"This book wisely shifts our attention from the disputed technical properties f GM crops to the kinds of politics needed. If one book could prod the GM debate out of its current sterile stalemate, then this would be it."
Sheila Jasanoff, Professor of Science and Technology Studies, Harvard University, USA

Through the subtle studies in this book, GM crops become nothing less than a powerful and poignant metaphor for whatever it is that has replaced the ruthless innocence of modernity."
Daniel Sarewitz, Professor of Science and Society, Arizona State University, USA

"This fascinating and unique book shows that GM agriculture is neither ievitably a good thing nor a bad thing: it depends on the social, ecological and political circumstances."
Jules Pretty OBE, Professor of Environment and Society, University of Essex, UK

"An alternative pluralistic and inclusive model for decision making on GM crops – a model that just might move us toward better governance of technological change."
Lawrence Busch, University Distinguished Professor, Michigan State University, USA

though GM crops are seen by their advocates as a key component of the ture of world agriculture and as part of the solution for world poverty and unger, their uptake has not been smooth nor universal: they have been marred controversy and all too commonly their regulation has been challenged inadequate, even biased. This book aims to understand these dynamics, amining the impacts of GM crops in diverse geopolitical contexts and their otentials to contribute to sustainable agricultural futures. Part I draws on search from three global 'rising powers' – Brazil, India and Mexico – exploring e views of scientists, farmers and publics. Part II follows with a series of reflective ommentary pieces from 11 leading academics in the social and life sciences, dvancing new thinking on how to develop a governance framework for the sponsible innovation of agricultural GM technologies.

il Macnaghten is Professor of Technology and International Development Wageningen University, The Netherlands. He was formerly Professor of eography at Durham University, UK.

sana Carro-Ripalda is a social anthropologist, Honorary Research Fellow at urham University, UK, and currently Visiting Researcher at the Universidad del aís Vasco, Spain.

vironment / Sustainability

nforma business
BN 978-1-138-89182-1
781138 891821

Cover image: © GMFuturos

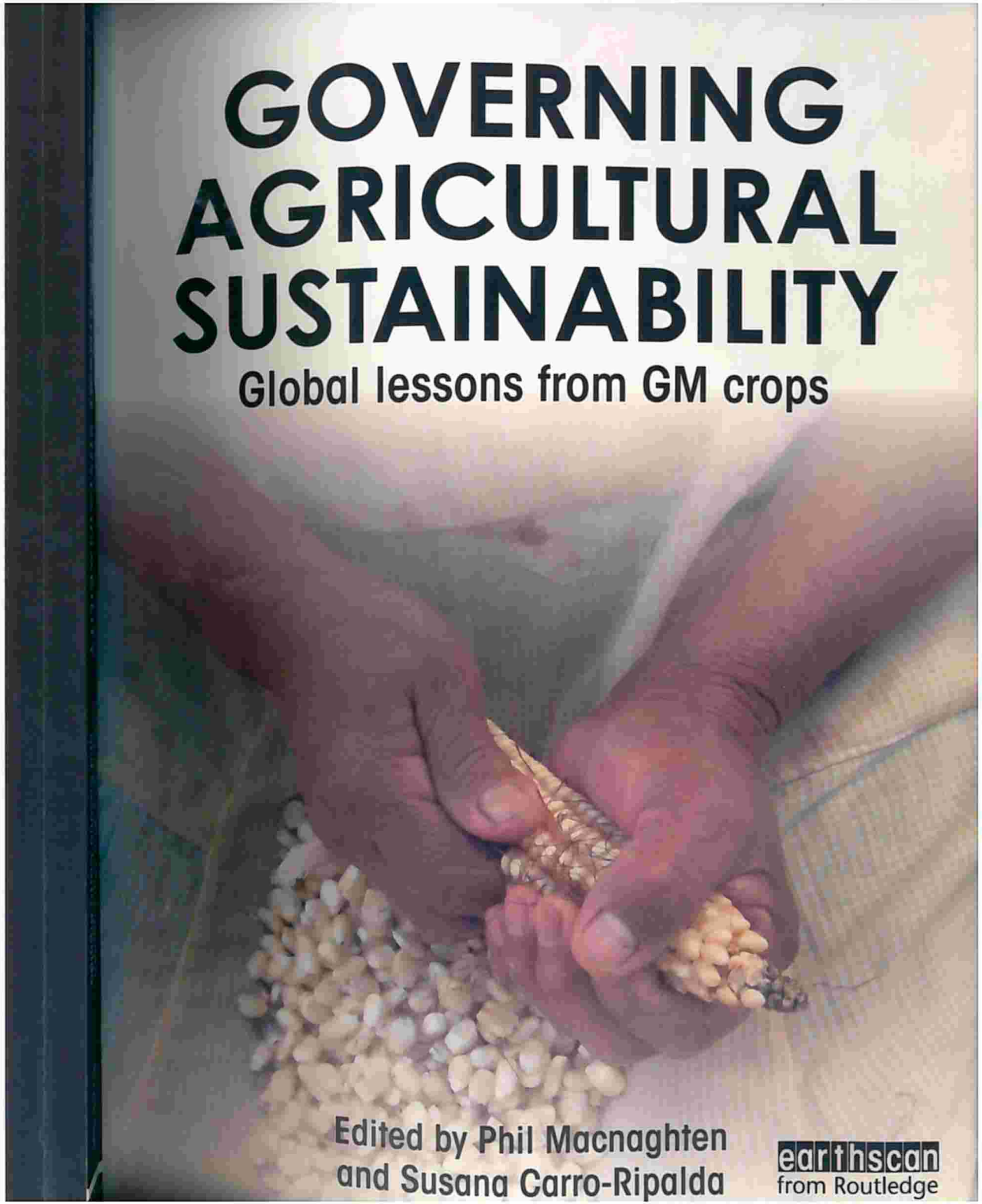
Routledge
Taylor & Francis Group
www.routledge.com

