatinga, Pantanal and Pampa). It employs a 2,389-strong research team (about 25% of its workforce). It is a public company affiliated to the Ministry of Agriculture, Livestock and Supply (MAPA). The National Centre for Soya Research – *Embrapa Soja* (CNPSo) was set up in 1975 and was responsible for the early expansion and adaptation of soya in Brazil, undertaking pioneering work to enable the soya bean to be adapted to the hot, humid and acid climes of the Cerrado biome, helping to position the country amongst the world leaders in soya productivity. Described as a ‘world reference centre for the cultivation of soya bean in the tropics’, it is situated on an 864-acre experimental farm housing 29 labs, 34 greenhouses, support installations and administrative areas, in which nearly 230 people work, 63 of whom are researchers. The Centre’s research agenda is shaped by national strategies for the sector. In partnership with companies and private foundations the Centre runs 105 experimental areas distributed by different biomes. Their research agenda is determined by institutional criteria, such as Embrapa’s strategic plan, international agreements, market demands, projects proposed by researchers themselves, and especially the national development strategies for the agricultural sector.

Following the release of GMOs in 2005, CNPSo scientists divided into two groups: the majority were in favour of the immediate release of GMOs whereas a smaller one defended the adoption of the precautionary principle. This latter position partially overlapped with the one held by the broader coalition opposed to the release of GMOs. However, the arguments promoted by Embrapa scientists tended to focus on questions of national sovereignty: for them it was critical to develop national science to make it competitive, to undertake their own GM research and to avoid technological dependence on outside corporations. In 2001, the project ‘Biosafety of Transgenic Products’ was set up in order to adapt Embrapa to international demands, to establish new partnerships, and to have access to funding sources to facilitate the marketing and licensing of products.

3.4.2 Perceptions of GMOs within the laboratory

Interviews with scientists working for CNPSo indicated that they tend to view GM technology as providing clear potential both to improve food quality and to feed a growing global population. For them, GM technology is seen as critical to further the national

priorities of poorer countries. However, in contrast with Embrapa's major achievements in the past, in recent years the organisation has lost ground to multinational biotechnology companies who have led the way in developing new varieties of GM soya and maize for Brazil's large agricultural sector. Field research data revealed that, between 2005 and 2008, the company controlled about 75% of soya bean cultivars in Brazil. In 2013, estimates pointed to only 7% to 8%. Embrapa scientists attributed this decline in market share to a combination of factors that include chronic underfunding and a cumbersome bureaucracy.

Embrapa researchers did not see any major difference in kind between GM and conventional soya beans. The key aspect in GM technology lies in its ability to modify characteristics or traits, introducing or modifying genes for plants or animals to produce targeted results. Every species is susceptible to improvements, in principle, and in this case Embrapa researchers saw their role as that of producing more productive and resilient cultivars with genetic resistance to pests and major diseases. GM technology tended to be viewed as equivalent to other kinds of agricultural innovation but with added potential. For these researchers, the possibilities for future development were seen as enormous, and researchers evaluated that the varieties that have been released today are safe, in that modern science had found that there is no evidence that the risks of harm are significant. Moreover, if risks were to be identified in the future, Embrapa researchers believed that these could be adequately controlled on a case-by-case basis within current frameworks of regulation and oversight:

'(...) there is no great difference between regular and transgenic soya beans. Differences are quite particular. Is there a difference? There is a difference! Soya beans are different among themselves. You have thousands of soya bean cultivars, each different from the others. If you collect wild soya beans all are different. It's the same variability among humans, no two people are alike.'

(Embrapa researcher)

Scientists acknowledged that even within the scientific community there is still debate about how much is known about GMOs, both in terms of understanding basic genetic processes and their potential for the genetic improvement of plants. This situation is seen as positive given that it opens up apparently limitless possibilities for research. Genetic modification is seen as allowing for the indefinite extension of human intervention in nature.

Researchers also stressed that the use of new technologies should not be used at the expense of previous ones. Generally, it was seen as necessary to use technologies in an integrated and combined manner. The exclusive use of a specific technology can lead to imbalances and, in extreme cases, can lessen the production potential of the agricultural system. If farmers, for example, in order to maximise short-term profits and minimise labour, did not undertake proper management, in a few years plants and insects will become resistant, as is happening with weeds that have acquired resistance to glyphosate. Thus, while farmers were seen as important players in the adoption of new technologies, they are also seen as chiefly responsible for the shortcomings of GMOs.

The ability of Brazilian science to develop innovative new agricultural technologies was one of the points highlighted by researchers. However, they warned that, although Brazilian science has a proud tradition, the current model of Embrapa's state-funded research – its level of funding, and its associated business model – have restricted its research work and its ability to develop genuinely transformative technologies for Brazilian agriculture.

3.4.3 Arguments and narrative resources

When considering the wider public, Embrapa researchers had a tendency to reproduce the same arguments available on the official website of CNPSO. The arguments are basic and simple, and based on instrumental reasoning: they emphasise economic benefits, the qualities of GM seeds such as those that offer resistance to diseases, improvement in nutritional compounds and benefits to the consumer. Researchers deliberately sought to avoid the pro/against debate on GM crops and did not offer any explanation for scientific controversies or risks associated with scientific breakthroughs.

They are however convinced not only that the technology can deliver on productivity and safe consumption, but that a ban on GM crops would incur a much slower development of conventional alternatives, leading to decreased productivity and higher prices. Legal and funding constraints on the development of research and partnerships also were seen to reproduce external technological dependency, which did not help poorer (or scientifically more peripheral) countries including Embrapa itself.

When questioned if human beings have the right to modify the natural structure of soya, researchers tended to invoke arguments of national sovereignty, the necessity of scientific advance and the challenge of world hunger. For them the genetic code is universal; if something works well on a plant, when transferred to another it will/ should also work. Why not use this knowledge and procedure? *'So if you understand that the genetic code is universal, you cut and paste [genetic information] from one species to another – that will work [too]'*. Thus, in principle, everything is amenable to be manipulated, provided it is done, according to them, in an *'ethical and rational way'*. In that respect, researchers are not willing to endorse any and every kind of GM technique, but call for a case-by-case discrimination.

Embrapa researchers admitted that farmers or society at large had not requested GM crop technology. Seed companies had offered the technology to farmers in a top-down manner. However, it was argued, if the technology had not been helpful to farmers it would not have been adopted by so many. Currently, one interviewee noted, a farmer who does not use the technology is left out of 90% of the market.

3.4.4 Reflections on science in society

There was little evidence of a structured and sustained debate with society at large. Lay opinion tended to be dismissed as ill-informed and as overly focused on the negative aspects of the technology. Any existing dialogue with those outside the laboratory has to date been largely restricted to farmers and academic peers. Even in the latter case, human and social scientists who are members of CTNBio, for instance, were often mistrusted in their scientific credentials. Embrapa scientists did not feel they needed 'to sell' their achievements by convincing the wider public. Rather, according to these scientists, it is up to the market and for individual consumers to decide whether or not to adopt GM. For the researchers interviewed, Embrapa's target stakeholder was the farmer, not the consumer.

For these reasons we found that there was no clear and deliberate strategy for Embrapa to communicate to a wider audience of relevant interlocutors, nor was there a developed or collective sense of accountability to those people who will be affected by the technology, even in the absence of whether these people have intentionally chosen to adopt GM foods

or not¹². This understanding also leads to a complicated question as to what constitutes the relevant role and rationale for the human and social sciences. For the latter, criteria of informed, meaningful and fair participation are often viewed as a necessary pre-condition for the legitimacy of public decisions, technical and scientific ones included. Given that this understanding is not shared by for example Embrapa researchers, it is thus not surprising that dialogue across the natural and social sciences remains fraught with misconceptions and resistances.

Respondents did agree, however, that the debate with society is not a practice of the laboratory, and considered this a communication failure, even though a number of them considered CTNBio the appropriate forum for such a debate. Overall, the voices of non-scientists were seen as unqualified for this task both for failing to understand what GMOs are and for introducing unscientific considerations into the debate (for instance, through 'ideological' premises). According to our respondents, although GMOs are widely discussed they are poorly understood. For our researchers, debates arising from society were seen as guided by political actors that do not know the benefits of the technology and who, in general, emphasise only the negative aspects. Interestingly, this argument does not apply to private seed companies or farmers who seek economic gain out of the technology, and who engage in partnerships with scientists to fund research and its outputs.

3.5. Focus groups with urban consumers

3.5.1 Introduction to research

This element of the study examines Brazilian public responses to agricultural biotechnology and to genetically modified foods. The research sought to analyse the perception of urban consumers to GMOs, to current debates both for and against the technology as well as to wider questions of governance, regulation and responsibility. Based on the interpretation of five focus group discussions, that took place in Florianopolis in the state of Santa Catarina between November 2012 and February 2013, the research was designed to elicit clues about factors shaping public attitudes, in a field where few people could be said to be knowledgeable about the technology and its application, or that could be claimed to have 'settled' or 'informed' views.

The focus groups reflected a spectrum of social classes and age groups, with a particular bias towards women and the middle classes. Each group included five to eight participants and lasted between two and two and a half hours. The sampling specification was theoretically derived: designed to cover a diverse variety of background but with topic-specific variants. The first two groups were of professional men and women (all class A or B), chosen because of their relatively high levels of education and personal agency, and their likely engagement with complex issues of governance and decision-making processes. The third group was one of housewives and mothers of young children (all class B), chosen because of their status as mothers and their likely detailed engagement with food and culinary processes. The fourth group was one of religious men and women, from a diverse range of classes and levels of education, chosen to explore the religious dimensions to public responses on GM foods. The fifth group, in turn, was composed of students, all studying social sciences at the Federal University of Santa Catarina, chosen to explore the views of young people.

¹² It is important to stress that these views do not express the position of Embrapa as an organisation, including the strategic vision of the company as a whole, but rather the views of some researchers who observe these dynamics from the lab bench.

The materials were developed by the authors and presented using a data projector. The focus groups began with a discussion of food, designed to understand how people understood and used foods in daily life, how food was embedded in everyday practices, why they made the food choices they did and the role of health, naturalness, tradition and different sources of information in these choices. This was followed by a discussion on the concept of GM foods and crops: what they are, the history of their production and use in Brazilian agriculture, their diffusion into different kinds of food products, the existence of labeling schemes and their potential for GM technologies to create new kinds of foods. Subsequently, current debates on GMOs were set out and discussed, both those in favour of the technology and its widespread application and those against. While in the fourth and final part of the group participants explored the responsibilities and roles of different actors in the debate, including their own.

3.5.2 Food and daily practices

Food appears to be a topic of growing salience for Brazilians. In all the groups, with the partial exception of the students' group, there was a lively and articulate discussion of food and food practices and of their increasing importance in everyday life. For some participants there was an appreciation of the lifecycle of foods, and of the social and ecological processes involved as foodstuffs travel from the field to the plate. Especially for women, good food was seen as a core contributor to health and well-being. There was a fairly intense concern with the industrialization of foods, and, for at least the better off, a desire to consume foods as organic and local as possible as a response. There was also a consciousness about the factors contributing to unhealthy foods: about the use of pesticides and herbicides, and the overuse of salt, sugar and unsaturated fats. However, such concerns tended to be considered at the level of individual health rather than as a wider concern with the environment, and were viscerally expressed at certain lifestages, such as when women had become mothers of young children. Participants, for the most part, displayed an intense desire for reliable and trustworthy information on nutritional content and more broadly on healthy foods. However, people rarely trusted the media to provide such information – which was seen as typically producing inconsistent, contradictory advice, all too often aligned with their own 'self-interests' – preferring instead to rely on face-to-face contact with nutritionists and other trusted individuals.

3.5.3 Responses to genetically modified foods and products

When introduced to the concept of genetic modification, and the subsequent and widespread adoption of the technology both in Brazilian agriculture and across an extensive array of everyday food products, participants expressed surprise. Few were knowledgeable about GM agricultural technologies and fewer still were aware of the extent to which the technology had become permeated into everyday foods products. Across all the groups, people responded negatively and for two reasons: because of the outstanding scientific uncertainties surrounding the health impacts of GM foods, and because they had not been consulted. These two factors led to an array of visceral responses: *'I feel betrayed'*; *'we are all guinea pigs'*; *'even with our level of enlightenment, we ignored it [...]'*; *'[this] is a leap in the dark'*.

As the groups developed their thinking on GMOs throughout the discussions their attitudes became more settled and mature. Broadly speaking, participants saw few direct benefits from GM agriculture for consumers. GM crops had not in their day-to-day experience reduced the cost of foods (at that time rising food prices was a national concern); it had not apparently produced environmental benefits (a number of participants were aware of the expanding use of herbicides and pesticides in Brazilian agriculture, including the use of

products banned in other countries); it produced no apparent health benefits (only unknown long-term risks); it was viewed as benefitting the large producer at the expense of the traditional family farmer; it was seen as providing foodstuffs principally for animal feed and thus as having had little practical impact in feeding the poor; GM crops were seen as being regulated by interests which were not purely scientific thus questioning the impartial and public authority of science (an institution that is hugely trusted in Brazil).

In addition, when asked to reflect on the label that is currently used in (some) food packaging – a small T sign set in black against a yellow triangular background with the associated text that it contains transgenic material – people for the most part claimed that the label was both confusing and misleading. Here is how the group of students responded:

Nico¹³: 'Here you see 'tested and approved': it's all hype! And that goes for everybody we consume, since more will be produced [with GMOs]. I think the move is great for entrepreneurs who want to produce more. Not caring if they harm or kill or if many people die from cancer or diseases ... Are [they] not concerned with that? [No] only with production and earning profit.'

Gisela: I think it will not end world hunger. It is another advertisement, as mentioned above.

Elisa: It's getting much everything in the hands of science and the 'we buy'. We purchase a medicine or food that is ready in 15 minutes. There is a whole chain of factors that are needed to combat hunger. It is not simply GM that will fight hunger....

Nico: What is missing for sure is information. In my family there are three nutritionists; so I guess I should have known [about GMOs]. Someone told me something and that has given me a warning. As a dietician who works with this [food] in a clinical capacity, I see that people have a number of concerns with GM foods and that there is no help. I do not think they [nutritionists] know about this.'

(Students)

For the participants, the key point of disagreement within the groups was not whether GM agriculture was a good or a bad thing (most of the participants were fairly negative in this regard), but of the relative importance of GM foods as an issue as it compared with more immediate social, political and cultural issues in Brazil (including food issues such as obesity and the over-use of salt and sugar in Brazilian diets).

3.5.4 Responses to public debates

We next presented participants with some of the key debates and arguments on GM crops and foods, both for and against. On the one hand, arguments were examined concerning its claims in providing solutions to world hunger and global food security, its role in contributing to national economic competitiveness and its potential to stimulate scientific innovation. While on the other hand claims were examined concerning outstanding risks to the environment and human health, religious arguments against messing with God's creation, as well as problems of injustice and the concentration of economic power in the hands of the few.

Participants tended to respond in a couple of ways. On the one hand the materials confirmed to them that the public debate had so far been largely restricted to academic

¹³ Please note that the names of respondents have been anonymised.

scientists, government actors, and seed companies at the expense of wider civil society, with the additional sense that these actors may have ‘manipulated’ the debate to promote their own interests. Thus, a number of participants were highly motivated to uncover those elements which (to them) may have been kept invisible, such as the need for wider discussion and research on the possible (long-term) risks of GM foods. In relation to arguments in favour of GMOs, there was some salience in the argument that GM foods could help feed the world, although most participants suggested that the problem was political and cultural in origin, involving more than simply the production and allocation of foods for the poor. Surprisingly, participants omitted any reflections on the importance of Brazil's competitiveness in strategic sectors, whether in technological innovation or in food production, even though a number of participants held professions in some way related to commerce.

3.5.5 Governance and responsibility

In this section we explored how people perceive key actors involved in the debate on GM crops including government, regulators, large and small agricultural producers, NGOs and the academy. Contrary to expectations, NGOs were repeatedly mentioned as actors not to be trusted, not least because of recent high profile cases of corruption. Scientists with links to the seed industries were also discredited. This kind of scientist was seen to be committed to the promotion of economic interests rather than the public interest, and thereby questionable in terms of his or her scientific credentials. The seed companies similarly were not trusted given that their interest lay in promoting commerce, not the public interest. Indeed, the same dynamic held for the media, who again were seen as inevitably compromised through their need to promote their own self-interests.

Responsibility, by contrast, was seen to lie primarily with government and with educational establishments, notably public universities. Government should be responsible for regulation, for assuring safety, for raising consciousness and for promoting the public interest. Interestingly, few considered that the government had fulfilled these obligations so far in a credible manner. The responsibility of scientists was to respect the public interest while those of universities – and to a lesser extent schools – was not simply to educate but to foster the creation of critical and participative citizens¹⁴, while the responsibility of NGOs was to bring information to the public sphere. Below is how the group of male professionals discussed the role of universities:

Federico: ‘Who is going to be part of this debate on [GMOs]? In this respect, I think we need better training for our consumers. The education system has a responsibility to develop our capacity to discuss controversial issues. Without saying what is good or bad, because I think it is not for us to judge, and the school can not provide all the answers – I think science can not [provide all the answers] - but at least it can promote discussion....’

Rafael: [...] what I meant by that is that education exists - not at the university level, but at a more basic level – but we have little investment in education. And we know that in Brazil, the majority of the population receives public education. Now this is the issue, this government's disinterest in investing in basic education to produce a critical citizen – that is just one more bullshit, it [education currently] is more to keep kids in school while parents work, just to reach the end, and they all leave school unquestioningly.’
(Male professionals)

¹⁴ A very similar position was expressed by participants in the deliberative workshop, who tended to expect the university (and somehow schools as well) to play such a role.