earthscan
from Routledge

Routledge titles are available as eBook editions in a range of digital formats

GOVERNING AGRICULTURAL SUSTAINABILITY

Global lessons from GM crops



Edited by Phil Macnaghten and Susana Carro-Ripalda

earthscan
from Routledge

GOVERNING AGRICULTURAL SUSTAINABILITY

Although genetically modified (GM) crops are seen by their advocates as a key component of the future of world agriculture and as part of the solution to world poverty and hunger, their uptake has not been smooth nor universal: they have been marred by controversy and all too commonly their regulation has been challenged as inadequate, even biased.

This book aims to understand these dynamics, examining the impacts of GM crops in diverse contexts and their potentials to contribute to sustainable agricultural futures. Part I draws on research from three global 'rising powers' – Brazil, India and Mexico – exploring the views of scientists, farmers and publics. Using a diverse array of ethnographic and qualitative methodologies, the book examines the dynamics that have underpinned the controversy in three diverse geopolitical contexts, the manner in which dominant institutional framings have been closely aligned with the interests of powerful elites, and the multiple ways in which these have been resisted through local, symbolic and material practices. Part II follows this analysis with a series of reflective commentary pieces from 11 leading academics in the social and life sciences, developing new thinking on how to develop a governance framework for the responsible innovation of agricultural GM technologies.

This innovative book offers new insights for researchers and postgraduates in science and technology studies, agro-ecology and environmental studies, development studies, anthropology, human geography, sociology, political science, public administration, Latin American studies and Asian studies.

Phil Macnaghten is Professor of Technology and International Development at Wageningen University in The Netherlands. He was Professor of Geography at Durham University (UK), and Founder Director of Durham University's Institute of Hazard and Risk Research. He coordinated the GMFuturos research project.

Susana Carro-Ripalda is a social anthropologist, Honorary Research Fellow at Durham University, and currently Visiting Researcher at the Universidad del País Vasco, Spain. She was Senior Research Fellow and GMFuturos Project Manager in the Department of Anthropology at Durham University, and has lectured at the universities of Durham, Glasgow and Edinburgh.

Pathways to Sustainability Series

This book series addresses core challenges around linking science and technology and environmental sustainability with poverty reduction and social justice. It is based on the work of the Social, Technological and Environmental Pathways to Sustainability (STEPS) Centre, a major investment of the UK Economic and Social Research Council (ESRC). The STEPS Centre brings together researchers at the Institute of Development Studies (IDS) and SPRU (Science and Technology Policy Research) at the University of Sussex with a set of partner institutions in Africa, Asia and Latin America.

Titles in this series include:

Dynamic Sustainabilities
Technology, environment, social justice
Melissa Leach, Ian Scoones and Andy Stirling

Avian Influenza
Science, policy and politics
Edited by Ian Scoones

Rice Biofortification
Lessons for global science and development
Sally Brooks

Epidemics
Science, governance and social justice
Edited by Sarah Dry and Melissa Leach

Regulating Technology
International Harmonization and Local Realities
By Patrick van Zwanenberg, Adrian Ely, Adrian Smith

The Politics of Asbestos
Understandings of Risk, Disease and Protest
By Linda Waldman

Contested Agronomy
Agricultural research in a changing world
James Sumberg and John Thompson

Transforming Health Markets in Asia and Africa
Improving quality and access for the poor
Edited by Gerald Bloom, Barun Kanjilal, Henry Lucas and David H. Peters

Pastoralism and Development in Africa
Dynamic change at the margins
Edited by Ian Scoones, Andy Catley and Jeremy Lind

The Politics of Green Transformations
Ian Scoones, Melissa Leach and Peter Newell

Carbon Conflicts and Forest Landscapes in Africa
Edited by Melissa Leach and Ian Scoones

Governing Agricultural Sustainability
Global lessons from GM crops
Phil Macnaghten and Susana Carro-Ripalda

Gender Equality and Sustainable Development
Edited by Melissa Leach

Adapting to Climate Uncertainty in African Agriculture
Narratives and knowledge politics
Stephen Whitfield