3.6. Deliberative workshop

3.6.1 Introduction to workshop

The Brazilian workshop was organised in two main parts: (a) presentations of preliminary results of the field research conducted in Brazil, followed by plenary discussion, and (b) a deliberative session with participants. The presentations included three aspects covered by the field research: ethnographic work with small farmers and women, ethnographic work within *Embrapa Soja*, and focus groups with urban consumers. The deliberative session was divided into small group work and a plenary presentation of each group's conclusions followed by plenary discussion. This was aimed at eliciting reflection and informal group deliberation on the research preliminary outcomes and the current 'political economy' of GM in Brazil. Both the small groups and the final plenary activities were facilitated by members of the project's local team under the guidance of one of the main project team members.

Participants were drawn from a range of governmental, civic and private organisations representing scientists, traders, social activists and small farmers. The following organisations were represented: The Brazilian Agricultural Research Corporation (Embrapa); Serra Geral Hillsides Ecological Farmers Association (AGRECO), Council for Information on Biotechnology (CIB), Federation of Workers in Family Agriculture in the state of Santa Catarina (FETRAF), Centre for Support to Small Farmers (CAPA), National Technical Committee on Biosafety (CTNBio), Ministry of the Environment (MMA), Ministry of Agriculture, Livestock and Supply (MAPA), Agricultural and Livestock Farming Research and Rural Extension Company (EPAGRI), Brazilian Association of Farmers of Non-Genetically Modified Crops (ABRANGE), and the National Council of Food Security (CONSEA).

3.6.2 Analysis of findings

Though basically considered as an issue that is 'settled' by scientists, seed companies and government officials, GM crops and foods were seen as poorly and ambivalently understood in the absence of an informed public debate. Fieldwork results and the workshop's discussions seen to reveal large gaps in public knowledge, disputed evidence as to the benefits of GM crops, and distinct social impacts arising from its adoption by small farmers, women and consumers.

With very few exceptions, the great majority of participants agreed on the need to reopen a public debate on GM crops and foods: on its regulation and oversight, on the need for concerted action to communicate reliable information, and for proper channels of citizen participation in strategic decisions.

Though the priorities and suggested actions did not entirely match among the three groups, as could be expected, there were interesting overlaps. Group 1 prioritised a demand for central government to undertake a mediating role in the debate and a responsibility to clarify issues on GM food to the wider population. Its preferred actions involved communication (through devising strategies to reach different publics) and education (stressing the provision of reliable information on GM crops and foods and their various effects on food production and public health). Group 2 prioritised the promotion of citizens' participation in GM debates. Its suggested actions pointed to organising deliberative policy conferences (a participatory tool that has had significant impact in Brazil since the 1990s) on GM agriculture, at municipal, state and federal levels, and related mobilisations such as at fairs, GM-free zones campaigning, activist use of social media, etc. Group 3 prioritised educational activities, through public events and the Internet. In summary, educational

activities were targeted as a way forward, with particular roles allocated for governments or organised citizens. The State was seen as a major nodal point in the various recommendations, being asked to mediate and promote informed debate and to provide participatory channels for public deliberation.

Despite quite a few disagreements during the discussions, some of which were sharp (particularly between scientists and farmers or anti-GM activists), the choice of priorities was developed without significant glitches. An underlying acknowledgement was that even though people do not show explicit interest in the GM question, communication and education would definitely raise the public salience of the issue. This was highlighted by reaction of urban consumers in the focus groups who while generally unknowledgeable on this issue, nevertheless called for rigorous and unbiased information on GMOs, on where it was being adopted and why, and on the various issues (both positive and negative) associated with its adoption. It was also argued that media dissemination alone is not enough, because of how the media was seen as likely to contribute to fragmented and disputed views, thus potentially contributing to public uncertainty and confusion. In any case, there were acknowledged to be different ideological positions that needed to be accurately reflected both in the media and in the academy. For this reason, informed debate and educational strategies were seen as needed. Education was associated with the right to be properly informed and as a necessary precondition for a genuine public debate, thus closely connected to questions of participation. Teachers, university lecturers, researchers and journalists, accordingly, were seen as key actors, alongside consumer and citizen groups, to promote better access to clear and reliable information and data on policy options.

3.7 Conclusions

We now briefly summarise the key findings from the Brazil case study. First, we reviewed the debate on GM crops in Brazil. We identified the trajectory of the debate and the factors that led both to the resistance and to the widespread adoption and take-up of GM crops in Brazil, analysing the actors, discourses, arguments, politics, government and legal actions. We found that the story of GM crops in Brazil was deeply polemical, plural (at the level of elite actors if not of wider society) and political. We concluded the section by pointing to the changing structure of the non-GMO alliance – more pro-non-GM than anti-GM – and its potential for future mobilisation in the context of growing concerns over weed resistance to glyphosate and its implications for increased herbicide and pesticide use.

Second, we presented fieldwork research with family farmers, women's groups and representatives from seed companies from the western agricultural part of the southern state of Santa Catarina. We identified the various ways in which GM technologies had been adopted into local practices. While GM crops were perceived to have certain technical advantages (e.g. ease of working the land), we found that GM crops had tended to be accepted mainly on pragmatic terms – whether as survival for small farmers, as market rationale for cooperatives and producers, or as competitive innovation for scientists and technicians. Especially women and those working in organic agricultures felt marginalised from debates on GM crops, which in many cases were impacting on their livelihoods but which tended to be presented as an inevitable part of Brazil's agricultural future. We also found evidence of a conflict between farmers and technical experts from the seed companies, each blaming each other for the growing problem of weed resistance to glyphosate.

Third, we reported on the results of a survey and interview research with a variety of local stakeholders involved in the debate on GM agriculture. Notwithstanding a diversity of views,

we found a clear alignment of responses with negative claims, chiefly: the propensity of GM agriculture to create dependency on seed companies, to cause potential problems with human health and/or the environment, and to threaten traditional forms of life. We found that while most respondents agreed that the debate had receded, that it had been thus far dominated by a few powerful voices (large farmers, scientists and corporate interests), and that there had been limited involvement of the wider public or access to quality information.

Fourth, we reported on findings from a laboratory ethnography conducted at the soya research division (CNPES) of the state-owned agricultural research organisation Embrapa, located in the southern state of Paraná. We found clear and unqualified optimism amongst scientists on the role of GM technologies to provide significant future agricultural improvement, producing more productive and resilient cultivars with genetic resistance to pests and major diseases. The arguments deployed tended to be instrumental and nationalistic, emphasising economic benefits, the apparent unparalleled ability of GM technologies to provide 'improvements' and the necessity for GM research to have a strong national base. We also found little evidence of a structured and sustained debate with wider society who was represented, by and large, as uninformed. Non-scientific actors were seen as equally unqualified for entering the debate on GM crops.

Fifth, we presented research with urban consumers on Brazilian public responses to GM crops and foods. Using a series of focus group discussions, we found evidence of food quality and safety as a topic of growing salience for urban Brazilians, with a fairly intense concern with the industrialization of foods, and, for at least the better off, a desire to consume foods as organic and local as possible as a response. When introduced to the topic of GM crops and foods, we found little knowledge or awareness and genuine surprise about the extent of its adoption. Through the discussions, participants adopted largely negative opinions, not least because the technology was seen as benefiting the producer (not the consumer) and because they had not been consulted. They were concerned that the public debate had so far been largely restricted to academic scientists, government actors, and seed companies at the expense of wider civil society, with the additional sense that these actors may have 'manipulated' the debate to promote their own interests. As a response, participants called for wider responsibility, particularly from government, for assuring more robust regulation and oversight, for raising consciousness and for promoting the public interest.

Six, we reported on a deliberative workshop, conducted with a range of national stakeholders, set up to explore research findings and how to develop the public debate on GM crops. We found that the clear majority of participants agreed on the need to reopen the debate on GM crops, on its regulation and oversight, on the need for concerted action to communicate reliable information, and for proper channels of citizen participation in strategic decisions. We found also a widespread feeling of impotence in confronting the power of the current alliance between scientists, the seed companies and politicians.

There are two points to make on the implications of the findings for governance: first, that public debates are rarely settled once and for all, especially when in the past these have been restricted to a limited number of powerful actors; second, that in democratic societies there is a growing expectation that experts and scientists have a responsibility towards society, beyond the mere provision of reliable knowledge. These points together imply that the institutional staging of two-way public debates on GM crops are a critical element in producing socially robust and fair decisions, and that public institutions have a responsibility to secure effective participation, involving a broad range of stakeholders in the decision-making processes. The Brazilian case study on the adoption of GM crops represents a highly technocratic approach to science-based public policy-making. The GM case is thus one in a long tradition of top-down, closed-circuit policymaking, which continues despite changes to

the structure and culture of the State, and to expectations of transparency, accountability and inclusive participation as promoted by organised civil society. More deliberative forms of policy-making seem to be a particularly relevant condition for the development of socially-sensitive public policy.

Chapter 4: India

Yulia Egorova and Kamminthang Mantuong

4.1: A review of the debate in India

'We reject the approval of Bt brinjal. We traditionally save our own seeds and consider them as sacred' (farmer from Chengua, Odissa; quoted from Guardian 14 January 2010)

Timeline

- 2001: Genetically modified (GM) Bt cotton is found to be grown illegally in India.
- 2002: The Genetic Engineering Approval Committee (GEAC) grant retrospective approval of Monsanto/ Mahyco's (Maharashtra Hybrid Seed Company) Bt cotton for commercial cultivation. This is the first, and until now, the only GM crop to be legally cultivated in India.
- 2008: Pushpa Bhargava, the leading molecular biologist of India, appointed by the Supreme Court of India to oversee the functioning of GEAC, writes a letter to the Prime Minister indicating that GEAC's procedures for the approval of GMOs are inadequate.
- 2009: GEAC approve the commercial release of Mahyco's Bt brinjal (aubergine). However, they recommend that the Indian Government take the final decision. Brinjal is a highly symbolic crop for India.
- 2010: The Environment Minister Jairam Ramesh asks the opinion of the six Indian academies on the desirability of the commercial release of Bt brinjal. The academies produce a report recommending that Bt brinjal is approved for release. The report is found to have been plagiarised from a document prepared by a US-based lobbying organisation for the biotechnology industry. The report is dismissed by Ramesh who places a moratorium on the release of Bt Brinjal.
- 2012: Following the report of the parliamentary committee on agriculture, a panel of technical experts appointed by the Supreme Court recommends a ten-year moratorium on field trials of all GM food crops in India and termination of all ongoing trials of GM crops.
- 2013: A committee of experts, made up of scientists from leading public research laboratories and academic institutions set up by the Supreme Court, changes the ten-year moratorium on GM field trials, to what appears to be an indefinite moratorium on GM crops and field trials.

4.1.1 Rationale for biotechnology

A key challenge for policy-makers in India is how to feed a population of 1.1 billion and growing, while at the same time ensuring people access to sufficient, safe, nutritious food to maintain a healthy and active life. Following the Green Revolution (1970-1990), India had become largely self-sufficient in food grains, including wheat and rice, the two main cereals cultivated and consumed in India. Yields had increased from around 50 million tonnes in the early 1950s to over 200 million tonnes at the turn of the century but have been leveling off since the 1990s (Ejnavarjala 2012). 2002 predictions by the United Nations' *World Population Prospects* report suggest that demand for food crops is likely to increase dramatically in India, especially for cereals (United Nations, 2003).

With increased urbanization and household incomes in both rural and urban centres, there is likely to be an increase in *per capita* consumption of food. Along with the increased demand, there is predicted to be a 'shift' in patterns of food consumption, with relative increases in the consumption of dairy, poultry and meat. As Indira and others have pointed out, this will most likely entail an increase in the demand for cereal consumption (including maize and soya beans) for livestock farming (Indira et al. 2005). To meet this demand, either new land has to be made available for agriculture or farmers will have to adopt more intensive agricultural inputs. With the productivity benefits of Green Revolution appearing to be tapering off, pro-GM actors have been advocating agricultural biotechnology as a means for increased crop yield, using 'improved seeds'.

Public sector research on GM crops began in India in the early 1990s with active support and funding from the Department of Biotechnology (DBT). Out of 19 GM crops that have been developed in 24 publicly funded institutions, GM rice is the most intensively researched crop, with 15 institutions working on 4 varieties. These include: varieties aimed at resistance to insects and other viral and fungal diseases, varieties bred for increased tolerance to drought and salinity, delayed ripening varieties, aimed at improving shelf life, and (varieties with improved protein and micronutrient qualities (Indira et al. 2005). With the exception of the 'Amaranthus' gene (used for protein addition), developed and isolated by an Indian research team from New Delhi, all other transgenes used in GM crop research in India have originated from abroad, either from public sector research institutions from leading OECD countries or from transnational corporations (TNCs), thus subject to the intellectual property rights (IPR) of the transferring institutions and companies (Indira et al. 2005).

A dominant narrative underpinning the widespread promotion of agricultural biotechnology is the desire to promote India as a leading advanced scientifically innovative nation while ensuring that people have access to sufficient, safe and nutritious food. The commonly expressed tacit desire is not to be 'overtaken' by China in advanced science and technology and this narrative has helped lever substantial investment by the public sector for the development of GM crops.

4.1.2 History of the controversy over GMOs

National media attention began in 1998 with fears that Monsanto's importation of Bt cotton would include a terminator gene that would have the effect of making farmers more dependent on foreign seed companies. Despite Monsanto's protestations that this would not be the case, this touched many chords and Bt cotton became symbolic of a struggle against multinationals, neoliberal logics, the US and an unwanted form of imposed globalization. The KRRS (the Karnataka farmers movement) became highly active, mobilising an NGO campaign 'Monsanto leaves India'. Its leader, Prof. Nanjundaswamy created a series of slogans ('*Stop Genetic Engineering*', '*No Patents on Life*', '*Cremate Monsanto*', '*Bury the WTO*') and gave notice that all GM trial sites would be burned. The media debate continued at a high pitch throughout 1999 and 2000. Vandana Shiva, leader of the Research Foundation for Science Technology and Ecology (RFSTE), initiated a court case claiming Government knowledge of illegal sales of GM seeds. Citizens Juries at Karnataka (2000) and in Andhra Pradesh (2001) provided foci for activists to denounce GM crops and its associated and implied high-tech and externally-dependent future for agriculture. Following identification of illegal Bt cotton in 2001, the regulatory body, the Genetic Engineering Approval Committee (GEAC) granted retrospective approval of Monsanto/ Mahyco's (Maharashtra Hybrid Seed Company) Bt cotton for commercial cultivation. Mahyco is Monsanto's technology partner in India and their Bt-cotton hybrids carried the same Bt gene licensed from Monsanto. This is the first, and as of 2014, the only GM crop to be legally cultivated in India.

Bt cotton became widely adopted by Indian farmers. According to figures produced by the ISAAA, by 2012, India had the largest hectareage of cotton in the world at 11.6 million hectares, with Bt cotton accounting for 10.8 million hectares or 93% of the total coverage (ISAAA 2013b). Since 2002, a complex debate has taken place as to whether there is an association between the approval and subsequent adoption of Bt cotton and the level of suicides among Indian cotton farmers. Since 1995, an estimated 270,000 Indian cotton farmers have killed themselves. Some NGOs and activists are claiming that the high price of GM seeds may be a contributing factor, forcing many into a cycle of unmanageable debt, while others see no change of the suicide rate for farmers since the introduction of Bt cotton (see Gilbert 2013).

In 2008 Pushpa Bhargava, the leading molecular biologist of India, appointed by the Supreme Court of India to oversee the functioning of GEAC (Genetic Engineering and Approval Committee, the regulatory agency for biotechnology crops) arrived at a conclusion that GEAC's procedures for the approval of GM crops were inadequate. In 2009, the introduction of Bt brinjal – a type of aubergine indigenous to India – was approved for commercial release by GEAC following field trials in 2008. In 2010, the Environment Minister Jairam Ramesh asked the opinion of the six Indian academies on the desirability of the commercial release of Bt brinjal. The academies produced a report recommending that Bt brinjal should be approved. The report was found to have been plagiarised from a document prepared by a US-based lobbying organisation for the biotech industry. Ramesh dismissed the report and placed a moratorium on the release of Bt Brinjal (for a detailed analysis see Menon and Sidharthan 2014 forthcoming).

According to the Environment Minister Jairam Ramesh, *'Public sentiment is negative. It is my duty to adopt a cautious, precautionary, principle-based approach'*. Minister Ramesh was responding to the public mood after the Indian government held a number of public meetings throughout India in places such as Bhubaneshwar, Ahmedabad, Hyderabad, Bangalore, Nagpur, and Chandigarh. Attending such meetings were farmers, scientists, environmentalists, and ordinary citizens. One of the central concerns of India farmers is to protect the diversity of aubergines grown in India. India is the largest producer of aubergines in the world, growing more than 4,000 varieties. Bt brinjal is a product of the Maharashtra Hybrid Seed Company (Mahyco), which is a partner of the US multinational corporation Monsanto. Monsanto has been operating in India since 1949. It has three Indian subsidiaries: Monsanto India, Monsanto Enterprises, and Monsanto Chemicals. In early 1998, Monsanto acquired a 26% stake in the Indian seed company Mahyco.

In 2012, following the report of the parliamentary committee on agriculture, a high-profile panel of technical experts appointed by the Supreme Court recommended a ten-year moratorium on field trials of all GM food crops in India and termination of all ongoing trials and mandatory labelling of all GM foods. The committee undertook their review because of 'the serious differences of opinion amongst the various stakeholders and the controversies surrounding the cultivation of transgenic food crops' and arrived at their conclusions only after detailed examination (Bagla 2012). In 2013, a committee of experts comprising scientists from leading public research laboratories and academic institutions set up by the Supreme Court, changed the ten-year moratorium on field trials of Bt crops to an indefinite moratorium on GM food crops and field trials. The rationale given for this decision was that the Indian regulatory system contained major gaps that would have to be addressed before further field trials could be allowed.

In February 2014 Environment Minister M Veerappa Moily granted permission to seed companies and agricultural research institutes to continue with the field trials of different varieties of GM crops which had received clearance from GEAC, arguing that GEAC was not

bound by the Supreme Court's moratorium on field trials order. He emphasized that research institutions would need to seek permission from their respective state governments (Mohan 2014a). Moily's decision was severely criticised by the parliamentary panel on agriculture, recalling that agriculture is a state subject according to the constitution of the republic of India. So ideally the Central or Union Government should have no say in Agriculture. They further argued that any new 'research and development' on GM crops should be done only in strict containment, and that field trials should not be undertaken till the government puts in place 'all regulatory, monitoring, oversight, surveillance and other structures' (Mohan 2014b).

4.1.3 Analysis of governance, regulation and actors

GMO regulation in India has been analysed at length by Lian Chawii (2005), who explored India's experience with its first GM crop Bt cotton in order to assess India's capacity to cultivate GMOs on a larger scale. Chawii demonstrates that the way India handled its first commercially grown GM crop reflected serious weaknesses in the national governance structure, which included severe limitations both in policy structure and in implementation. As a party to the Cartagena Protocol on Biosafety, India committed itself to ensure a safe transfer, handling and use of GMOs. At the same time, Chawii's survey noted that the authorities demonstrated an inability to deal with the use of illicit GM crops. Indeed, there are any other cases of spurious pesticides, low quality seeds, and adulteration of various sorts being reported where no action is taken. India's Genetic Engineering Approval Committee tried to prevent farmers from planting unapproved seeds, by ordering them to be burnt; however, no action was taken against those farmers who failed to comply with the order. Drawing on Chaturvedi (2002), Chawii also reported that due to a lack of GMO detecting equipment in quarantine agencies in ports, India is not in a good position to detect GMOs in imported agricultural products. Moreover, she observed that GMO related regulations have been implemented by ad hoc committees without proper consultation with social scientists and general public (Chawii 2005: 4285). Chawii's conclusion therefore is that if it is to develop a more effective biosafety regime, the Indian government will need to develop more democratic forms of decision-making in the sphere of biotechnology – forms that need to include public participation – and to strengthen the institutional infrastructure, which would help ensure a more effective implementation of agricultural regulations. Although one needs to ask the question of why calls for more public participation, and more democratic decision-making, in this and other contexts have rarely been implemented.

4.1.4 Analysis of public perceptions and the role of the media

Anthropologist Glenn Davis Stone (2002) has observed that India's GM crop debates have attracted the attention of the global media and the international community, including its claimed role in contributing towards agrarian suicides caused by failed crops, which occurred at their worst in Warangal District of Andhra Pradesh, and have continued occurring elsewhere. As Stone put it, 'India is a key battle line in the global war over GM crops, and both sides interpret the Warangal suicides as supporting their position' (2002: 1). While Monsanto attributed suicides to crop destruction by bollworm and offered their GM 'Bollguard' Bt cotton seeds as a response, Vandana Shiva, one of the high profile anti-GM activists blamed the suicides on globalization and intrusive GM technologies. Stone has suggested that monolithic praising or condemning of GM crops appears to be misguided, as it has failed to evaluate the wider contexts of GM interventions and suggests a framework that would begin with farmers' own views of such suicides (Stone 2002).

Ronald Herring has explored the way the GMO debate has developed in India in the context of wider Indian politics (2006). He demonstrates that, as with many social movements in

India, the anti-GM movement has linked their opposition to Gandhian ideals organized around the notion of *swadeshi* (self-reliance). Anti-GM activists in India have portrayed multinational companies as imperialists seeking to dominate Indian farmers and the whole of India. This critique of 'neocolonial dependencies' is also linked to attempts to re-think internal democracy which now increasingly occupies Indian social movements. Herring shows that opposition to the trials of Bt cotton was also partly opposition to 'Delhi's rule' with protesters arguing that the new technology was imposed top-down in violation of democratic norms. Herring advocates an approach to the study of GM protests in India that seeks out the voices of individual farmers rather than organizations that are supposed to represent them, and explores the 'micro politics' of such protests. Thus he notes that on the ground the anti-GM protests were started with the Karnataka Rajya Raitha Sangha (Karnataka State Farmers' Organization), an organization that is led by rich farmers and that has a long history of opposition to multinationals. Herring's interviews with individual farmers demonstrate that not all of them trust the KRRS's explanation of GM technologies and wanted to use GM seeds 'to see for themselves' (Herring 2006: 209). The discovery of illegal Bt cotton in Gujarat also indicates that Indian farmers are not uniform in their opposition towards GM crops.

4.1.5 Qualitative research on actors

Elizabeth Bowles has focused her discussion of the GM crop debate in India on the context of Andhra Pradesh (2003). She begins her analysis by positing that there are two main settings for the biotechnology debate in developing countries. Biotechnology is presented as an opportunity for ensuring food-sufficiency and for giving developing nations a chance to boost their economies. Bowles demonstrates that both contexts apply to India. Firstly, in a country where 350 million people live below the poverty line, GM crops could help the poor to obtain affordable nutrition, if introduced in a pro-poor manner. Secondly, in light of India's changing place in the world economy, biotechnology could be seen as an opportunity for increasing the country's competitiveness. On the basis of her analysis of attitudes towards GMOs in Andhra Pradesh Bowles, she suggests that perceptions of GM crops are dependant on the way one perceives power, and that much of the resistance to GM crops in Andhra Pradesh and throughout the world is related not to the 'nature' of GMOs themselves, but to a view that GM crops are a threat to the poorest farmers who will not be able to compete with modernized agriculture.

4.2 Ethnographic fieldwork

4.2.1 Introduction to fieldwork

The ethnographic fieldwork in the state of Odisha (formerly Orissa) was conducted in August and November 2013. The fieldwork was conducted with small farmers, women's Self Help Groups, NGOs, government officials, seed suppliers, distributors, and retailers in the Kalahandi district of Western Odisha. The site for ethnographic study was conducted in both an organic farming village community and a conventional farming village community. In both villages, the farmers practiced cotton and rice cultivation. In the organic farming village, cotton and rice cultivation was practiced with the help of NGOs through a farmers co-operative association. In the conventional farming village, Bt Cotton cultivation was practiced using conventional methods. The Odisha State Government classify marginal farmers as having between 0 to 2.5 acres of land, small farmers as having 2.5 to 5 acres and large farmers as having more than 5 acres of land. In both villages, the majority of farmers in the community were either marginal or small farmers. The ethnographic study included 28 interviews conducted using semi-structured interviews, participation in community festivals

and weekly markets and observation of farming practices. The organic farming community were supported by an NGO-run organic farmers' association and possessed, at the village level, their own self-help group and organic farmers' club, unlike the conventional farming community.

4.2.2 Meanings and practices surrounding cotton

In both village communities, cotton cultivation is practiced in the uplands and paddy cultivation in the lowlands. Both villages are dependent on rain for cotton and rice cultivation. Organic cotton growers use 'Nuziveedu', 'Shalimar', 'Tulsi', and 'Takat' seeds (all hybrid high yield varieties), while conventional farmers use Bt GM cotton produced by Monsanto/ Mahyco.

In organic cotton farming, farmers use three kinds of methods for controlling pests:

a) Cultural method: farmers use trap crops such as castor or marigold flowers to attract the harmful bollworm away from the cotton plants. They also use plants such as maize for hosting beneficial pests that act as predators, and practice mixed cropping or intercropping agriculture using crops such as red gram, yam or maize to improve the fertility of the soil and increase crop yield. These also act as a fallback option for the farmers in case of cotton crop-failures.

b) Indigenous technical knowledge method: farmers use organic pesticides such as chilly-garlic extracts. Chilly garlic extract paste is made into a solution and applied on the growing plants. Another example is the Neem Seed Kernel Extract (NSKE). The solution is sprayed on the plants after thirty days of cotton-germination. It acts as a repellent and an anti-feedent, effectively repelling pests and preventing attack, with minimal impact on non-target organisms or on human health. Another method adopted is the use of cow urine to control sucking pests that include thrips, jassids, aphids, etc.

c) Mechanical method: In this method, farmers mechanically collect caterpillars with a hand net or sweeping basket. In addition, a pheromone (scent) can be used to trap the heliothis and spodoptera bollworm, by using a lure (in tablet form) to attract the heliothis and spodoptera moths. If one moth is destroyed, up to 700 eggs can be destroyed; thus it can be highly effective.

In the conventional farming community village, Bt cotton seeds were bought from seed companies who demonstrated the benefits of the seeds by letting the farmers buy the seeds without upfront payment. This is a regular practice from seed companies and traders in rural India which is also called 'credit linked input markets' and which acts as an informal kind of credit or debt. The success of Bt cotton has become a rallying point for the companies to advertise their seeds. Farmers who were initially skeptical saw the success of Bt cotton cultivation by comparing the quantity of bale produced per acre in Bt cotton fields with local varieties of cotton. In order to get the maximum benefit, we found in our research that farmers tended to use an excess of fertilizers and pesticides, with probable adverse impacts on the long-term fertility of the soil and thus the future sustainability of cultivating Bt cotton. Pesticides were seen to be sprayed often without using proper gloves, masks, etc., which was likely to adversely affect the health of the landless agricultural laborers. In their interviews, farmers indicated that in the absence of any 'safety-nets' that would allow their households to survive in case of crop failure, they believed they had to use pesticides on Bt cotton to be 'on the safe side'.

4.2.3 Factors mediating concerns over GM cotton

The adoption of Bt cotton in India has been widespread; today around 95% of all cotton cultivation in India is grown from Bt cotton seeds. This has led to increased income for those farmers who have the capital to invest in the new technology. The cultivation of cotton, whether organic or Bt cotton, is profitable to the farmers. Bt Cotton has become popular in the Indian countryside not least due to innovative marketing from the seed companies through 'demonstration' distribution of loans and through the delivery of the whole package at the doorstep of the farmers. In terms of profits, farmers get a return of 2-3 times their investment, which is seen as more profitable than the local varieties. However, over the years, cultivation of Bt cotton has been affected by increased pest attacks (such as from white fly, sucking pests, etc.), impacting on the profitability of the crop. We found that some farmers were looking for alternatives but reported that they were lacking choice. Farmers were finding it difficult to return to earlier form of farming, finding that previously available local varieties including indigenous seeds are no longer easily available (except for those which have been saved through seed-banks or by local farmers).

In spite of declining profits, farmers are finding it difficult to identify alternatives since Bt cotton still remains more profitable than local varieties. The incentive for cultivating Bt cotton comes from the promise of immediate financial gain, which then is commonly used to invest in their children's education, their daughter's marriage, or to buy mechanical cultivators.

4.2.4 GMOs and cultural meanings of food.

Cooking is at the heart of notions of purity and pollution in India. People of different caste status eat different foods – for instance, as we learnt from ethnographic interviews conducted in the two villages and during participant observation, women from 'pure' caste groups could not eat chicken, because, according to the local tradition, in the past chicken were reared by Scheduled Castes (former untouchables). Eating food that is not appropriate to his or her caste status is perceived to pollute a person, with ritual repercussions. In this context, when we raised the question of GM food with our research participants they pointed out that in a hypothetical situation where a GM plant was produced using DNA from chicken, it would not be suitable for 'pure' caste women. At the same time, they opined that a GM tomato with a gene derived from fish could be appropriate for consumption. One could therefore suggest that, in principle, local religious cultures do not call for a blanket rejection of GM crops. Each crop will be considered in the context of purity and pollution rules for each specific caste in each particular region (e.g. in some regions Brahmans are vegetarian, in others they eat fish).

At the same time, when we asked farmers whether they would welcome the introduction of Bt rice, many responded that they would be reluctant to do so for two reasons. First, they suggested that in growing Bt rice they would face the same problems that they and their neighbours were already facing in the production of Bt cotton, such as the growing resistance of pests. Second, they pointed out that unlike cotton, which was used mainly for the production of clothing, rice was food and therefore was less appropriate for genetic modification for reasons of safety.

4.3 Structured interviews and questionnaires

4.3.1 Introduction to data set

Fourteen individual interviews were conducted in Delhi and Odisha using a pre-designed set of questions. The interviewed stakeholders were representative of key persons in their respective organizations. Altogether, they included natural and social scientists, NGOs, farmers' organizations, consumer association, global seed companies, regulators, women's groups, and religious organizations. An online questionnaire was in addition sent to 53 stakeholders in different parts of the country. Out of this, the return rate was 26%. From the sample, 64% of the respondents held PhDs, 29% a masters degree and 7% a graduate degree. 86% were men and 14% women. 62.5% agreed they were 'greatly interested in the policies, debates and regulations of GMOs'.

4.3.2 Analysis of Questions

a) *Opinion on GMOs* – There were complex shades of opinion expressed on the issue of GMOs. The highest number of respondents (14.8%) agreed that GMOs 'can help improve agriculture and farmers' lives'. The second preference for the respondents (11.5%) was that GMOs 'create dependency toward agri-business and seed companies.' While, the third preference (9.84%) was to agree that GMOs 'can help to reduce hunger in the world.' Responding to the current debate on GMOs in India, when forced to choose one statement out of 13, the highest number of respondents (19.4%) agreed that '[current debates on GMOs] had not provided [sufficient] information to the public'. The second majority (16.1%) agreed that '[current debates] had provided [sufficient] information to the public'. While the third (9.68%) agreed that '[current debates on GMOs] have not helped to resolve the controversies they aimed to address'. Responding to the perceived relevance of GMOs for the future of agriculture and future of India, the first preference for the respondents (25%) was that GMOs are a 'good example of scientific advances'. While, a similar number of respondents (24.1%) agreed that 'they [GMOs] pose a risk or are dangerous to human health and/or the natural environment'. While, a nearly equal number (21.6%) agreed that the main advantage of GMOs was that 'they help agricultural development'. Thus, to summarize, the two consistent negative views on GMOs in India are dependency on agri-business and seed companies and the possible risk or danger to human health and environment.

b) *Openness and efficacy of the public debate on GM* – A high proportion (35.3%) of respondents agreed with the statement that they were able to 'keep up to date on all advances' on GMOs. 22.2% of respondents kept up to date on scientific or technological developments principally through 'the internet' with a further 22.2% of respondents choosing the 'academic publications' option. Responding to the question of whether the public debates about GMOs and their governance have been transparent in India, there was a clear division of opinion. An almost equal proportion of respondents' three opposing statements: that debates in India have been 'open' (around 20%), that they have been 'closed' (around 20%), or that they have been 'transparent only to a certain extent' (around 20%). When assessing (on a range of 0-5) which voices have been 'most heard' in debates on GMOs, NGOs scored the maximum scale of 5 by 8 respondents. The least heard 'voice' (who scored the minimum scale of 0) was small farmers (by 7 respondents). Scientists, politicians and policy-makers, business people, academics and consumers were in the intermediate level with an average score of 4.4. The most important argument presented in the debates on GMOs were seen to be arguments on 'food security' (6 respondents), 'risk/lack of risk to human health' (5 respondents), 'risk/lack of risk to natural environment' (5 respondents) and 'domination of global agribusiness' (5 respondents).

In questions related to the vocality of actors, NGOs were seen as having real power to affect decisions with a score of 5 (on a scale of 0–5) being awarded by 5 respondents. Politicians, government actors and business came next (with a score of 5 awarded by 4 respondents). Scientists come next (with a score of 4 awarded by 5 respondents). People who were considered to have the lowest influence in decision-making were small farmers, indigenous groups, consumers, women and religious groups. The groups that were considered to have benefitted the most from GM crops were ‘business people’ (the score of 5 being awarded 6 times) and medium to big farmers (the score of 5 being awarded 4 times). People who were considered to have benefitted the least from GM crops were small farmers, indigenous groups, women and religious groups.

c) *Participation and decision making* – Responding to questions on the decision-making process on GMO implementation, use and evaluation, we found that ‘technical or expert commissions’ were perceived to be mainly responsible for current decision-making processes (the score of 5 being awarded 5 times), followed by ‘multinational companies’ (the score of 5 being awarded 4 times), followed by the ‘executive’, ‘parliament’ and ‘business organizations’ (the score of 5 being awarded to each 3 times). When an open question was posed on who should take decisions about the implementation, use and development of GMOs in India, there seemed to be little shared sense of who ultimately should take decisions on GMOs. Responses ranged from scientists to farmers, regulators to traders, and others.

On the related issue of who should be excluded from the decision-making process, respondent suggestions of excluded actors included: ‘scientists and officials who have conflict of interest’, ‘interested business groups’, ‘politicians and activists who are driven by populism or sensational media stories’, ‘NGOs who are ‘not knowledgeable about the science involved and who usually represent a vested interest’, ‘churches and religious groups who are not directly dealing with these issues’, ‘public and consumer societies who are not experts on the issue’.

On the issue of participation in decision-making, even though most of the stakeholders undertaking the survey agreed that they had taken part in previous consultations, they nevertheless were of the view that their suggestions had not been taken up in policymaking. The majority of the stakeholders believed that it was the technocrats who make the ultimate decisions. To summarise, the questionnaire survey points to a highly contested set of opinions on GMOs, both between the grassroots and national policy-making, and between different actors and constituencies. There remains a lack of a shared holistic understanding of GMOs among different actors.

4.3.2 Structured interviews with stakeholders

In-depth interviews were conducted with the following stakeholder groups: natural scientists, seed companies, environmental NGOs, peasant/ small farmer associations and consumer groups. Perhaps unsurprisingly, the views presented on agriculture, and on the role of GMOs, were strikingly divergent. All interviewees acknowledged that the Indian countryside was in a state of change. For the representative from the seed company and the natural scientist (a geneticist), these changes were represented as part of a natural and evolutionary process associated with modernisation, urbanisation and the adoption of advanced technology in the agricultural sector. By contrast, for the NGO and small farming representatives, these changes were described as an agrarian crisis, symbolically represented in the image of over 250,000 farmers having committed suicide since 1990. This was seen as being driven by a deregulatory state:

See, with this kind of a regime: Whether it is the BJP or the Congress, economic policies, there is no difference. So, they are carrying on the neoliberal economic policies. The state is increasingly withdrawing, deregulations of all sectors, giving a free hand to the fertilizer industry, the seed industry, the pesticide industry. And the legal framework is also being made, such that it will be favouring the corporate interest.