'Distilling a decade of research at UK institutions, this wide-ranging collection wisely shifts our attention from the disputed technical properties of GM crops to the kinds of politics needed to accommodate GM agriculture on a global scale. If one book could prod the GM debate out of its current sterile stalemate then this would be it.'
Sheila Jasanoff, Pforzheimer Professor of Science and Technology Studies, Harvard Kennedy School, USA

'Can GM crops feed the world? Such an apparently straightforward question is revealed in this book instead as a lens on the daunting intersections of technological advance, globalization, political and economic power, and cultural identity. Through the subtle studies in this volume, GM crops become nothing less than a powerful and poignant metaphor for whatever it is that seems to have replaced the ruthless innocence of modernity.'
Daniel Sarewitz, Professor of Science and Society and Co-Founder and Co-Director of the Consortium for Science, Policy & Outcomes (CSPO) at Arizona State University, USA

'A fascinating and unique book addressing the development and deployment of GM crops in a wide variety of different agroecosystems and countries. It steers between the unhelpful dichotomies of the past, and shows that GM agriculture is neither inevitably a good thing or a bad thing: it depends on the social, ecological and political circumstances.'
Jules Pretty OBE, Deputy Vice-Chancellor and Professor of Environment & Society at the University of Essex, UK

'The quest to document, to make sense of and to advocate solutions to the continuing controversies surrounding genetically modified crops has spawned a large library of literature. This edited but integrated volume both contributes to that discussion and extends it in new directions. Rather than starting with an analysis of the claims and counterclaims for GM crops, it asks why such crops have not been viewed as a universal public good. In asking that question, it moves beyond the endless polemics and identifies how and under what conditions GM crops might be widely accepted. Moreover, by focusing on Mexico, Brazil and India – three nations where empirical research has been limited – the authors show how these technologies are framed differently in different settings. In so doing the authors illustrate the limits of both the information deficit model and formal risk analysis as means for resolving controversies. In their place, the authors present an alternative pluralistic and inclusive model for decision-making – a model that just might move us toward better governance of technological change. Scholars and decision-makers concerned about public controversies surrounding technological change would do well to read this volume.'
Lawrence Busch, University Distinguished Professor at Michigan State University, USA

GOVERNING AGRICULTURAL SUSTAINABILITY

Global lessons from GM crops

Edited by
Phil Macnaghten and Susana Carro-Ripalda

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

earthscan
from Routledge

First published 2015
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

and by Routledge
711 Third Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
[CIP data]

ISBN: 978-1-138-89177-7 (hbk)
ISBN: 978-1-138-89182-1 (pbk)
ISBN: 978-1-315-70946-8 (ebk)

Typeset in Bembo
by FiSH Books Ltd, Enfield

MIX
Paper from responsible sources
FSC® C013056

Printed and bound in Great Britain by
TJ International Ltd, Padstow, Cornwall

CONTENTS

3

AN ANALYSIS OF THE GM CROP DEBATE IN BRAZIL

Julia S. Guivant and Phil Macnaghten

A review of the debate in Brazil

As noted in Chapter 1 of this volume, Brazil has experienced a very particular historical relationship with GM crops. 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 in some ways remarkable. Indeed, even though GM crops were not legalised for cultivation until 2005, by 2013 Brazil had become the second largest producer of GM crops in the world, behind only the United States. In this chapter we start with an analysis of 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.

Our story starts in 1998 when the National Technical Committee on Biosafety (CTNBio), the Brazilian regulatory committee set up in 1995 as the key scientific and multilateral agency responsible for approvals, received its first application from the global biotechnology company Monsanto for approval of its Roundup Ready (RR) herbicide-tolerant GM soya. Even though CTNBio approved Monsanto's application, there remained dissonant voices both inside the committee and in and across different ministries, which 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 helped create a set of conditions in which GM crops 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 GM crops. The mix of social actors can be understood as a 'discourse coalition' (Hajer 1995), and included a coalition composed of scientists, politicians, activists and consumer organisations, 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, that included the PT and MST, incorporated the issue of GM crops within a leftist discourse against globalisation, imperialism, multinational corporations, the USA, the International Monetary Fund and so on (Guivant 2002). While another set of actors, that included 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 PT 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 tended to have 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 GM crops was not based on the facts (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 either in the production or in the consumption of GM crops and foods (Lajolo and Nutti 2003; Guivant *et al.* 2009a, 2009b).

Up until 2003, the coalition against GM crops 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 orders,[1] in March and September 2003, that permitted the temporary sale and distribution of illegally grown GM soya and later the cultivation of GM seeds. This meant in effect the practical end of the moratorium on GM crops 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 commercialisation 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 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 its adoption, the coalition against GM crops 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 mobilised 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 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 GM crops in Brazil in 2011, a function of its inability to mobilise opposition and debate following the approval of the Biosafety Law.

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 Brazil.[2] 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 Brazil.[3] 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 mobilisation and in the construction of alternative notions of scientific citizenship (Callon *et al.* 2009; Macnaghten and Guivant 2011; Jasanoff 2011). AS-PTA actions include the rescue of native seed for smallholder 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 criticising 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 GM crops has attempted to influence the approval decisions of CTNBio through the courts, with some success. In 2007, for example, members of the coalition filed a claim against the federal government contesting the decision of CTNBio to authorise 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 GM crop varieties. Nevertheless, despite some achievements that have helped to slow down or halt the decision-making process,[4] approvals of GM crops have continued at a 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. All the GM plants have been modified to be either herbicide tolerant or insect resistant or, in some recent cases, for both.

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 2013), 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 per cent of the global biotechnology 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 per cent were GM crops. Notwithstanding questions

surrounding the reliability of these figures (for a critique of the methodology used by PG Economics in putting together such figures, see Food and Water Europe 2012; see also Dominic Glover's commentary in Chapter 8, this volume), 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-GM 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 GM crops as a moral and political crusade, using arguments from bioethics, smallholder 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 their implications for increased herbicide use.

The field ethnography

The fieldwork ethnography in Brazil was conducted in the western region of the southern state of Santa Catarina between January and February 2013. The region was chosen as the research site because of the historical, social, economic and political relevance of its family farming traditions; the general pattern of income distribution and land occupation in the region, which is less concentrated than in other regions of the country; the fact that the region is one of the original sites of contemporary land reform and women farmers' movements in Brazil; the degree of heterogeneity of organisational forms in family farming economic activities (including collective production); and the growing adoption of GM soya bean and GM maize as the main crops in local farming practices. As with the other case studies, our research focused on ethnographic participation with smallholder family farmers and with representatives of NGOs, extension agencies and private companies (mainly seed industries, cooperatives and agro-industries) that provide technical assistance to farmers. We ran thirty-one interviews and undertook observation visits at agricultural product fairs (called 'Field Days'), ran by cooperatives in the region. In addition, we participated in meetings of trade unions and family farmers organisations.

In recent years, the western region of Santa Catarina has undergone a serious economic crisis exacerbated by 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

TABLE 3.1 GM crops in Brazil: chronology of events

Date	*Event*
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-tolerant 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 GM 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 commercialisation 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 establishes 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 per cent of the global biotechnology crop. Brazil has become the world's second largest producer of GM crops, behind the United States.
2008	A new alliance develops promoting non-GM 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.

about unhealthy eating practices, about pesticide residues in food and about the overuse of agrochemicals in agriculture. Within this group of farmers were two clusters:

- Farmers cultivating non-GM organic soya and other organic horticulture products including creole maize – this cluster was composed of smallholder organic farmers who cultivated creole maize seeds, many of which had been distributed free of cost through regional, state assisted small-scale cooperatives. In addition, Epagri (the rural extension agency of Santa Catarina state government) had provided 'improved' creole seed varieties that had been bred to be more resilient to pests and resistant to droughts than traditional varieties. However, in our research we found that farmers worried that these seeds were not a good long-term option for a variety of reasons: because their preferential offer had been reduced and because they were not perceived to be as resistant to climate variation as GM seeds. It can be predicted that these seeds will continue to lose market share in the face of the continued predominance of GM seeds. For some farmers, creole maize was used to feed dairy cows especially for personal consumption where farmers were concerned that GM maize could 'contaminate' their cows' milk, given the perception of outstanding uncertainties on grounds of safety and perceptions of improved taste.
- Farmers cultivating non-GM creole maize and conventional soya seeds – this cluster of farmers had abandoned organic production for reasons that included the adventitious presence of GM crops (and associated problems of pest control) from neighbouring farms. GM crops were seen to be responsible for the spreading of pests to their crops, which had proved to be very difficult to control, thus endangering coexistence. These farmers claimed that neighbouring farms had not respected the segregation distances required by law and that herbicides had been spread by neighbours onto their farms using tractors – for some 'in total disregard'. These farmers were critical of GM crops and associated farming practices, and tended to emphasise the environmental and health problems the latter may cause. The land was seen as already 'intoxicated' and as needing to be 'detoxed', just as one would with regards to one's health.

Farmers cultivating GM crops

Farmers cultivating GM crops in our sample were small and medium-scale farmers, who had followed the trends facilitated by the most important regional cooperatives (like Cooperalfa). These were capitalized farms that exhibited a significant infrastructure for production and that were open to what was considered as 'progressive' and 'modern' technological innovations.

- Farmers cultivating GM soya and creole maize seeds – a number of these farmers had previously been swine and poultry producers involved in contract farming. First, they had changed to dairy milk production and later to GM soya bean cultivation. They tended to display a well-organised administration and were market oriented. Many continued to cultivate creole maize, especially for local family consumption, because they found the taste of the maize sweeter and the content richer in proteins than GM varieties. The function of GM soya bean cultivation was to sell to the cooperatives. For them, the main advantage of GM soya was that it is easy to plant and that it reduced costs, principally because pesticides needed to be applied only once. With the conventional seed, they need to clean the '*inço*' (weeds), and apply pesticides many times.
- Farmers cultivating GM seeds only – again, for these farmers the main advantage of GM soya and maize was the ways in which GM crop technologies had simplified working practices. With conventional crops, farmers had needed to be much more precise about the amount of agrochemicals used and when to apply them. GM crops, as one of them described, are 'beautiful, grow quickly and are clean'. However, even these producers tended to avoid direct consumption of GM food products, reserving some of their subsistence farming for the use of conventional or creole seeds, particularly maize. Practically all of animals used in meat production were fed GM soya and maize.