(Representative of peasants organisation)

Views on GMOs were similarly divided. For the NGO and small farmer representatives, GM crops were seen in a wholly negative light: as being driven by external interests, with no labelling, a lack of transparency in decision-making, compromising biosafety, creating superweeds, leading to dependency of farmers on seed companies and distracting from alternative forms of sustainable agriculture. For the representative from the seed company and the natural scientist, GM technologies was seen in a wholly positive light: as increasing the inherent potential of a crop variety, as meeting both farmer needs (e.g. with insect-resistant plants) as well as national (e.g. feeding a growing population) and global needs (e.g. food security). Bt cotton was claimed to have led to a significant decline in the use of pesticides and to be safe. For the NGO and small farming representatives, the missing voices in the debate were the independent public sector scientist, the small farmer and the (urban middle class) consumer while for the representative from the seed company, the missing voice was the farmer and an assessment of his or her needs. For the NGO and small farming representatives, the recent moratorium on GM crops was attributed to increasing sensitivity from the government to the issue, while for the representative from the seed company and the natural scientist, the moratorium was variously attributed to government ministries working at cross-purposes, self-appointed NGOs (mis)-representing public opinion and who have dominated media coverage, and misinformed natural scientists.

Regarding the wider cultural and social aspects of the debate, the religious dimension of the issue was mentioned by a small number of stakeholders, but on the whole did not appear to be very prominent in the interviews. None of the anti-GMO stakeholders focused their critique of GM crops solely around cultural or religious issues. For instance, one prominent anti-GM campaigner we interviewed (Vandana Shiva) did argue that GM crops were likely to alienate the farmer from the seed in cultural terms, but also offered the more conventionally 'rational' science-derived arguments in support of her position (e.g., that Bt cotton weakens the ability of the plant to resist pests other than bollworm). At the same time, in answering our questions about the future of GM crops in India, both pro-GM and anti-GM actors made references to the colonial experience of South Asia. Thus, while the pro-GM interviewees argued that it was important for India to continue developing GM science to be taken seriously in the international arena of biotechnology and not to 'lose out' to foreign companies, some of the anti-GMO actors also used the rhetoric of post-colonial discourse and talked about the importance of keeping Indian seeds 'intact' and avoiding their 'colonization' by GM seeds from abroad.

An interesting observation is that both sides tended to mobilise science as supporting their claims. For the environmental NGO representative, the principal problem with GMOs lay in existing regulatory and governmental processes being insufficiently independent and scientifically rigorous (e.g. existing scientific regulatory processes seen as having been captured by the corporate interests of the seed companies), whereas for the representative of the seed company the problem was also presented as the regulatory and governmental system being insufficiently scientific (e.g. being swayed by emotion and ideology rather than a clear presentation of the facts and a process that enables technology providers to respond to the needs of the farmer). Both interviewees appealed to science as the foundation to

provide justification for their claims: either that GM crops were safe and that public concerns were emotional ('hysterical' according to our natural scientist) or that GM crops were not proven to be safe and that what was required was the active engagement of independent scientists who have '*serious concerns on the way GMOs are promoted in this country... [they are the] silent majority and the reason why they are silent is also because the government in power has promotional approach towards GMOs*'.

4.4 Participant observation at a research laboratory

4.4.1 Social organization of the laboratory and its objectives/ mission

Access for the laboratory study was secured at the New Delhi branch of the International Centre for Genetics and Biotechnology (ICGEB). The ICGEB is an international, nonprofit research organization, which was established as a special project of the United Nations Industrial Development Organization and which became fully autonomous in 1994. ICGEB now includes over sixty member states, mainly from the countries of Africa, Asia and Eastern Europe.

The aim of ICGEB is to conduct innovative research in the life sciences for the benefit of developing countries, as well as to provide educational and research support for its member states. At the time of fieldwork ICGEB consisted of three main branches, located in Trieste, New Delhi and Cape Town. The Delhi component is located within the ICGEB Campus in South Delhi, which comprises an area of approximately 16 acres, situated alongside the Jawaharlal Nehru University. The Laboratories comprise a main building, Bioexperimentation Unit, Biosafety Level-3 Facility, and a number of greenhouses for agriculture related research.

The main research areas at ICGEB in New Delhi include mammalian and plant biology. More specifically, biomedical studies are conducted in virology (hepatitis B and E viruses, human immunodeficiency virus and SARS virus), immunology (biology of the immune response and tuberculosis), development of diagnostics and vaccine candidates for dengue fever, structural biology (development of synthetic antibiotics, crystal structure determination of proteins and polypeptides), basic research and vaccine and drug development for malaria, as well as development of technologies for biopharmaceuticals and for diagnosis of infectious diseases. In the plant biology, which was the focus of our study, ICGEB projects focused on insect resistance and biopesticides, abiotic and biotic plant stresses and crop improvement through biotransformation.

ICGEB New Delhi has 36 principal investigators (PIs) distributed in 9 different research groups, whose research was funded from a wide range of funding bodies including both national (Department of Biotechnology) and international, such as The Wellcome Trust, European Malaria Vaccine Initiative, European Commission, International Aids Vaccine Initiative, National Institute of Health, Bill and Melinda Gates Foundation, Dupont and PepsiCo¹⁵.

Fieldwork was conducted for 20 days in September 2013 in the laboratory for plant molecular biology. The laboratory has five principal investigators, over twenty postdoctoral research fellows, sixteen PhD students, and four technicians. Research conducted at the laboratory involves a wide range of projects including the production of plants resistant to herbicides, plants resistant to pesticides, crops resistant to abiotic stress (dry conditions and

¹⁵ See www.icgeb.org/home-nd.html

salty soil), rice with improved nutritional value (an analogy to Golden Rice). The main crops that the laboratory was focusing on included rice, potatoes, tobacco, cotton and tomatoes. The topics of research projects were determined by principal investigators. Most respondents noted that their research was mainly funded by the Department of Biotechnology. Postdoctoral research fellows apply to work on specific projects with a particular principal investigator. PhD students apply to ICGEB (and are eventually awarded a PhD from Jawaharlal Nehru University) and, if accepted, have an opportunity to choose a principal investigator to work with.

4.4.2 Perceptions of GMOs within the laboratory

Participant observation in the laboratory was focused on the work on two PIs and their postdoctoral research fellows and PhD students. The research team of one of the PIs was developing work on the creation of herbicide and abiotic stress resistant rice, while the other PI was developing a project aimed at enhancing the nutritional content of rice. All the scientists we interviewed, irrespective of their position in the laboratory, had a strong pro-GM stance. All respondents expressed disappointment at the recent introduction of the moratorium on GM crops trials. Most supported the argument that their research was safe and that GM research was a logical step forward in the development of agriculture. As one of the PIs put it in the very first interview we conducted after the aims of our project were described to him:

'If you want to know if I am pro-GM or anti-GM I can tell you straightaway that I am pro-GM because this is the future. What geneticists are doing is hardly different from what breeders have been doing for a very long time and what we are doing is safer.'
(ICGEB Researcher)

At the same time, all scientists agreed that current GM crops are not offering better nutrition than non-GM crops. All the respondents stressed that GM crops were particularly needed in developing countries like India and the argument that they put forward was that without GM crops India would not be able to feed its growing population. As one respondent put it:

'Going organic' may be good for Europe where there is surplus of food, but not for India, where many people are starving and where pest control is particularly difficult because of the climate. Using GM crops would be much healthier than using pesticides which is common practice now.'
(ICGEB Researcher)

When discussing whether GM crops were safe to use, all respondents emphasized the importance of developing and following strict safety protocols. However, again, in conversations about biosafety, references were often made to the specifics of the Indian context of food production, which included a hot climate, a large population, wide-spread poverty, and lack of regulation of pesticide use. For instance, when we asked whether GM food should be labeled as such when offered to consumers, one PI argued the following:

'Sometimes they have to spray crops up to 90 times with poisonous chemicals. So, how come you have to put a label on a GM vegetable saying that it is a GM vegetable, but you don't label 90-times sprayed vegetables as '90-times sprayed'.'
(ICGEB Researcher)

4.4.3 Arguments and narrative resources

The rhetoric of our respondents oscillated between the position that emphasized that GM food was safe and the one that argued that GM crops were only needed in the developing countries, which could not afford non-GM food, and that therefore it was 'the lesser of two evils' when compared with starvation and the use of pesticides. Interestingly, like activists in the anti-GM camp who argue that GM crops are harmful for India as they represent the colonization of the Indian countryside by foreign companies, such as Monsanto, the pro-GM scientists from the laboratory also framed their discourse about GMOs in terms of postcolonial critique. Back in 2008, the eminent biologist Pushpa Bhargava (often regarded as the architect of modern biology and biotechnology in India), observed in his letter to the Prime Minister that 'as India is primarily an agricultural country, with 60 percent of its population deriving its total income from agriculture and agriculture-related activities, it would cease to be a free country if its agriculture is brought under the control of foreign multinational companies through control of seed and agrochemical production.'¹⁶

At the same time, several respondents based at ICGEB suggested to us that India needed to continue developing GM research and to do field trials in order not to fall behind in this particular area of biotechnology, which, they argued, was the technology of the future. Many interviewees noted that they appreciated that the Indian Department of Biotechnology continues to fund their laboratory work, but expressed concern that without field-trials Indian GM science would fall behind, and young scientists would lose interest in this research, as they could not see the results of their work either in the fields or in the supermarket.

4.4.5 Reflections on science in society

All respondents shared the opinion that the voice of scientists had not been adequately heard in the GM crops debate in India, and argued that the government had imposed a moratorium on growing GM crops without having conducted a proper consultation with scientists, including those of them that had been undertaking research in the laboratory. The anti-GM position was construed by our respondents as ignorant. Many scientists also argued that the reason why existing GM crops (Bt cotton) did not work for the farmers as well as they were supposed to was because the farmers were not following the necessary and relevant guidelines (e.g. creating the required GM-free zones and refuges around GM planted fields). Each interviewee argued that the general public needed to be educated about the GMOs and that they would be happy to engage with the public and the mass media, but did not have access to necessary channels for that.

Scientists saw anti-GM NGOs as their main opponents and argued that theirs had been the voice that was heard most in GM food debates in India. When we asked whether they had ever received any negative responses to their work from religious groups, they suggested that that was not the case. They were aware of ethical problems that could arise out of transgenic research involving mixing genes taken from animals and inserting them into plants (potential violation of the dietary requirement for vegetarians for some caste groups) and argued that this kind of insertions could be easily avoided.

At the same time, when asked to explain their choice of working with GM crops, most respondents replied that their goal was to improve Indian agriculture and to benefit society.

¹⁶ Letter to the Prime Minister from Dr Pushpa Mittra Bhargava, 11 December 2008 (accessed on https://groups.google.com/forum/#!topic/grassroots-in-action/_84l84lOIM0 on 15 May 2014).

This is how one PI explained the potential social benefits of his work on herbicide-resistant plants:

'You see, we don't want to be using labour any more to weed plants. India is known to be a country of cheap labour and we want to put a stop to this. Weeding is very labour intensive and time-consuming. Therefore, we have to use herbicides, otherwise you have to weed rice manually. My job is to develop plants that are tolerant to herbicides. This way, farmers could still use herbicides but they will only be killing weeds and not my plants.'

(ICGEB Researcher)

4.5: Focus groups with consumers

4.5.1 Introduction to data set

This part of the study looks at Indian public responses to genetically modified crops and GM foods. The research aimed to understand the perception of different groups of consumers, grouped for the purposes of this study as professional women, students, housewives and householders. The participants were of different age groups and social classes. Each group was composed of between 6 and 10 individuals. Since they came from different backgrounds, their understanding of GM crops and food was also varied. The first group, consisting of students drawn from different disciplines, offered an interesting debate on GMOs. The group was broadly divided into pro-GM and anti-GM participants, responding to the scientific basis of the GM debate, the controversies and the likely benefits to be derived from the use of GM products. The second group consisted of professional women engaged in different project work, administration and teaching. The third focus group was of women from rural settings, currently engaged in various self-help groups (SHG). The last group consisted of householders who were engaged in farming activities. These participants were actively involved in grassroots organizations.

The materials used for the focus group discussion included posters with various reports on the issues posed by GM food. The posters were designed to elicit responses from the interviewees on the controversy of GM foods from a range of perspectives. The debate revolved around the technology of GM, current applications in crops and foods, health issues related to GMOs, environmental impacts, governance and economic feasibility.

4.5.2 Responses to genetically modified crops and technologies

Initially the debate revolved around the ways in which the GM debate had been presented in the media in the context of wider concerns about food and agriculture. The participants raised the issue as to whether GM crops and foods had nutritional benefits. They also raised concerns over the hazards of overuse of pesticides and the uncertainties associated with genetic manipulation. Most of the consumers, who were also farmers, raised the issue of seed preservation and exchange. They expressed concern over the introduction of new GM varieties, and whether this would lead to the demise of traditional varieties. They also raised the issue of the economic feasibility of growing GM crops, and whether it would be sustainable in the long run. Most of the participants' responses seemed to revolve around the issue of 'seed sovereignty'. They were concerned about how GM crops lead to dependency on 'outsiders' and seed companies. The householders and housewives, who were mostly farmers, were concerned about increased pest resistance in Bt cotton. They also expressed concern on the impact of GM crops on the ecology and health of the soil.

Except for the discussion in the students' group, most of the responses on GM crops and foods were largely negative. Most of the concerns of the interviewees related to the likely side effects of introducing GM crops and foods, as reflected in the concern of one of the participants in the women's professional group, reported below:

'With hybrid [seeds] also, you are trying to merge two different kinds of species, right? But I think this thing [GM technology] goes a little beyond this, because this is inter-genus you know, bacteria and plants. Or so, I think, it also makes me think of our mythology, you know, Mahabharata and all that, we have so many different kinds of ages... makes you feel that way also, I find. And it becomes difficult later to control, this kind of, if again, mutation can arise. Something... anything can happen.'

(Woman professional)

There were also concerns expressed about the accelerating speed in 'science and technology' innovation, especially with regards to GMO research. One of the participants stated:

'We are going very fast. You are trying a lot of things, as long as you know when a gene is inserted, so that some cancer doesn't happen, or some serious thing is being prevented. Till that, it is fine. But if we are just doing it for pleasure, to see if green things become red and red things become yellow, then I don't know what will happen in the future.'

(Professional woman)

4.5.4 Perception of GMOs in foods

A number of participants agreed that GM technology should not be used for superficial consumer desires (as opposed to genuine needs), drawing boundaries over the kinds of application where GM technology should or should not be applied (e.g. in responses to suggestions that GM technologies could be used merely for artistic or aesthetic appeal). There seemed to be general concerns as to whether GM technologies were tampering with nature. They believed that GM technology may be accelerating evolutionary processes, with unknown effects. The participants questioned whether the human body could adapt to new kinds of food, produced through genetically modified techniques. For participants, the use of GM technology for sustainability appeared as a contradiction in terms.

Most of the participants in the rural farming community group agreed that genes inserted from one vegetable plant to another vegetable may in principle be acceptable. However, genes transferred from animals to food crops would be less acceptable, as they believed that this would go against their religion and tradition. One of participants was asked whether she would eat vegetables injected with chicken (Oriya: *kukuda*) gene; she responded that she would not eat such vegetables as this would go against her traditions and religion. For the women of Odisha, chicken is considered to be a food taboo. Only male members of the family eat chicken and eggs. Interestingly, one of the participants said that she might take the *kukuda*-injected vegetables without knowing, but she cannot take them with full knowledge. According to Ramya¹⁷, both the female and male members of her family do not eat chicken. Indeed, she would not touch *kukuda* injected vegetables. She asked: *'Who would wash the plates if the male members in the family take such food?'*

¹⁷ All names of participants have been anonymised.

Another of the participants from the group of rural householders, Kumar, expressed a view of being against GM crops because such a form of agriculture does not allow for indigenous seeds like pulses and paddy to be saved and utilized in the next season, which increased farmers' dependency on outsiders, including seed companies. Moreover, he reported that with the cultivation of Bt cotton, there has been an observed increase in pests, which have become resistant to pesticides. Another participant from the group of rural householders, Parbat, doubts the germination potential of Bt or any outside seeds cottonseeds; rather, he is in favor of indigenous seeds.

4.5.5 Factors underpinning responses

The majority of the participants expressed a negative opinion to GM crops and foods (current and proposed), and this was to do largely with issues of trust and uncertainty. Many of the participants were skeptical of the role of multinational seed companies and of the scientists who work for them. Many of the participants seemed to perceive that all GM foods were in the hands of global corporations. According to them, even if research were to be undertaken in government research institutions, the eventual users and beneficiaries of the research would be the corporations. They argued that GMO research and products from government research centers may not be public acceptable, but the public would very likely not be given a choice. However, by contrast, the minority of participants who had a scientific background or who had expertise in biotechnology argued that innovations in science (including in GM) would be able to solve many current human problems, including the current crisis in agriculture. They suggested that GM crops, especially those that are bred to be drought-resistant, could save farmers from famine-like situations. They also suggested that saline tolerant GM rice could be grown in coastal areas, which would ultimately increase the area under rice cultivation. However, many participants observed that there seemed to be a disconnect between what happens in the laboratory and what actually happens in the field and raised the issue of the need for a stronger regulatory framework, which could effectively regulate GM production at the grass-root level to the public good.

4.5.6 Responsibilities and Institutions

Many of the participants believed that the core responsibility for effective GM regulation lies with the government. Regulation of GMO research and products was seen to be effective only when there was transparency and when debates on health and environment impacts were allowed to take place. Much of the current impasse was seen to arise when there is dissent within the scientific community and with government appointed committees. Once dissent within the scientific community becomes known, the media quickly picks up and publicizes it. This was seen to create considerable confusion in the minds of the public, as they cannot differentiate between what is true, and what is false. Much of the disagreements arose over debates on the risks of GMOs to human health and the environment. There was perceived to be a need for an open debate on national television, where people could hear both sides of the argument. This, according to some participants, would dispel much confusion in the minds of the public.

Sushma: *So many things are there in the media that you really [are] confused with: what GM crops are? Are they good? Are they bad? Should we propagate...? Everything is so confused.*

Neela: *Both sides of the debate – and the scientific community ... is so divided. So let them come in public and debate. Let us hear both sides of the argument on television. Discuss it. Are they willing to do such an open debate so that people form an opinion of what is going on? You can't be given 10000 parts of the same things, and one is saying 'good', and one is saying 'may be', and the*

other is saying 'it's very bad'. Then try it in (sic) different, at least scientific research is about trying it hundred of trials.

(Professional women)

Within the groups there was considerable discussion on whether they would feed GM rice to their family members, if at all, if GM rice was made available in the market. Even if it was supposed that GM rice is cheap, of high quality and of good taste, participants' responses remained ambivalent, reflecting their sense of uncertainty or fear over GM food. As one of the participants from the group of professional women put it: *'There is a bit of that reluctance... That niggling fears that something might go wrong'*.

Section 4.6: Deliberative workshop

4.6.1 Introduction to the workshop

The Indian deliberative workshop was organized in two main parts: a) presentations of preliminary results of the field research conducted in India, followed by the plenary discussions, and b) a deliberative session with the participants. The workshop presentation included three aspects covered by the field research: ethnographic work in Orissa with marginal and small farmers and women groups, participant observation in the research laboratory ICGEB (Delhi) and focus group interviews with urban and rural consumers. At the workshop, the participants were divided into three small breakout groups each of which presented their discussion and insights to the plenary group. The aims and objectives of this workshop were to elicit participants' reflections and informal discussions on various issues of GMOs as presented as preliminary research findings by the project team. Members of the project local team, under the guidance of the project research manager, facilitated the small-group discussions and activities.

The participants were drawn from organizations and governmental agencies representing a range of stakeholders that included: scientists, farmers, NGOs and activists, academics, indigenous and women groups. The following organizations were represented: Greenpeace India, Gene Campaign, All India Kishan Sabha (AIKS), University of Delhi, National Agricultural Innovation Project (NAIP) under ICAR, Association of Biotechnology Led Enterprise – Agriculture focus Group (ABLE-AG), Bharat Mata Self Help Group, Chetna Organic Farmers Association, Agri-Business Management College of Agriculture, Jawaharlal Nehru University, Centre of Social Markets, Kerala Agricultural University, Indian Institute of Chemical Biology (Council of Scientific and Industrial Research), Center for Social Markets, International Competence Centre for Organic Agriculture, Consumers' Forum, Department of Anthropology, Durham University, SciDev.Net, NISTADS (National Institute of Science, Technology and Development Studies), Farmers' Rights, Monsanto Holdings Ltd.

4.6.2 Analysis of Findings

Addressing the science, technology and society interface on the issue of GMOs, there seems to be a disconnect between scientific practices and imaginaries in the laboratory and in situ practice in the field. Farmers are not passive recipients or agents of technology. They change, they modify or improvise technology (including GM) to suits their own conditions and needs. For instance, farmers often use detergents or shampoo to ensure the quick and smooth flow of pesticide solutions through the sprayer, helping pesticide applications stick longer on the leaves of the plants, thereby making it more effective. Even during spraying, we witnessed the majority of farmers not using masks or gloves. This has adversely affected the health of the landless agricultural labourers, who form the major part of the rural labour

force. At the grassroots level also, there is a vast difference in perception between the application of GM for cotton growing and the application of GM for food crop. The perceptions of the farmers changed dramatically in their responses to GM food. It was further observed that while plant-to-plant transfer of genetic material may be acceptable (both for farmers and the wider public), the transfer of animal-to-plant genes was not. The results of the fieldwork result and from the workshop's deliberations suggest that there is a further need to explore the socio-economic and cultural aspects of the GM debate.

The majority of the workshop participants were against the introduction of GMOs. However, following deliberation on various aspects of GM crops and food, they understood the need for strong regulatory frameworks at the national level and the need for monitoring agency and practice at the grassroots level. The majority also suggested that active citizen participation and a holistic approach to the regulation and governance of GM crops and food were necessary.

Each of the breakout groups presented their views of the strategic priorities and action points for GMO governance. The strategic priority for Group 1 was for a constructive and inclusive critical engagement with the technology using public consultation to fulfill local needs assessment. Its suggested action points were for: wider accountability by public funded agricultural research bodies to be oriented towards social needs, and for governance institutions – including the national agricultural research system headed by Indian Council of Agricultural Research (ICAR) and other associate bodies – to be properly concerned with health, food, nutrition and agricultural production impacts of GM crops. In addition, the group stressed the importance of accommodating different framings of the issues surrounding GM, including cultural and religious sensitivities.

The strategic priority for Group 2 was to ensure that farming communities have the capacity to manage their own seeds systems. Such capacity includes storage, the provision of warehouses, proper scientific breeding maintenance. There was also the perceived need for seeds to be regularly sown so that they can adapt to climatic change. The suggested action points for the group were to keep the debate on GM on-going and to make decisions based on good meso-level data. Another strategic point suggested by the group was to promote a range of alternative, appropriate farming systems, including agri-ecological systems.

The strategic priority for Group 3 was to promote the argument that GM crops do not provide the answer for India's strategic needs. There was perceived to be a need to widen and deepen the debate on GM crops and to listen to a wider range of stakeholders. In particular, this group called for the debate to extend beyond one of determining the correct 'scientific facts' (which as we have seen here is used by both sides) and to move the debate firmly into the social, political and cultural arena. This was perhaps the highlight of the workshop. The suggested action points were for greater accountability, transparency, and democratization of the regulatory system.

There were some strong disagreements during the workshop deliberations, mainly between those holding pro-GM and anti-GM positions. However, the main strategic action point was developed among the workshop participants without much difficulty. This was:

'To sustain the adoption of a 'science-plus' approach, ensuring the participation of the heterogeneity of stakeholders, and accommodating different framings of the challenge – all implicitly equal. Doing so will help promote a range of alternatives, socio-culturally appropriate farming systems, well grounded in the diverse agro-ecological contexts of India.'

Section 4.7: Conclusions

We now briefly summarise the key findings from the India case study. First, we reviewed the debate on GMOs in India. We identified the trajectory of the debate and the factors that led to the ongoing resistance to the adoption and take-up of GM crops in India, culminating in the 2013 ten-year moratorium. We found that the issue has been hotly debated by parliament, by the government, by NGOs and in the media, much of the debate revolving around concerns regarding the regulation of GM trials and crops. We found that the promotion of GM crops has been encouraged by the government of India, by its Minister for Agriculture, and by the wider science and technology establishment. There are a few within these organizations who voice concerns about the agronomic, political, economic and ecological implications of GM crops. Within this context it has been the NGOs who have spearheaded the articulation of these concerns.

Second, we presented fieldwork research with small family farmers – both in organic and conventional farming villages – in the Kalahandi district in the west of Odisha (formerly known as Orissa). In the organic village we found strong support networks from NGOs and farming associations. We found an increasing prevalence towards the cultivation of Bt cotton in the conventional village, especially in upland areas, due to higher yields and increased incomes. We saw that Bt cotton, now accounting for around 95% of cotton cultivation in India, was being aggressively marketed by seed companies: through demonstration projects, the provision of advantageous loans and the delivery of inclusive technological packages. This was perceived to be having both positive and negative effects. As well as increasing incomes, the increased coverage of Bt cotton was making it difficult for the farming community to access traditional varieties of food crops, including millet, jawar (sorghum) and lentils. Increased incomes came with increased cultivation costs, seed costs especially, and increasing dependence on external agents. Moreover, in recent years Bt cotton crops had become affected by increased pest attacks and have led farmers to consider previously available seed varieties. However, farmers find themselves often ‘locked-in’ to using Bt cotton with indigenous seeds no longer so easily available.

Third, we reported on the results of a questionnaire survey with a variety of local stakeholders involved with the debate on GM agriculture. We found that the two consistent negative views on GMOs in India were dependency on agri-business and seed companies, and the possible risk or danger to human health and environment. We found an interesting observation that both stakeholders in favour of GM crops (e.g. representatives from seed companies) and those against (e.g. environmental NGOs) tended to use a similar argument from science: that what was required in both cases was more rigorous science to help settle the issue. For the environmental groups independent science would bolster their claims that GM crops had not been proved to be safe, while for the seed companies science would prove that GM crops were safe and that public concerns were emotional.

Fourth, we reported on findings from a laboratory ethnography conducted at the New Delhi branch of the International Centre for Genetics and Biotechnology (ICGEB) research laboratory. We found that all scientists whose work we observed were opposed to the moratorium and constructed and perceived the position of anti-GMO actors as ‘ignorant’ or aimed at ‘publicity’ seeking. Scientists’ critique of the moratorium was often framed in terms of post-colonial discourse, as they argued that India could not afford the risk of ‘falling behind’ in the development of biotechnology.

Fifth, we presented research with urban and rural consumers on Indian public responses to GM crops and foods. Using a series of focus group discussions, we found the majority of our research participants had a negative view of GMOs. Urban consumers pointed out that they

did not trust the government and the local authorities to provide a reliable regulatory system for the production of GM crops and therefore would prefer to avoid the consumption of GM food. Our research participants from the urban groups also suggested that the information about GM that was available in the Indian mass media was confusing and that they would welcome better structured TV debates which would provide a forum for both pro-GM and anti-GM actors to present their positions. Rural consumers also expressed negative views of GM crops and argued that using GM seeds was interfering with the preservation of indigenous seeds.

Six, we reported on a deliberative workshop, conducted with a range of national stakeholders, set up to explore research findings and how to develop the public debate on GM crops. We found that participants from different categories of stakeholders were eager to engage in a dialogue and emphasised the importance of considering diverse points of views in deciding the future of GM crops in India.

We conclude by making a few final observations. In India, both the pro-GM and the anti-GM sides of the debate have framed their concerns in the form of postcolonial critique. In this sense, the case study of India would be first and foremost relevant to the study of GM debates in the countries of the Global South and societies 'in transition'. However, this insight from the Indian case study may also be useful in exploring responses to GM crops and foods in the West, as it suggests the importance of taking into consideration the historical experiences of the groups that voice concerns over GM and of examining the global and local structural inequalities that surround the production of GM crops.

Another point to make on the implications of our findings for governance is to ensure that in future governance debates on GM crops, to ensure that 'marginalized' stakeholders (such as small farmers in the Indian case) are provided with a forum for expressing their views and for feeding their experiences into the process of GM regulation. Here again, it is important to be paying particular attention to the way that the structural inequalities of each society under consideration may be placing marginalized groups at a disadvantage in any consultation process.

Finally, the study elucidates the importance of taking into consideration the specifics of the agri-ecological system of each country where the production of GM crops is debated, and to ensure the survival of a wide range of diverse farming systems appropriate to the agricultural context of the country.

Chapter 5 A comparative analysis

5.1. A comparative look at the controversies over GMOs

In preceding chapters we reviewed the trajectory of the debate and controversy over GMOs across Mexico, Brazil and India. We found considerable patterns of overlap, but with important specificities too. We now comment on points of difference and commonality. In terms of the policy regime we can see close parallels across the three national cases. In all cases, we witnessed in the 1990s the creation of national regulatory bodies set up to regulate GM crops, both to provide technical advice on applications for approvals (for field trials and for commercial cultivation) and to provide specific advice on the risks to human health and the environment from the release of GMOs. The regulatory bodies were principally the National Agricultural Biosafety Committee (CNBA) in Mexico, the National Technical Commission on Biosecurity (CTNBio) in Brazil, and the Genetic Engineering Approval Committee (GEAC) in India. Even though all three committees were set up to include representatives from leading public universities and research institutes, and even though each technical committee was situated within a complex network of variously configured inter-ministerial responsibilities and obligations, this did not provide what Maartin Hajer refers to as 'authoritative governance' (Hajer 2009): in other words it did not lead to decisions, developed through reasoned, open and transparent deliberation, that were seen as trustworthy and as worthy of acceptance by the broader community.

Across all three jurisdictions, we saw the decisions made by these technical committees rejected as biased, unlawful, unconstitutional and lacking in transparency, both by farmers and scientists, and, at times, by judges in court. We also witnessed wider criticisms: that the decisions adopted by these committees were discursively constructed as a threat to smallholders and indigenous agriculture, promoting (perhaps unwittingly) a form of agriculture in tune with neoliberal policies that (arguably) were not in the national or public interest. Indeed, undeniably, there are important and legitimate political, cultural and social dimensions associated with the transformation from conventional crops and traditional husbandry practices to GM agriculture, including the choice of not pursuing alternative options such as agro-ecology. At least first generation GM crops – plants modified to be either herbicide or insect resistant or both – have enjoyed a particular social constitution: i.e. they imply, or at least are favourable towards, a particular pattern of social relations. As stated earlier, they can best be described as 'mechanization' technologies that principally help farmers reduce labour costs and farm larger acreages (Buttel 2005). In addition, as analysed in previous research, they have been associated with an oligopolistic industry structure with an inflexible and unresponsive relationship with consumers, questionable or indirect consumer benefits, a political-regulatory framework seen by many as facilitatory and compromised, and invisible, potentially unretrievable hazards internal to the body (Grove-White et al. 2000). Thus, perhaps it is not surprising that the decisions from government appointed technical regulatory bodies have been so mired in controversy. Given that nation states are (more or less) counseled to approve applications for GM crops in the absence of evidence of harm either to the environment or human health (under WTO rules etc.), and given that the power and authority to undertake this work lies principally with technical regulatory committees, it is to be expected that wider considerations become effectively hidden from public accountability and influence. In other words, in the absence of a framework that can evaluate these wider considerations (including what kind of agriculture we as a society collectively want), important political discussions and debates become conducted through these technical committees in ways that are largely segregated from democratic deliberation.

Nevertheless, such an overarching argument does little to explain why the controversy surrounding GM crops has taken different forms across the three global 'rising power' case sites. Why have GM crops been approved in Brazil with rapid and widespread adoption since 2005? Why have GM crops been less successful in Mexico with a moratorium that continues to remain in place for new applications for GM maize including field trials? Why in India, with the exception of GM cotton, is there a moratorium in place on all GM crops, including GM field trials? These are challenging questions on which we have no definitive answers. However, we can point to a set of factors that appear to be relevant. These include: the cultural resonance of the crop in question, the strength of civil society actors and their (largely ad hoc) discourse coalitions, the perceived capacity and integrity of regulatory bodies to undertake their roles, the gaze of the global media, the intensity and durability of protest movements, the significance of the GM crop to the national economy, the extent to which GM can become represented as the symbol for wider struggle, the degree and intensity of public engagement, the level of reflexivity within the scientific community, and the propensity of institutional actors (particularly the legal establishment) within parts of the state to enter into critical dialogue with other parts of the state.

With these points in mind we can revisit each country in turn. In Mexico, the controversy over GM maize came to prominence in 2001 and 2002, following a highly publicised article in the journal *Nature* reporting the flow of transgenes into wild maize populations (the paper was later retracted), setting the scene for widespread and continuous protest. Maize is highly culturally resonant in Mexico, and protests against GM maize came to signify the defence of Mexican culture and identity in the face of unwanted globalization. The decisions by regulatory bodies have been seen by multiple actors as compromised and lacking in transparency. They have been contested vocally by NGOs and questions have been raised about their legality. And there has been little sustained effort by institutional actors, including the Mexican State, to engage the public.

In Brazil, the issue came to prominence after 1998 following the intervention from a couple of innovative NGOs contesting CTNBio's decision to approve Monsanto's application for Roundup Ready herbicide resistant GM soya, leading to a *de facto* moratorium. Even though soya had little cultural resonance, it attracted an intense protest movement that was sustained up until 2003 when a presidential decree in effect ended the moratorium. Decisions by the regulatory bodies remain contested even within the relevant committees, with routine accusations of partiality and bias. Between 1998 and 2003, GM became a symbol of wider struggle against unequal land ownership, US hegemony and neoliberalism. Following the approval of the Biosafety Law in 2005, the coalition against GMOs lost momentum and GM crops became widely adopted. Again, there have been limited attempts by institutional actors to engage the public in discussions on GM, with some exceptions (a few media initiatives for example), which discussions remaining technocratic and elitist in character.

In India, the controversy over GM cotton began in 1998 with fears that Monsanto's importation of GM cotton would include a terminator gene that would make farmers dependent on seed companies. Despite Monsanto's protestations that this would not be the case, this led to widespread and highly mediatized visible protests where Bt cotton became symbolic of a struggle against multinationals, neoliberal logics, the United States and globalization. Cotton is a highly symbolic crop in India, signifying, strength and self-sufficiency for the poor. The regulatory authorities have struggled to maintain authority in the face of inadequate frameworks for public consultation and a lack of capacity in implementing decisions, including a lack of detecting equipment and an inability to deal with the use of illicit GM crops. The formal reason for the 2013 indefinite moratorium on GM

crops and field trials recommended by India's Supreme Court was that there were major gaps in the regulatory system. And again, there has been little sustained effort by institutional actors, including the Indian State, to engage the public.