Factors mediating concerns over GM soya and maize

Gender

Gender was a factor mediating farmers' perceptions of GM crops, derived from a clear division of labour that continues to endure around agricultural practices in the region. We found that women largely produce vegetables and fruit for family consumption and take care of 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. We found that the women who were most active in the production process tended to be those involved in organic production or in the cultivation of creole maize. In our research, these women spoke enthusiastically about their values and about their engagement in wider activities outside the farm (for example, the women farmers' movement). One example was a woman farmer from a farm that centred on milk production and the cultivation of creole maize. She was part of a women's group of farmers that produced and exchanged seeds of different vegetables, including a type of lettuce (*rabicho*), among others. They met once a month and exchanged information and seeds. These women were also involved with the cultivation and exchange of medicinal herbs, something very valuable in the region, given that these are used both for human health and well-being as well as for animal husbandry. These women also played a critical role in the handling and preservation of creole seeds. Although some of these women did not seem to worry

about eating GM maize, most associated healthy food consumption with non-GM (and preferably organic) products. For the group of women who worked with GM crops, grain crops tended to be represented as 'men's issues'. Some women farmers even found it hard to provide specific information on arable crops in their farms, for example on areas under cultivation, or on the types of seed used. The women tended 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). These women appeared to be marginalised from decision-making processes on arable production, and thus from the question of whether or not to adopt GM crops.

Food practices

We found that the food practices of farming communities had changed significantly in the last few decades. Some food recipes used in the preparation of meals were still traditional but the ingredients used were increasingly bought at local supermarkets. For example, in the preparation of traditional *polenta* with maize, farmers now tended to buy the flour from supermarkets, whereas when these female farmers spoke about how it had been when they were children, everything then had been produced at the farm. Nevertheless, some farmers still produced creole maize using a traditional windmill in their locality to make flour, which they would then keep frozen for consumption all year round. Mainly organic farmers were careful about sustaining this tradition not least because they wanted to make sure that the ingredients they were consuming had not been 'contaminated' by pesticides. For the farmers cultivating creole and conventional maize, the former was preferred for family consumption not least because the taste was perceived to be sweeter.

Farmer–expert conflicts

In a number of interviews with stakeholders in the region, we identified tensions between farmers who had adopted GM seeds and technicians from seed companies, as to the cause of the problem of weed resistance that was being witnessed increasingly with GM crop production. Both farmers and representatives of major seed companies operating in the region (Pioneer, Monsanto, etc.) both recognised the problem and tended to blame each other for it. The increasing resistance of some weeds to glyphosate herbicide used on GM soya is already widespread in crops across the three southern Brazilian states (Rio Grande do Sul, Santa Catarina and Parana). In infected crops, the fall in productivity can reach 40 per cent, not counting the costs associated with the need for increased herbicide use and the loss of quality of soya bean due to higher grain moisture and impurity. In our research, we found that technicians from the seed companies complained that farmers were not following recommendations: for example about maintaining a buffer zone between GM and non-GM crops, or doing crop rotation. Not adopting such precautionary measures was for the seed company representatives the source of increased weed resistance. For them, farmers were 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.
>
> *(Monsanto Roundup Ready technician)*

From the technical experts' point of view these 'bad' practices were seen as having been triggered by farmers' desire for 'short-term' profit:

> They [farmers] see profit; they only want profit. Soya bean prices are good, so they see no need to rotate [soya] with another product; but they are going against themselves because [subsequent] weed management is complicated and expensive.
>
> *(Monsanto Roundup Ready technician)*

Farmers who already were facing the problem of weed resistance, however, claimed that they were not the ones responsible for this situation and that the problem of weed resistance had arisen because the technology had not fulfilled its claimed promises. However, these farmers hoped and believed that 'science' would find new alternatives:

> Will there be a day when things [referring to herbicide tolerant weeds] will be put right? [Yes] Because science tries to evolve. I believe, I hope, that with more research things will work better for us. We depend on it [science] for our health, and for the wellbeing of animals and farming. We depend on researchers and those who are in search of new knowledge.'
>
> *(Farmer)*

Interestingly, in our research we found that representatives of small cooperatives tended to side with the farmers, blaming the technicians of the seed industries (and not the farmer) for the problem of weed resistance:

> What we observed was that farmers had planted GM crops without following any of the recommendations, without even knowing the law. The law requires the use of buffer zones. Yet, farmers are tricked by technicians from seed companies who say that GM crops are cheaper, that they yield more – which is a lie, because they do not produce more. If you take a variety of Pioneer GM seed and another non-GM variety, they yield just about the same.'
>
> *(Farming cooperative representative)*

This understanding of the conflict, as explained in terms of the different attribution of blame by actors, points to the active role of users in shaping their relationship with technology, and in this case to key differences in the use and adoption of GM crops by farmers compared to those assumptions designed into the technology by innovators. Indeed, one has to ask whether the problem of weed resistance is a product of unrealistic assumptions being built into the design of the technology system? The discipline of science and technology studies (STS) has a long tradition of research that has examined the relationship between design preconceptions in innovation architectures and the future uses of those systems in practice (Bijker and Law 1992; Winner 1986). Akrich and Latour (1992: 226) use the concept of an 'anti-programme' to describe user actions that do not align with designer's scripts about what ought to take place. They further offer the term 'de-inscription' to describe the period of adjustment that needs to take place between idealised use (or those uses assumed to take place by designers) and actual use in everyday practices in the real world. In our research we saw that this 'de-inscription' has yet to take place. With little recognition by representatives of the seed companies of the everyday lived realities of farmers, and thus of the implausibility of prescriptions and recommendations being operationalised into agricultural practices, it is difficult to see how this conflict will be resolved or settled in the near future. Whether farmers continue to buy the promises and apparent 'hype' of the seed companies in the medium term future remains an open question.

To summarise, we found that those farmers who had not adopted GM crops had found themselves pushed to the margins of the productive system, and to have needed support for sustained non-GM crop cultivation from small regional cooperatives, NGOs and local markets. Many of these farmers had become involved in the production of organic horticulture and in the sowing of creole seeds of maize, both for animal feed for domestic production and for direct consumption. There were a number of important perceived advantages in the adoption of GM seed from the point of view of farmers: 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. Although there was some degree of coexistence of GM seeds with creole and hybrid varieties, we found that coexistence practices were often not harmonious, and that alternatives to GM agriculture were 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 were being raised about GM crop technologies. GM crops had tended to be accepted on pragmatic terms, whether as survival for smallholder farmers, as market rationale for cooperatives, large agribusiness companies and governments, or as competitive innovation for scientists and technicians.

However, it is far from clear whether the perceived advantages of GM crops will be sustained in the long-term, especially in relation to the promises and claims of benefit from the seed companies. Indeed, one can suggest that there exists at present a degree of hype in relation to GM crops, defined as an 'overestimation of the significance of a new discovery, invention, or application of science and a focus more on the benefits and less in the risks' (Master and Resnik 2013: 324). So far, the acceptance of GM crops, and their embedding in everyday farming practices, have been sustained by a widespread belief that GM crop technologies will continue to simplify agricultural production and that they will continue to improve farmers' livelihoods. Indeed, this belief is dependent on the assumption that if difficulties emerge downstream – and are happening in relation to the increasingly persistent problem of so-called 'superweeds' (i.e. weeds resistant to the herbicide that is part of the GM technology package) – that these problems will be overcome through further scientific innovation and advance, involving typically more advanced GM crop technologies. Whether this belief will be sustained in the future remains again an open question.

Interviews with stakeholders

Using a list of open questions we undertook a series of face-to-face interviews in the west of Santa Catarina, with representatives from a public research centre, a social movement organisation, a NGO and with technicians from seed companies. We also undertook an electronic survey, identical to what was used in the other national project case studies, which we sent to over two hundred people in the region, with a 12.5 per cent return rate. The majority of the respondents were highly educated, holding either a PhD or a master's degree. About two-thirds of the respondents were male. Nearly all of the respondents considered themselves 'well' or 'reasonably informed' about debates on agricultural biotechnology. Yet a clear minority of those sampled expressed positive opinions on how open or how accessible the debate of GM crops and foods in Brazil had been, up until now.

We found that representatives from NGOs and from social movements deployed an anti-GM discourse, using predominantly principled arguments in their opposition to GM crops. In interviews with scientists and with technicians from seed companies, in contrast, the debate tended to be framed around the opposition between 'modern' (GM) and 'backward' (non-GM) agricultural practices. But virtually all stakeholders were well aware of one dynamic: the increased operation of major multinational agricultural corporations in the region (such as Pioneer, Monsanto and Dow), heavily impacting on the local economy and on local farming practices. Indeed, notwithstanding the views of some hard-core scientists, there was often some sensitivity from actors that GM crops, and the more intensive agricultural systems of which they are part, posed potential negative and long-term impacts on traditional forms of life and local cultures. It was also clear that despite the widespread uptake of GM crops, many stakeholders felt 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. Many also raised questions about the lack of participation in technical decisions and the apparent disregard of social actors affected by them.