Table 1. Factors shaping the controversy on GM crops between Mexico, Brazil and India

<i>Country</i>	<i>Perceived authority of the regulatory agencies</i>	<i>Cultural resonance of the crop</i>	<i>Intensity of protest movements</i>	<i>GM as symbol of wider struggle</i>	<i>Degree of public engagement</i>
Mexico The controversy over GM maize	Low Decisions by regulatory bodies seen as lacking in authority and transparency and judged at times to be illegal	High Maize is an integral part of Mexican identity, history and culture	High The anti-GM campaign has sustained its presence since 2002	High GM maize constituted as a symbol of the protest against neoliberalism and NAFTA	Low There has been little sustained effort by institutional actors to engage the public
Brazil The controversy over GM Soya	Low/ Medium Approvals have been successfully authorised by CTNBio leading to widespread planting but decisions remain contested	Low Soya has little cultural significance in Brazil	High (until 2003) then Low following the passing of the Biosafety Law	High (until 2003) GMOs situated within anti-globalisation discourse. Then Low	Low There has been little sustained effort by institutional actors to engage the public
India The controversy over GM cotton	Low Regulatory bodies seen as lacking in transparency and capacity. Perceived gaps in the regulatory system led to 2013 moratorium	High The fragile thread of cotton is a symbol of Indian self-sufficiency	High The anti-GM campaign has sustained high profile protests	High Bt cotton a symbol of a struggle against multinationals and neoliberalism	Low There has been little sustained effort by institutional actors to engage the public

These factors are set out in Table 1. The penultimate point to infer from this analysis is that it would thus be a mistake, even in the case of Brazil, to assume that the current widespread adoption of GM crops means that the issue is settled, or that the decisions by the regulatory bodies are somehow authoritative, or even that GM crops have been accepted by the public. Indeed, given the lack of sustained effort by institutional actors to engage the public across all three cases, it remains the case that most citizens in India, Mexico and Brazil remain unfamiliar with the technology and the issues it raises – a point confirmed in our focus group research and explored further in Section 5.6 below.

The final point is to note that GM crops have rarely, if at all, been requested either by farmers or consumers. Rather, GM crops have been developed externally and then promulgated by companies in a top-down manner. In addition, in both Brazil and India, both GM soya and Bt cotton was found to be grown illegally and then retrospectively approved by the State largely for pragmatic reasons. This dynamic subscribes to what von Schomberg describes as a 'technology push': where major stakeholders (e.g. NGOs, civil society, the public) feel they had little influence on the direction the technology would lead us, and where governance is focused exclusively on safety, with minimal deliberation on broader environmental, social and agricultural dimensions (von Schomberg 2013). This dynamic,

what von Schomberg calls ‘irresponsible development’, will be explored further in Chapter 6. We now flesh out the points highlighted above by examining comparatively our fieldwork results across the three case countries.

5.2 A comparative look at the field ethnographies

The nine week ethnographic studies, undertaken in specific rural communities in each of the three case studies, sought to understand the debate on GM crops – GM maize in Mexico, GM soya in Brazil, GM cotton in India – in the context of local farming and food practices. They produced rich contextual detail on socio-cultural dynamics.

In Mexico, our research was carried out with mainly smallholder farmers in the Pátzcuaro Lake region in the State of Michoacán. We found that debates on GM maize were situated within the context of an on-going crisis in rural agriculture, compounded by the end of rural subsidies, rising input prices and intense competition from imported cheap grains. Within this context we found strong and enduring social relations around maize agriculture, reproduced by systems of local community exchange and day-to-day food and religious practices. Native maize seeds were accorded a special significance, both as family heirlooms passed from one generation to the next and as capital to ensure survival in difficult times. Maize agriculture fitted within *milpa* landowning practices, which helped consolidate traditional practices and ontologies and which led to an enduring sense of pride in agricultural labour, closely linked to local and regional identities. Within this context GM maize was seen, unequivocally in our research, as a likely intrusion into traditional practices, with unknown and likely negative impacts. Suspicion was exacerbated by deep and historical patterns of mistrust expressed in the motivations of key actors, notably the government (typically seen as corrupt) and the seed companies (typically viewed as self-interested). Smallholder farmers tended to be ontologically opposed to GM maize, seeing it as artificial, manmade, unnecessary and a threat to traditional patterns of agriculture.

In Brazil, our research was carried with small family farmers (some cultivating GM crops, others not) in the western region of the State of Santa Catarina. We found that the region was also experiencing a serious economic crisis, driven by falling relative agricultural prices. We identified that the main option for family farming was seen to lie in the production of GM soya (and GM maize to a lesser extent), and that those who have not adopted GM crops were being pushed to the margins of the productive system. We found those involved in non-GM agriculture – typically involving small-scale, organic or agro-ecological farming – were choosing not to adopt GM due to their desire to produce high quality, healthy foods both for their families and for (niche) markets. Even those adopting GM crops often used creole (non-GM) maize for domestic consumption, on grounds of taste and the perception of outstanding safety concerns. Organic farmers also complained about neighbouring GM farms not respecting legally-binding segregation distances, thereby ‘intoxicating’ their farms with herbicides. For those adopting GM crops, perceived advantages were less labour, ease of application and better productivity and prices. We found evidence of conflict between farmers cultivating GM crops and technicians from the seed companies, each blaming each other for the increasing prevalence of glyphosate-resistant weed species (glyphosate being the herbicide designed to treat Monsanto’s Roundup tolerant GM crops).

In India, our research was carried out with small family farmers – both in organic and conventional farming villages – in the Kalahandi district in the west of Odisha (formerly known as Orissa). In the organic village we found strong support networks from NGOs and farming associations. We found an increasing prevalence towards the cultivation of GM cotton in the conventional village, especially in upland areas, due to higher yields and

increased incomes. We saw that BT cotton, now accounting for over 95% of cotton cultivation in India, was being aggressively marketed by seed companies, through demonstration projects, the provision of advantageous loans and the delivery of inclusive technological packages. This was perceived as having both positive and negative effects. As well as increasing incomes, the increased coverage of GM cotton was making it difficult for the farming community to access traditional varieties of food crops, including millet, jawar (sorghum) and lentils. In recent years Bt cotton crops had become affected by increased attacks from bollworms and other pests and have led farmers to consider previously available seed varieties. However, farmers find themselves often 'locked-in' to using BT cotton with indigenous seeds no longer so easily available.

Comparing the three cases, it is clear that GM maize in Mexico represents a unique case. The cultural resonances surrounding maize clearly indicate that any introduction of GM maize, especially in the southern States, would be most likely perceived as a threat both to local traditional practices and to a historically situated sense of identity. In Brazil, on the other hand, soya has little cultural resonance (much of it is produced for export and for animal feed in any case) and there was little sense of GM soya as violating local senses of identity. India represents perhaps a more interesting case. Even though cotton is represented as a potent symbol of Indian national identity and self-sufficiency, in our local agricultural communities, Bt cotton was rarely represented as embodying a threat to traditional ways of life. In India and Brazil, however, GM crops had been aggressively (and successfully) marketed by seed companies with promises of increased productivity, ease of application and profits. However, with the increase of weed resistance, farmers are finding themselves increasingly dependent on seed companies, finding it hard to revert to previously available indigenous seeds and having to resort to using ever-larger dosages of herbicides and pesticides.

5.3 A comparative look at the structured interviews and questionnaires

Structured in-depth interviews and an associated electronic survey were conducted with key stakeholders in the three case sites. These included representatives from multinational seed companies, indigenous organisations, women's associations, environmental groups and other NGOs, religious organisations, smallholder farmers, medium and largeholder producers, social scientists, natural scientists, consumer associations and regulators. Interestingly, bar a few exceptions, all stakeholders considered the countryside to be in some state of crisis. Representatives from NGO and small holder associations tended to attribute this crisis, across the three cases of Brazil, Mexico and India, as a product of two decades of deregulatory policies, whereas representatives from the seed companies and from large holder producers tended to advocate more deregulation and the adoption of innovative technologies as the solution to make agriculture more competitive internationally and thus help resolve the situation.

a) Opinion about GMOs – Most of the stakeholders interviewed, with the exception of representatives of smallholder farmers and women's associations, were fairly familiar and knowledgeable about debates on GM agriculture. As would be expected, the Mexican stakeholders differentiated between the case of GM maize and other GM crops. Many of the stakeholders, with the exception of representatives from the seed companies and large farmer associations reproduced the arguments highlighted above: that Mexico is the Centre of Origin of maize, that this represents a substantial and collective responsibility, that current regulatory systems and capacities are not to be trusted to preserve native maize biodiversity and so on. The representatives from the seed companies and large farmer associations offered a different opinion. For them, GM maize offered significant potential to

improve food security and help resolve the crisis in agriculture. They also represented GM agricultural technologies as part of a gradual and continuous path of science working towards agricultural improvement, rather than as a rupture or break with conventional breeding practices as the other stakeholders tended to believe. Stakeholders in India and Brazil reproduced similarly divergent perspectives on GMOs in responses although there was little differentiation associated with the GM crop in question (i.e. GM soya and GM cotton) compared to other GM crops. Concern was expressed that GM crops create dependency on seed companies, that it could cause problems to human health and the environment and that it could further worsen conditions in rural areas. A minority opinion, largely shared by (some) natural scientists and representatives from seed companies, was that GM crops were a good example of scientific advance that could assist the country to become more economically competitive and to help feed the world. Ontological arguments (e.g. that GM crops were wrong, that they were an example of hubris or 'messing with nature') were more common in stakeholder discourse in India and Mexico, less so in Brazil.

b) Openness and efficacy of the debate on GMOs – The general picture in Brazil was that the public debate on GMOs had receded. This was not the case for Mexico or for India where the debate was perceived as ongoing and live. However, across all sites, the majority of respondents agreed that access to reliable and quality information had been limited and that the public debate, so far, had been unable to resolve underlying problems of agricultural innovation and food security. Generally, stakeholders agreed that there existed a lack of informed debate and a lack of transparency or participation in decision-making processes. For the Mexican stakeholders in particular this was emblematic of wider problems in political culture.

c) Voices in decision-making processes – There was further convergence in the perception of whose voices had been vocal and effective and whose had not. The voices who had been least heard were perceived to be consumers, smallholder farmers, indigenous groups and (for Mexico and India) the independent neutral scientist (e.g. those not funded by the seed companies). Whereas the voices that had been most vocal in the debate were perceived to be the seed companies, politicians, government agencies and (for India) NGOs. Interestingly, both in Mexico and India, large farmers felt under-represented, while in India in particular, natural scientists felt that their opinions had not adequately been taken into account.

In addition, across India and Brazil (less so in the case of Mexico), there was little support for the view that indigenous and religious groups should have more of a voice in decision-making processes. Generally, participants tended to agree that decision-making should be guided by independent scientists (for some this included social scientists with expertise on social impacts) and that those who should be excluded were: scientists with a conflict of interest, corporate actors who have a vested interest, NGOs who were commonly viewed as having had a negative influence, churches and religious organisations (who lack expertise) and (for representatives of the seed companies and some natural scientists) consumers and consumer organisations who lacked relevant knowledge.

5.4 A comparative look at the laboratory research

Within each case site we undertook qualitative research, involving participant observation and interviews, in public or nonprofit research laboratories. These were: the publicly-funded National Laboratory of Genomics for Biodiversity (LANGEBIO) in Guanajuato, Mexico, the state-owned soya research division (CNPSO) of the Brazilian Agriculture Research Company, Embrapa, in Londrina, Brazil, and the New-Delhi branch of the nonprofit organization, the International Centre for Genetics and Biotechnology (ICGEB). All three were high profile,

nationally-significant research laboratories, led by eminent academics and staffed by elite researchers. Nevertheless, all three were suffering to various degrees from a lack of confidence. At LANGE BIO (Mexico), within the Maize Genetics and Genomics group, there was no research being undertaken on the development of GM maize; at CNPSO (Brazil), where earlier pioneering research had been responsible for the expansion and adaptation of the soya bean to the hot, humid and acid climes of the Cerrado biome, the organization had lost group to foreign-owned multinational seed companies who now commanded the market of soya bean cultivars in Brazil; while at ICGEB (India), the organization, while still receiving state funding, had been rendered partially impotent by the 2013 indefinite moratorium by the Indian Supreme Court on GM food crops, including field trials.

All three were conducting their research with a strong social mission, developing projects aimed at providing solutions to the pressing problems of the global South, namely feeding a growing population, improving resilience and food security, and developing high yield crops better suited to local conditions. Research projects included the production of new varieties of crops resistant to herbicides, varieties breed for increased tolerance to drought and salinity, the development of varieties resistant to insects and other fungal and viral diseases, crops with delayed ripening varieties, aimed at lengthening shelf life, and varieties with improved nutritional qualities.

Most of the researchers interviewed in the labs were strongly and unequivocally pro-GM, a position justified for differing reasons. At ICGEB (India), for example, the rhetoric oscillated between the position that emphasized that GM food was safe and the one that argued that GM crops were needed specifically for developing countries, which could not afford non-GM food, including organics, and that therefore it was 'the lesser of two evils' when compared with starvation and the over-use of pesticides. At CNPSO (Brazil), researchers tended to view GM crops as offering the potential both to improve food quality and to feed a growing global population. However at LANGE BIO (Mexico), the rhetoric was more variegated. Whereas older and more senior researchers tended to adopted a more avowedly pro-GM stance for all crops, including GM maize, younger and more junior researchers were more nuanced. In relation to GM maize in particular, these researchers tended to distinguish between the introduction of 'foreign' (i.e. non-maize) genes into maize and the re-working of genetic material within the maize's genome, and to be more cautious as to whether we have sufficient understanding of the maize genome to consider its genetic modification, as well as promoting a collective sense of responsibility for protecting maize's genetic diversity.

Ontologically, the researchers tended to deploy a reductionist form of discourse. They tended to see the genetic modification as no different in kind from conventional forms of breeding. Plants considered as an amalgam of genetic material (rather than as a product of social practices) led researchers to believe that there existed apparently limitless possibilities for genetic improvement. Genetic modification was seen as allowing for the indefinite extension of human intervention of nature. Ethical and social responsibility were defined primarily as that of ensuring that research was being conducted in the national interest: helping the nation to become more economically competitive, helping the nation feed its growing population and helping the nation develop its science base. Researchers believed that current varieties of GM crops were safe and that future varieties would be safe so long as regulation continued to be carried out using strict biosafety protocols. The retention of national sovereignty was a key concern across the three research laboratories, with concerns expressed at all levels of the organization about the widespread adoption of GM seeds from foreign-owned multinationals.

Researchers also tended to adopt a traditional division of academic labour, viewing their responsibility as that of producing reliable knowledge (within the context of nationally-

agreed research strategies) with little responsibility for how the fruits of their research would be used (or abused) downstream. Science tended to be represented as essentially neutral while the science of GM tended to be represented as essentially producing social goods and thus not in need of external societal shaping. Thus, across both the CNPSO (Brazil) and ICGEB (India) labs, there was irritation expressed in the ways in which GM farmers were applying crops whose practices, driven by the desire for short-term profit, were perceived to be creating weed resistance by not following the necessary and relevant management guidelines (e.g. recommended crop rotation practices and the planting of refuges).

Within each of the research labs, there was little evidence of a structured and sustained debate with society at large. Lay opinion tended to be dismissed as ill-informed and as overly focused on the negative aspects of the technology. Any existing dialogue with those outside the laboratory was largely restricted to farmers and academic peers. Even in the latter case, human and social scientists were often mistrusted in their scientific credentials. Laboratory scientists did not feel they need 'to sell' their achievements by convincing the wider public. Rather, according to these scientists, it is up to the market and for individual consumers to decide whether or not to adopt GM. The target stakeholder for the research laboratories was viewed as the farmer, not the consumer.

For these reasons we found that there was no clear and deliberate strategy for the research laboratories to communicate to a wider audience of relevant interlocutors, nor was there a developed or collective sense of accountability to those people who will be affected by the technology, even in the absence of whether these people have intentionally chosen to adopt GM foods or not. This self-understanding presents considerable difficulties for the development of interdisciplinary research, including the role and remit of the human and social sciences. For the latter, criteria of informed, meaningful and fair participation are often viewed as a necessary pre-condition for the legitimacy of public decisions: technical and scientific ones included. Given that this understanding is not shared by for example laboratory researchers, it is thus not surprising that dialogue across the natural and social sciences remains has been fraught with misconception and tension.

To summarise, notwithstanding the high quality and at times pioneering research being undertaken within and across each of the three research laboratories, the research culture of the laboratories across the three sites could be described as lacking in '*reflexivity*' and '*inclusiveness*'. With the partial exception of some of the LANGE BIO (Mexico) researchers, the researchers interviewed for the study appeared to lack reflexivity in three regards: first, they appeared to lack the motivation to understand the (legitimate) reasons why GM crops have become controversial in each country, preferring instead to regard such resistance as ill-informed, ideological and ignorant. Second, they further lacked the motivation or encouragement to work with other disciplines from the human and social sciences, including those could help provide sociologically-informed understandings of the controversy and understanding of (latent) public concerns, preferring instead to view such disciplines as lacking in relevance and/or competence. And third, even through each of the research laboratories operates with a national and strategic context, what constituted the national public interest tended to be taken as a given, and there were few forums for scientists to deliberate with other actors as to whether their framings aligned with wider social values and needs. The research culture of the laboratories were similarly lacking in inclusiveness. Researchers did little to listen to, understand, or engage with wider social actors or views – and their often divergent framings of the issues – and had not developed a collective sense of responsibility for the outcomes of their research as they would be used in practice. These two dimensions (inclusiveness and reflexivity) will be examined further in Chapter 6 when we propose a novel framework for the responsible innovation of GM crop technologies.

5.5 A comparative look at the consumer focus group research

A key element of our research involved the attempt to understand lay public attitudes to GM crops and foods across Mexico, Brazil and India. As evidenced one striking feature of the debate on GMOs across all three countries is the lack of an informed and comprehensive public debate. In addition, except from a few opinion surveys and a couple of ad hoc public engagement exercises, little knowledge exists on what ordinary people actually think about the subject. What are public attitudes? Are people generally negative or positive? Do they accept the technology? Do attitudes differ between and within countries? Does this depend of the particular crop being modified? Or what gene is used in the modification? What social factors structure public responses? How familiar are publics with GM foods? And, perhaps most importantly, is it possible to develop meaningful research with publics when they are not familiar with the technology.

In our research we developed a methodology specifically designed to open up conversations with lay publics when they may (or may not) be familiar with the technology. This methodology was developed in the UK to help understand the factors shaping public perceptions to GM foods and crops (see Grove-White et al. 1997), and subsequently amended and deployed to explore public responses to GM animals (Macnaghten 2004), nanotechnology (Macnaghten 2010) and solar radiation management geoengineering (Macnaghten and Szerszynski 2013). It involves developing conversations on the social context through which attitudes are expected to form, followed by an introduction of the technology and deliberation on the views and perspectives of diverse actors. In relation to this research, we began with a discussion of everyday food practices and their meanings, followed by discussion on the concept of GM agricultural technologies and how they were used in practice, followed by a discussion of current debates on GMOs, both for and against. The groups had a bias towards women (women tend to be more implicated in the buying and cooking of foods), the middle classes (all three countries are witnessing a rapid rise in the middle classes) and the urban (where increasing proportions of people are living). In each country we included a group of people who practice religion to help understand the role of religion in structuring public attitudes.

The first point of comparison relates to the different underlying cultures of food emerging in and across the three national contexts. In Mexico, we found and heightened and shared appreciation of maize products and cooking, as a part of Mexican identity and as a medium in the maintenance of diverse social practices. Such an appeal to tradition provided a foundation for structuring subsequent responses to GM foods, and to GM maize in particular. In Brazil, by contrast, we witnessed a different dynamic. We found evidence of a fairly intense concern with the industrialization of foods, and, for at least the better off, a desire to consume foods as organic and local as possible as a response. This unease with the direction in which food was heading provided a different kind of foundation for structuring subsequent responses to GM foods.

A second point concerns the care and attention with which our participants were able to engage with the issues presented by GM foods and crops. At the start of the discussions, most of our participants were unfamiliar with the technology and how it was being applied across GM crops and foods. However, as the discussion progressed people's thinking matured and hardened as people began to consider questions of trust, governance and the responsibility of different actors. In this respect, the methodology worked to good effect. It enabled people to discuss the technology and to develop views.

The third point concerns the overall perception and tone of public responses to GM crops. With the exception of a few members of the student group in India (students who were

studying biology and who were enthusiastic advocates of biotechnology), there was little expressed public enthusiasm for GM foods and crops, which were considered, more or less across the board, as an intrinsically unsettling technology. Reasons for this were various. For many of the Brazilian participants, when introduced to the topic of GM crops and foods, we found little knowledge or awareness and genuine surprise about the extent of its adoption. People thus adopted negative views partly because they felt they had not been consulted. When coupled with the uncertainties of outstanding health impacts, people responded viscerally: *'I feel betrayed'; 'we are all guinea pigs'; 'even with our level of enlightenment, we ignored it [...]'; '[this] is a leap in the dark'*. Similarly, for the Mexican participants, the perception that the food companies were opposed to the labelling of GM foods, generated suspicion and outrage that their 'right to know' was being usurped.

Other factors shaping people's negative attitudes to GM crops and foods included: that the case for why it was needed had not been demonstrated (Mexico), that current cultures of science did not have the proven capacity or integrity to predict future harms (Mexico), that regulatory agencies were not to be trusted (Mexico), that the good intentions of the seed companies were not to be trusted (Mexico), that it would benefit the large producer at the expense of the family farmer (Brazil and Mexico), that they saw few consumer benefits (Brazil), that those promoting the issue (scientists, government actors and seed companies) were 'manipulating' the debate to suit their own interests (Brazil), and that the promise that GM crops would promote sustainability was a contradiction in terms (India). The claim that GM crops and foods could feed the world was seen as unrealistic by most participants (across all case sites). The political economy surrounding (at least first generation) GM crops made such claims highly implausible.

However, there were some interesting and relevant specificities in the group discussions. For the Mexican participants (as this research shows fairly conclusively) there was increased sensitivity with GM maize whose promotion – by seed companies and parts of government – was seen as a symbol for wider unease, namely, the apparent collusion between the political class and large corporations at the expense of the wider public interest. For some of our Indian participants, particularly from rural areas, the actual gene used in the genetic modification of plants was seen as relevant. Insertion of animal genes into plants was seen generally as less acceptable as this would transgress religious taboos.

Finally, there is the question of governance. Many of the participants called for government to take more active and proactive responsibility in governing for the public interest. Government should be responsible for clear and transparent regulation, for assuring safety, for raising consciousness and for promoting the public interest. Public universities and educational establishments were also accorded a priority role in fostering the creation of critical and participative citizens. Interestingly, institutions who did not command trust, and whose motivations were seen as doubtful included NGOs (for Brazil to some extent, less so in India or Mexico), the media and the seed companies.

5.6 A comparative look at the deliberative workshops

At the close of each fieldwork session our local teams, under the guidance of the Durham research leaders, organized local deliberative workshops with stakeholders. The workshops had two functions: to elicit reflection and deliberation on the field research, and develop (if possible) a set of consensual priorities through small breakout group work for how to best progress the debate on GM crops. The workshops were well attended, spectacularly so in Mexico, and included, inter alia, representatives from government departments, regulatory bodies, seed companies, civil society organisations, women's organisations, small holder

organisations, indigenous organisations, environmental and consumer groups, as well as natural and social scientists.

The workshops generated rich and varied debate. By and large, participants welcomed the debate as a valuable, and atypical, contribution. Bar a few disagreements (between participants with avowedly pro- and anti- positions) there was a surprising degree of consensus and common purpose, aided by the deliberative methodology and the non-confrontational style adopted by the workshops.

Excluding a few natural scientists and representatives from seed companies, who argued that the debate had been settled in favour of GM crops, the majority of participants shared the view on the need to open a new cycle of debate on the issue. For the Indian breakout groups, the agreed priority areas were to develop novel forms of public consultation, to develop constructive and critical public engagement, and to widen and deepen the debate and to listen to a wider range of stakeholders. Similarly, for the Mexican groups, the majority view was to advocate for transparent, inclusive and democratic debates. While, the Brazilian participants too called for concerted action to communicate reliable information, and for proper channels of citizen participation in strategic decisions including the organization of deliberative policy conferences. Such calls thus spoke of the shared perception, commonplace across the three national contexts, that the debate so far on GM crops had not been inclusive, transparent or participatory. In the Mexican context in particular, the voice of small farmers was perceived to have been dramatically absent.

A second priority area, common across the three national workshops, was the call for education and the development of critical citizens. For the Brazilian participants, the public universities were accorded a special role. The lack of quality, unbiased information was perceived as a significant and ongoing barrier with media outlets perceived as untrustworthy, and for many biased and self-interested. Public universities, public scientists, teachers, researchers and (some) journalists however, were trusted, alongside citizen and consumers' groups, and a priority area was for these actors to fulfill their responsibility of providing unbiased information and in creating critical citizens. The government too, was accorded a role both in promoting informed debate through public events and in providing participatory forums for public deliberation. Again, the implication was that these bodies were insufficiently fulfilling their obligations in this regard. A third priority was for initiatives that seek to bridge the gap between scientific practices and imaginaries in the laboratory and in situ practice in the field. In the Indian workshop in particular, participants spoke of the problems associated with agricultural laboring practices not confirming to agreed guidelines and standards, such as labourers not using gloves and masks when applying pesticides and herbicides. Again, the proposal was for government to develop both a more rigorous regulatory framework at the national level, and at the local level, to develop a stronger monitoring and implementation capability. A fourth and final priority area, again prominent in the Indian workshop, was the call for GM research institutions to develop greater socio-cultural sensitivity: to develop research that better responds to India's strategic needs, to both understand and accommodate different framings of the issue, including religious sensitivities, and to do so in a way that is accountable, transparent and responsive.

5.7 Conclusions

We now briefly summarise the key findings from the comparative analysis of the three case studies. First, we compared the national controversies over GMOs. We found that in all three cases, the technical regulatory bodies charged with approvals for the release of GMOs

had not provided 'authoritative governance'. Across all three jurisdictions, decisions had been all too often rejected by institutional and other stakeholders. We then offered a typology aimed at explaining why the controversy surrounding GM crops had taken different forms in different national settings. Factors that were seen to be relevant in structuring the controversy included: the perceived authority of the regulatory agencies, the cultural resonance of the crops in question, the level of intensity of protest movements, the extent to which GM can become represented as the symbol of wider struggle and the degree of sustained effort by institutional actors to engage the public. Using this typology, the authority of the regulatory bodies across all three national contexts can be seen as weak. The cultural resonance of the GM crop in question can be seen as high in the case of GM cotton (India) and GM maize (Mexico) but less so in the case of GM soya (Brazil). The protest movements against GM crops can be seen to have been sustained in India and Mexico but to have petered out in Brazil since 2005. Across all three cases, GM has been discursively constructed as a symbol against globalization and neoliberal policies. While in all three sites, there has been an absence of a sustained attempt by institutional actors to engage the public.

Second, we compared the field ethnographies. We found that GM maize in Mexico represents a unique case. The cultural resonances surrounding maize clearly indicate that any introduction of GM maize, especially in the southern states, would be perceived as a threat both to local traditional practices and to a historically situated sense of identity. In Brazil, on the other hand, soya has little cultural resonance (much of it is produced for export and for animal feed in any case) and there was little sense of GM soya as violating local senses of identity. India represents perhaps a more ambiguous case. Even though cotton is represented as a potent symbol of Indian national identity and self-sufficiency, in our local agricultural communities, BT cotton was rarely represented as embodying a threat to traditional ways of life. We also found on-the-ground evidence, both in India and Brazil, of the prevalence of glyphosate-resistant weed species. In both cases, we found that seed companies and farmers were tending to blame each other, with farmers sensing that they had become increasingly 'locked-in' to GM agriculture, finding it hard to revert to previously available indigenous seeds and having to resort to using ever-larger dosages of herbicides and pesticides.

Third, we compared the stakeholder interviews and questionnaires. Across all the national settings we found a clear divide between those who also represented GM crops as part of a gradual and continuous path of science working towards agricultural improvement (mostly representatives from seed companies and some natural scientists), and those who saw GM crops as a rupture or break with conventional breeding practices (mostly smallholder farmers, environmental and consumer NGOs, women's associations and indigenous groups), and as engendering further dependency on seed companies, with unknown risks and posing clear threats to traditional farming practices and lifestyles. There was also near consensus from the latter constituency decision-making thus far had lacked transparency and participation with minimal informed public debate.

Fourth, we compared the research laboratory ethnographies. Notwithstanding the high quality and at times pioneering research being undertaken within and across each of the three research laboratories, the research culture of the laboratories across the three sites was described as lacking in '*reflexivity*' and '*inclusiveness*'. With the partial exception of some of the LANGE BIO (Mexico) researchers, the researchers interviewed for the study appeared to lack the motivation or encouragement to work in interdisciplinary contexts with the human and social sciences, to understand the (legitimate) reasons why GM crops have become controversial in their country, or the opportunity to deliberate the strategic context

of GM crops with other actors in public forums. The research culture of the laboratories were similarly lacking in inclusiveness. Researchers did little to listen to, understand, or engage with wider social actors or views – and their often divergent framings of the issues – and had not developed a collective sense of responsibility for the outcomes of their research as they would be used in practice.

Fifth, we compared the consumer focus group research. We found that lay people, mostly living in urban settings, were able to engage in meaningful debate across all three national settings. We found that national emerging food cultures were important in structuring public responses: in Mexico the appeal for maize cooking and products as an element of national self-identity, In Brazil the growing concern with the industrialisation of food and the drive towards organics and local produce. Across the board, we found little public enthusiasm for GM crops and foods and a hardening of response as the discussions matured. People adopted negative views partly because they felt they had not been consulted, partly because GM foods were commonly perceived to be unnecessary and potentially harmful, and partly because regulatory agencies and the seed companies were not to be trusted. There were some specificities: in Mexico GM maize was represented as a symbol for the apparent collusion between the political class and large corporations at the expense of the wider public interest. While for some of our Indian participants, particularly from rural areas, the actual gene used in the genetic modification of plants was seen as relevant. Insertion of animal genes into plants was seen generally as less acceptable as this would transgress religious taboos.

Finally, we compared the stakeholder deliberative workshops. We found, generally, that the attempt to develop a new kind of conversation on GM crops and their governance was welcomed across all three contexts, with a surprising degree of consensus between participants, and as an alternative to the polemic style of interaction that had tended to characterize the debate. Across the three settings, stakeholders tended to prioritise the call for novel forms of public engagement, for the production of high quality and reliable information, for educational establishments to foster the development of critical citizens, and for governments to govern in the public interest. There were further calls for regulatory agencies to understand how regulations were being implemented (or not) in farming practices and, in the Indian workshop, for research institutions to develop greater socio-cultural sensitivity: to develop research that better responds to India's strategic needs, to both understand and accommodate different framings of the issue, including religious sensitivities, and to do so in a way that is accountable, transparent and responsive.

Chapter 6 A governance framework

So far we have developed a comparative analysis of the debate over GM crops in Mexico, Brazil and India. We found that in all three cases, the technical regulatory bodies charged with approvals for the release of GMOs had not provided 'authoritative governance'. Across all three jurisdictions, decisions had been hotly contested. The key factors underpinning the various controversies were analysed to be social and institutional in nature and included: the perceived authority of the regulatory agencies, the cultural resonance of the crops in question, the level of intensity of protest movements, the extent to which GM can become represented as the symbol of wider struggle, and the degree of sustained effort by institutional actors to engage the public. Importantly, these factors extended beyond the question of technical risk: the extent to which GM crops would (or would not) pose a risk to human health and the environment. Given that these criteria extend beyond the terms of reference of each of the regulatory agencies in question, and given their invisibility within the wider polity, it is perhaps not surprising that such considerations effectively became hidden from public accountability and influence. In relation to such considerations there existed what Maartin Hajer termed an 'institutional void': i.e. a situation where was 'no generally accepted rules and norms according to which policy making and politics is to be conducted' (Hajer 2003: 175).

We now propose a governance framework designed to help fill this institutional void, using the idea and framework of responsible innovation as a guide. We describe what the framework of responsible innovation is, how it is being implemented in practice, why it is relevant to the case of GM crops, and how we propose it should be applied to the governance of GM agricultural technologies.

6.1 A framework of responsible innovation

Rene von Schomberg (2013) proposes the following definition of Responsible (Research and) Innovation. It is, he suggests:

'A transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society).'

(Von Schomberg 2013: 63)

A broader definition is provided by one of the authors (Macnaghten, with co-authors Jack Stilgoe and Richard Owen) in a study commissioned by the UK research councils:

'Responsible innovation means taking care of the future through collective stewardship of science and innovation in the present.'

(Stilgoe et al. 2013: 1570)

The core idea of responsible innovation is to help reconfigure responsibility in technological governance, which historically have been concerned with the 'products' of science and innovation, particularly impacts that are later found to be unacceptable or harmful to society or the environment. Recognition of the limitations of governance by market choice has led to the progressive introduction of post hoc, and often risk-based regulation. This has created a well-established division of labour that reflects a consequentialist framing of

responsibility, as accountability or liability (Pellizzoni 2004). With innovation, however, retrospective accounts of responsibility are inherently limited given that the past and present do not provide a reasonable guide to the future (Adam and Groves 2011). We face a dilemma of control (Collingridge, 1980), in that we lack the evidence on which to govern technologies before pathologies of path dependency, technological lock-in, ‘entrenchment’ and closure set in.

The definitions of responsible innovation highlighted above embrace three elements: the need to move the site of science governance away from the governance of risk to the social shaping of innovation (see also Felt et al. 2007); the need to consider ethical responsibility as a shared and collective property of the system rather than as a of purely individual matter; and the need to embrace a prospective view of responsibility, that moves attention away from matters of accountability, liability and evidence and towards future-oriented dimensions of care and responsiveness. It is these dimensions, we suggest, that offer the greatest potential to accommodate uncertainty and that allow reflection on purposes and values.

Rather than appeal to abstract legal principles, our framework of responsible innovation sought to ground its legitimacy through orienting the focus of responsible innovation to the kinds of questions that public groups typically ask of scientists, and which they would like scientists to ask of themselves. From research that analysed cross-cutting concerns of UK publics to emerging science and technology (see Macnaghten and Chilvers 2013) we derived the following questions that are reproduced in Table 2. If we take these questions to represent aspects of societal concern, responsible innovation can be seen as a way of embedding deliberation of these concerns within the innovation process.

Table 2. Lines of questioning on responsible innovation

Product questions	Process questions	Purpose questions
How will the risks and benefits be distributed?	How should standards be drawn up and applied?	Why are researchers doing it?
What other impacts can we anticipate?	How should risks and benefits be defined and measured?	Are these motivations transparent and in the public interest?
How might these change in the future?	Who is in control?	Who will benefit?
What don't we know about?	Who is taking part?	What are they going to gain?
What might we never know about?	Who will take responsibility if things go wrong?	What are the alternatives?
	How do we know we are right?	

6.2 Four dimensions of responsible innovation

Our framework of responsible innovation comprises four dimensions: anticipation, reflexivity, inclusion and responsiveness (the AIRR framework), which provide a scaffold for raising, discussing and responding to such questions. The dimensions are important characteristics of a more responsible vision of innovation, which we argue can be heuristically helpful for governance.