Opinion on GM crops

In the questionnaire responses, there were conflicting views on respondents' general opinions on GM crops. When forced to choose only three responses (out of 13 options) a significant number of respondents aligned their opinion with negative claims. A significant number of respondents agreed that GM agriculture 'creates dependency on seed industries' (48 per cent), that GM agriculture 'may cause problems to the environment and/or to human health' (45 per cent), that 'GM agriculture actually worsens conditions in rural areas' (31 per cent), that GM agriculture 'destroys local cultures and traditions'[7] (31 per cent) and that 'GM crops are definitively harmful to human health and the environment' (17 per cent). Responding to positive claims of GM agriculture, a number of respondents agreed that GM agriculture constitutes a 'beneficial scientific advance' (38 per cent), that GM agriculture 'helps towards feeding the world' (21 per cent), that GM agriculture helps Brazil to become 'economically competitive and to enter global markets (14 per cent) and that GM crops provides 'benefits for the economic development of the country' (14 per cent). 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', while the three positive claims were 'scientific progress', 'global food security' and 'economic competitiveness'.

Openness and efficacy of the public debate on GM

Although the large majority of respondents (around 70 per cent) agreed with the claim 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 had been limited (80 per cent). Respondents also tended to agree with the claim that the technology had made little in-roads into solving current problems on agricultural innovation and food security (45 per cent). One reason may refer precisely to the lack of opportunity for widespread participation, as indicated above, which was viewed by respondents as having 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 scored at least 3.4, whereas smallholder farmers, consumers, women, indigenous and religious groups never scored higher than 1.4. 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 had 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 knew that formal decisions are taken mostly within technical committees with only marginal formal representation from non-academics. Indeed, whereas people view scientists as their main source of authority of these issues (over 55 per cent choose scientists as an authoritative source, or an average 4.3 out of 5), decisions were seen as not solely guided by science, since corporations and large producers were also seen to have influence, thus demonstrating a particular social and political bias. Down the scale, indigenous groups, religious groups, women's groups and consumer organisations featured lowest in having the least perceived power to influence decisions. While business-people and large farmers were by far those who were seen to benefit most from GM agriculture, indigenous people, religious groups and women were seen as those who would be the most disadvantaged. Smallholder farmers still clearly lose out, consistently scoring around 1.3 on average.

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 were highly valued, they tend to differentiate as one approaches issues of evaluation and implementation. Responding to an open question on who should take part in decision-making processes, the majority of respondents promoted the idea of independent, science-based technical committees. However, respondents differed on the latter's composition: whether these should be composed of natural 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 of scientists as critical actors in decision-making processes. 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 movement actors (seen as tendentiously radical), seed industry representatives or scientists working for the seed companies. A few replies focused on social actors who were seen as having inadequate knowledge to be involved, including indigenous groups, who were rarely seen as having a special stake in the issue.[8] A similar logic applies to religious groups, who were thought not to be relevant or to be an appropriate voice to be taken on board in the discussion of GM issues.[9] When asked about which actors should have additional influence in the decision-making process, besides scientists, there was a significant stress on the role of consumers.

Ethnography at a research laboratory

The laboratory ethnography was undertaken at the soya research division of the Brazilian Agricultural Research Company (Embrapa), located in Londrina, in the

southern state of Paraná.[10] The research took place on two separate occasions: the first, involving the application of a questionnaire and some secondary data collection on the operation of the unit, followed by 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, spread 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 per cent 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 among 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 approval of GM crops in 2005, CNPSO scientists divided into two groups: the majority were in favour of the immediate release of GM crops whereas a smaller group of scientists 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 GM crops. However, the arguments promoted by Embrapa scientists tended to focus on questions of national sovereignty: for them it was critical to develop a strong national science base to make it competitive, to undertake their own GM crop research and to avoid technological dependence on outside foreign corporations. In 2001, the Biosafety of Transgenic Products project 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 GM products.

Interviews with scientists working for CNPSO indicated that they viewed GM crop technology as providing clear potential both to improve food quality, to further Brazil's economic interests and to help feed a growing global population. For them, GM crops were seen as critical to further the national priorities of developing countries. However, in contrast with Embrapa's major achievements in the past, in recent years the organisation had lost ground to multinational biotechnology companies who had 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 per cent of soya bean cultivars in Brazil; by 2013, that figure had dropped to only 7–8 per cent. Embrapa scientists attributed this decline in market share to a combination of factors that included 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 crop technology, they suggested, lay 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, including those with added genetic resistance to pests and major diseases. GM crop 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 no evidence that the risks of harm to the environment or to human health to be 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 was seen as positive given that it opens up apparently limitless possibilities for research (and subsequent application). Genetic modification was seen as allowing for the indefinite extension of human intervention in nature. Researchers also stressed that the use of new technologies should not be 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 their adoption of GM crops, in a few years plants and insects would become resistant, as was seen to be 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 GM crop technologies. 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 widespread adoption in Brazilian agriculture.