6.2.1 Anticipation

The call for improved anticipation in governance comes from a variety of sources, from concerns with the pace of social and technical change, to critiques of the limitations of top-down risk-based models of governance to encapsulate the social, ethical and political stakes associated with technoscientific advances (see Felt et al. 2007; House of Lords 2000; Royal Commission on Environmental Pollution 1998). The detrimental implications of new technologies are often unforeseen, and risk-based estimates of harm have commonly failed to provide early warnings of future effects (European Environment Agency 2002, 2013). Anticipation prompts researchers and organisations to ask ‘what if ...?’ questions (Ravetz 1997), to consider what is known, what is likely, what is plausible and what is possible. Techniques that involve anticipatory discussions of possible and desirable futures include upstream public engagement (Wilsdon and Willis 2004), constructive technology assessment (Rip et al. 1995) and real-time technology assessment (Guston and Sarewitz 2002), amongst others. Anticipation is distinguished from prediction in its explicit recognition of the complexities and uncertainties of science and society’s co-evolution. Methods of foresight, technology assessment, horizon scanning, scenario planning and vision assessment can in addition be important techniques, although when used narrowly they risk exacerbating technological determinism. Anticipatory processes need to be well-timed so that they are early enough to be constructive but late enough to be meaningful (Rogers-Hayden and Pidgeon 2007). The plausibility of scenarios is an important factor in their success, and we should not underestimate the work involved in building robust tools for anticipation (Robinson 2009). We also need to recognise institutional and cultural resistance to anticipation. As Guston (2012) points out, a lack of anticipation may not just be a product of reductionism and disciplinary siloes. It may, at least in part, be intentional as scientists seek to defend their autonomy.

6.2.2 Inclusion

The waning of the authority of expert, top-down policy-making has been associated with a rise in the inclusion of new voices in the governance of science and innovation as part of a search for legitimacy (Irwin 2006). Over the last two decades, particularly in Northern Europe, new deliberative forums on issues involving science and innovation have been established, moving beyond engagement with stakeholders to include members of the wider public (see Wilsdon and Willis 2004; Stirling 2006). Small-group processes of public dialogue have been developed that now include consensus conferences, citizens’ juries, deliberative mapping, deliberative polling and focus groups (see Chilvers 2010). Often under the aegis of quasi-governmental institutions such as Sciencewise-ERC in the UK or the Danish Board of Technology, these can, according to the UK government, ‘enable [public] debate to take place “upstream” in the scientific and technological process’ (HM Treasury/DTI/DfES 2004: 105). Additionally, we can point to the use of multi-stakeholder partnerships, forums, the inclusion of lay members on scientific advisory committees, and other hybrid mechanisms that attempt to diversify the inputs to and delivery of governance. The importance of public dialogue in ‘opening up’ (Stirling 2008) framings of issues that challenge entrenched assumptions and commitments has been emphasised (Löfbrand et al. 2011). And while there has been a resistance to attempts to proceduralise public dialogue for fear that it becomes another means of closure (Wynne 2005) or technocracy (Lezaun and Soneryd 2007), there have been efforts to develop criteria aimed at assessing the quality of dialogue as a learning exercise. On the latter, Callon et al. (2009: 160) offer three criteria: intensity – how early members of the public are consulted and how much care is given to the composition of the discussion group; openness – how diverse the group is and who is represented; and quality – the gravity and continuity of the discussion.

6.2.3 Reflexivity

Responsibility demands reflexivity on the part of scientists and institutions. Reflexivity, at the level of institutional practice, means holding a mirror up to one's own activities, commitments and assumptions, being aware of the limits of knowledge and being mindful that a particular framing of an issue may not be universally held. This is second-order reflexivity (Schuurbiers 2011) in which the value systems and theories that shape science, innovation and their governance are themselves scrutinised. Unlike the private, professional self-critique that scientists are used to, responsibility makes reflexivity a public matter (Wynne 2011). Recent attempts to build reflexivity have tended to focus at the laboratory level, often with the participation of social scientists or philosophers. The argument is that in the bottom-up, self-governing world of science, laboratory reflexivity becomes a vital lever for opening up alternatives through enhancing the 'reflections of natural scientists on the socio-ethical context of their work' (Schuurbiers 2011: 769). Approaches such as 'midstream modulation' (Fisher et al. 2006) and 'ethical technology assessment' (Swiestra et al. 2009) give familiar ethnographic STS laboratory studies an interventionist turn. Such a call for reflexivity needs to extend beyond the contained space of the laboratory to embrace 'the wider range of activities, actors, interests, and relationships which constitute science and its distributed networks of stakeholders and innovation funders, practitioners and affected publics' (Wynne 2011: 794). These institutions have a responsibility not only to reflect on their own value systems, but also to help build the reflexive capacity within the practice of science and innovation. Finally, a reflexive scientific culture is one where, in the words of Bruno Latour, scientists do not abandon the fruits of their creations, but cultivate instead a sense of care for technology and its downstream effects (Latour 2008).

6.2.4 Responsiveness

There exist a range of processes through which questions of responsible innovation can be asked. Some of these processes focus questioning on the three dimensions of responsible innovation above. A few approaches, such as Constructive Technology Assessment (Rip et al. 1995), Real-Time Technology Assessment (Guston and Sarewitz 2002), midstream modulation (Fisher et al. 2006) and anticipatory governance (Barben et al. 2008), seek to interrogate multiple dimensions. However, for responsible innovation to have purchase, it must also seek to respond to such questions. Responsible innovation requires a capacity to change shape or direction in response to stakeholder and public values and changing circumstances. The limited capacity of public engagement initiatives to modulate innovation trajectories has been a significant criticism (Stirling 2008). We therefore need to design systems of innovation to be as responsive as possible. Responsiveness involves responding to new knowledge as this emerges and to emerging perspectives, views and norms. In the UK, Europe and perhaps more broadly, we can point to growing policy interest in 'grand challenges' (Lund Declaration 2009). Von Schomberg (2013) contends that the central challenge of responsible innovation is to become more responsive to societal challenges. But such challenges are not preordained, nor are they uncontested. There are various mechanisms that might allow innovation to respond to improved anticipation, reflexivity and inclusion. In some cases, application of the precautionary principle, a moratorium or a code of conduct may be appropriate. Existing approaches to technology assessment and foresight may be widened to engender improved responsiveness (Von Schomberg 2013). And value-sensitive design (Friedman 1996) suggests the possibility of designing particular ethical values into technology. As we describe in the next section, techniques such as stage-gating can also create responsive governance choices.

6.3 How responsible innovation is being implemented

The anticipation-inclusion-reflexivity-responsiveness (AIRR) framework for responsible innovation was first trialled in relation to the Stratospheric Particle Injection for Climate Engineering (SPICE) project, a research project funded by UK research councils that aimed to investigate the feasibility of a climate engineering proposition that would involve the delivery of large quantities of sulphate aerosol to the stratosphere to mimic the cooling effects of volcanic eruptions. A test was proposed of a one-twentieth scale delivery system: a 1-km high hose supported by a tethered balloon. Although this so-called test bed would not be geoengineering as such – it would spray only a small amount of water – the experiment was highly symbolic as the UK's first field trial of a technology with solar radiation management potential (Macnaghten and Owen 2011). In order to ensure that the project proceeded in a responsible manner, the funding agencies adopted a 'stage-gate' model of innovation governance. Funding for the test bed was conditional on the project team passing the stage-gate in respect of five criteria, directly modelled on the four dimensions highlighted above: the SPICE team was asked to anticipate, reflect, and deliberate with publics and stakeholders on the purposes and possible impacts of the research and what it could lead to. Macnaghten chaired the stage-gate panel. Following a complicated set of dynamics the test bed was cancelled (for a detailed account see Stilgoe et al. 2013). The responsible innovation framework thus helped provide a decision support tool for the panel to consider wider risks, uncertainties and impacts surrounding the SPICE test.

Since 2013, EPSRC has developed a series of initiatives aimed at operationalising responsible innovation in a day-to-day context. They have issued a statement on responsible innovation that sets out their own commitment and their expectations for the researchers they fund and their research organisations (EPSRC 2013a). They have endorsed the dimensions set out above, but translated into the more memorable acronym AREA (anticipate, reflect, engage and act). To support this approach they have pledged to:

- *'Promote reflection, understanding and training about Responsible Innovation approaches within the wider research community, encouraging broader interactions with other disciplines and spheres of expertise in order to develop capacity for responsible innovation'*
- *'Welcome funding requests within EPSRC research grant proposals that seek to explore aspects of Responsible Innovation as an integral part of that research endeavour'*
- *'Be vigilant to potential social, environmental, ethical and regulatory challenges which arise from new research at the limits of our knowledge, and to broaden debate at an early stage'*
- *'Ensure that Responsible Innovation is prominent in our strategic thinking and funding plans, including proposal assessment'*
- *'Alert policy makers in Government and regulators to emerging issues and opportunities associated with new research areas as soon as they become apparent.'* (EPSRC 2013a)

As a public funding body that at any one time are supporting a portfolio of research and training of between £2–3 billion, this is a significant development. A recent example of its implementation was EPSRC's 2013 Doctoral Training Centre competition where applicants were encouraged to include training in responsible innovation in their bids (EPSRC 2013b). External to EPSRC, a number of initiatives in the field of synthetic biology have sought to adopt frameworks of responsible innovation to assist with its governance. These include, *inter alia*:

- A Synthetic Biology Roadmap for the UK that uses a framework of responsible innovation as a means to ensure the technology continues to be socially responsible (UK Synthetic Biology Roadmap Coordination Group 2012).
- A statement of expectation from the European Federation of Biotechnology to ensure 'our members ... practice science and innovation that is socially desirable and undertaken in the public interest' (European Federation of Biotechnology 2014).
- A Technology Strategy Board funding call in which applicants are obligated to demonstrate how their proposed research responds to the framework of responsible innovation and its embedded principles (TSB 2012).
- An Innovation and Knowledge Centre (IKC) SynbiCITE, dedicated to developing synthetic biology through responsible innovation (Synbicite 2014).
- A European FP7 project Synenergyne that aims to foster an open debate on responsible research and innovation in synthetic biology (Synenergyne 2013).
- A 'Synthetic Biology Applications to Water Supply and Remediation' EPSRC project that aims to use responsible innovation to underpin the scientific research.

The interest in deploying frameworks of responsible innovation in the governance of synthetic biology has arisen, in no small part, through concern that synthetic biology, as a potentially transformative and strategic technology in the life sciences, may experience the equivalent public and political controversy that overtook GM foods and crops in the UK and Europe in the 1990s. Responsible innovation is seen as offering a framework that may help ensure that synthetic biology remains socially desirable, undertaken in the public interest and thus free from public backlash. Given that the debate on GM crops in the UK (and Europe) has been pushed back into the political limelight in recent months (see Baulcombe et al. 2014; Council for Science and Technology 2013), it is opportune to explore what responsible innovation might mean in the context of the future governance of GM crops.

6.4 The application of responsible innovation to the governance of GM crops

In this final section we set out a pathway for the responsible innovation of GM crop technologies, using the anticipation-inclusion-reflexivity-responsiveness framework to shape a debate on future governance. Our aim is to provide a template to be used in structuring a deliberative conversation with policymakers and other key stakeholders.

6.4.1 Anticipation and GM crops and foods

In our GM Futuros research we found a diverse – and often divisive – set of opinions that coalesced around the following set of questions: Are GM crops safe? Do GM crops impact on the environment? Are GM crops needed to feed a growing population? Do GM crops contribute to food security? Do GM crops provide a strategic opportunity for national economic growth? Do GM crops create dependency on seed companies? Do GM crops transgress natural boundaries? Do GM crops benefit large producers rather than smallholders or consumers and if so, does this matter? Do GM crops operate in the public interest? Do GM crop technologies embody a model of agriculture that does not align with societal values? Implementing the anticipation dimension demands that it is these kinds of questions that will need to be put to the fore in any discussion of GM crops. We need to develop an open and inclusive debate on the purposes that ought be driving future GM crop technologies. Such a conversation should be informed by an assessment of what is known, what is not known and perhaps what might never be known. This should include 'what if' assessments to open up scenarios of how, if at all, GM crops could be developed to meet broadly shared social goals, including the discussion of alternatives and whether the application of GM agricultural technologies may or may not be the best option. An

important question to ask is whether such projected futures are likely to lead to unwanted adverse impacts. How can we describe and analyse the possible future impacts of GM crop technologies, intended or otherwise? What kinds of disciplinary (and interdisciplinary) knowledge are required to provide best insights on economic, social, environmental, ethical and cultural dynamics. A further question to test is whether such scenarios are plausible, and what are the boundary conditions that would need to be in place for their realisation.

6.4.2 Inclusion and GM crops and foods

In our research we found that an inclusive debate on GM crops had not taken place in Mexico, Brazil and India. We found that key actors felt they had been excluded from decision-making processes, namely smallholder farmers, consumer associations, indigenous organisations and religious groups. Various, other actors felt excluded too: natural scientists in India, NGOs in Brazil, large farmers in Mexico and India. In addition, we found that lay publics sensed that they had been 'kept in the dark'. Part of the overall negative responses to GM foods and crops was the keen sense that ordinary people felt they had not been consulted. Across the three cases, institutional actors, including the state and the media, had made minimal attempt to engage the public or to provide reliable public information. Operationalising the inclusion dimension necessitates the opening up of stakeholder and public engagement. This is no easy task. A cautionary tale is the attempt by the UK Food Standards Authority (FSA) in 2009 to instigate a public dialogue on the use of GM in food. The dialogue had to be abandoned due to criticism that it had ill-advisedly framed the exercise as about GM science at the exclusion of wider socio-political issues (Lancaster University Press Office 2010). Thus, an important consideration is to ensure that the framing of dialogue exercises aligns with lay ethical judgments and concerns, and to recognize that this framing may (or may not) align with expert and dominant scientific framings. Examples of doing dialogue badly include: when the decision is already made; when the sponsoring body is not prepared to listen; when the dialogue does not involve an appropriately diverse array of stakeholders or members of the public; when the issue being debated has been framed without public or stakeholder input; and when the timeframe is not appropriate, being either too early in the R&D process (when the issues associated with the science are too provisional) or too late (when there remains little opportunity to change its trajectory) (see Sykes and Macnaghten 2013). Opening a new public and stakeholder debate on GM crops and foods will require considerable consideration to the following factors: Who is consulted? How diverse is the group? How early are people consulted? Have minds been made up? How much care is given to the group design? How serious and continuous is the discussion? In addition, conceptual frameworks will be required that do not assume that people are either for or against the technology. The key question is: under what conditions, if at all, are GM crops and foods publicly acceptable? A further stakeholder group that needs to be engaged is the farmer. Engaging with a diverse spectrum of farmers, and feeding the results of those discussions into governance processes, will help decision-makers understand the conditions, if at all, that GM crops can lead to genuine benefit.

6.4.3 Reflexivity and GM crops and foods

In the research we found a general absence of reflexivity across each of the research labs. Researchers appeared to lack the capacity and motivation to understand the reasons why GM crops have become controversial in each country, preferring instead to regard resistance to GMOs as ill-informed, ideological and ignorant. They also were rarely encouraged to work with other disciplines, including social scientists, tending to view such disciplines as lacking in relevance and/or competence. And even through each of the research laboratories operated within a strategic context, what constituted the national or public interest tended to be taken as a given, with little deliberation with external actors. A

reflexive scientific culture is one where scientists are encouraged to put a mirror to their own commitments, to engage in self-referential critique and to be mindful in the ways that they (and their colleagues) tend to frame the issue at hand. This requires humility concerning the limits of current knowledge and awareness of the values systems that shape their science, their innovation and their governance. For GM science (and for science more generally) to operationalise the reflexivity dimension requires a reconfiguration in scientific culture in which responsibility comes to be defined and practiced in ways that extend beyond traditional notions, as defined for example by the Mertonian norms: i.e. communalism, universalism, disinterestedness, organized skepticism and originality. Developing a more reflexive culture is a long-term project and will require initiatives both amongst researchers and within institutions. It will require *inter alia*, structured interaction from social scientists and ethicists, encouragement from funders, leadership from research leaders, training and the development of curricula.

6.4.4 Responsiveness and GM crops and foods

In our research we found regulatory bodies that were perceived to be weak and untrustworthy. Part of the problem lay with inadequate funding and capacity. However, in addition, regulatory bodies tended to be perceived as technocratic, elitist and closed, and, in the case of Brazil, as part of a tradition of top-down, closed circuit policymaking. In Brazil and Mexico, they (and the political system of which they were a part) were perceived to be too proximal to the interests of the seed companies at the expense of the wider public interest. A governance system, if it is to be responsive, needs to embrace two qualities: it needs to be able to respond to new knowledge and to answer new views and norms. In addition, it needs to be open, transparent and committed to the public interest. Importantly, too, it needs to demonstrate leadership and commitment. And finally, it needs to understand the political economy of a technology's development and where the private interest may or may not align with the public interest. Operationalising the responsive dimension for GM crops will require institutional innovation. Perhaps there are lessons from history. In the UK, the BSE 'mad cow disease' crisis left a lasting scar in institutional culture and, to this day, is 'shorthand for a government that prioritized production interests over those of the consumer' and 'the emblem of old secretive politics' (Hajer 2009: 125, 128). Part of the institutional response involved the dissolution of the old Ministry of Agriculture, Fisheries and Food (MAFF) and the formation of the new Food Standards Agency (FSA) to oversee the interests of food. The FSA can be seen as embodying a model of deliberative policymaking, with commitments to openness and transparency, public engagement and honesty about uncertainty (Hajer 2009). Clearly, what is required in relation to GM crop technologies is an equivalent kind of deliberative institutional innovation, a new body whose role and remit is to provide advice to government on wider socio-political issues, that complements the technical advice provided by the Advisory Committee on Releases to the Environment (ACRE), which focuses on the risks to human health and the environment from the release of GMOs.

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