When considering the role of the wider public, Embrapa researchers had a tendency to reproduce the same kinds of arguments that are available on the official website of CNPSO. The arguments were simple and tended to be based on instrumental reasoning. The CNPSO researchers emphasised the economic benefits of GM crops, the benefits of GM seeds such as those that offered resistance to diseases, as well as the potential for GM crops to lock in improvements in nutritional compounds. All the above were seen as promising benefits to the consumer. The researchers did not offer much in the way of explanation for the endurance of scientific controversies on GMOs or on the potential risks associated with scientific breakthroughs. They were 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 overall decreased productivity and higher prices. Legal and funding constraints on the development of research and partnerships were seen also to reproduce external technological dependency, which did not help poorer (or scientifically more peripheral) countries or research communities, including Embrapa itself. When questioned if human beings have the right to modify the natural structure of the soya genome, 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? As one researcher stated, '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 were not willing to endorse any and every kind of possible GM plant intervention, but called for case-by-case discrimination. Embrapa researchers admitted that farmers or society at large had not requested GM crop technology, and that 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 per cent of the market.

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 had to date been restricted largely 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 crops and eat GM food products. 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 the general public who will be affected by the technology, even in the absence of whether the public had intentionally chosen or not to eat GM foods.[11]

This understanding also leads to the 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 a debate with society is not a practice of the laboratory, and considered this a communication failure, even though a number of them considered the regulatory committee CTNBio to be a more 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 who 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 sector 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.

Focus groups with lay publics

As observed in Chapter 1 of this volume, we know very little about what ordinary publics think about GM crops and foods, including in Brazil.[12] We know little about whether people are generally for or against the technology. We know little about how people think about the technology. We know little about how public opinion is structured across age, gender and social class. And we do not know what social factors are important in structuring public responses. Brazil presents an interesting case given the strategic importance of (GM) agriculture to the Brazilian economy and due to the fact that Brazilian publics have been eating GM foods now for over a decade. Indeed, in the absence of a sustained research effort, more or less all that we know about public attitudes is that most people appear to know very little about GM technologies and their application in crops and foods. This is perhaps not surprising given that there has not existed a sustained effort by institutional actors – government ministries, funding agencies, regulatory bodies, seed

companies, NGOs or the media – to inform public on GM foods and crops or to enter into dialogue on the issues associated.

Our research on Brazilian publics was conducted to help fill this gap. The research involved the design, conduct and interpretation of five in-depth focus group discussions, which took place in Florianopolis in the state of Santa Catarina between November 2012 and February 2013. Our research methodology 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 who could be claimed to have 'settled' or 'informed' views. The focus group discussions 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 up to 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 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 men and women with strong religious beliefs, 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.

The materials were developed by the authors and presented using a data projector. Aligned to the focus group discussions conducted in the other national case studies, the 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 labelling schemes and their potential for GM technologies to create new kinds of foods. Subsequently, current debates on GM crops and foods 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 discussion participants explored the responsibilities and roles of different actors in the debate, including their own.

We found that food was a topic of growing salience for Brazilians. In all the group discussions, 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 industrialisation 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 life stages, 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, while people tended to trust expert systems, including science, they 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.

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 food 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 and clearly informed. 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 GM crops and foods 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); they had not apparently produced environmental benefits (a number of participants were aware of the expanding use of synthetic pesticides in Brazilian agriculture, including the use of products banned in other countries); they had produced few apparent health benefits (only unknown long-term risks); they were viewed as benefitting the large producer at the expense of the traditional family farmer; they were seen as providing foodstuffs principally for animal feed and thus as having had little practical impact in feeding the poor; and they were perceived as being regulated by interests which were not purely scientific thus questioning the impartial and public authority of science (an institution that tends still to be trusted in Brazil). And in addition, when asked to reflect on the label that is currently used in (some) food packaging to denote the use of GMOs – a small T sign set in black against a yellow triangular background with the associated text that it had 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 (names have been anonymised):

NICO: Here you see 'tested and approved': it's all hype! And that goes for everything we consume, since more and 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 moving everything into the hands of science and … '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 [crops] 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).

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 their claims in providing solutions to world hunger and global food security, their role in contributing to national economic competitiveness and their 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 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) appeared to 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 character, involving more than simply the production and allocation of increasing quantities of foodstuffs to 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 that were in some way related to commerce.

We then explored how people perceived key actors involved in the debate on GM crops including government, regulators, large and smallholder 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. Participants called for government to be held to be responsible for regulation, for safety assurance, for consciousness raising and for the promotion of the public interest. Interestingly, few people considered that the government had fulfilled these obligations so far in a credible manner. Participants called for scientists to be responsible for the conduct of research in the public interest, and for universities – and to a lesser extent schools – for be responsible for fostering critical and participative citizens through education.[13] The responsibility of NGOs, participants suggested, should be to bring information into the public realm. 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 cannot provide all the answers – I think science cannot [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.

(Professional men)

Deliberative workshop with stakeholders

The final element of the research was a Brazilian workshop organised with national stakeholders on the theme of GM crops and which was held in Florianopolis in Santa Catarina.[14] The workshop was divided into a series of presentations of preliminary results of the field research, followed by plenary discussion, followed by a deliberative session with participants. The presentations included short talks on the ethnographic field research with smallholder farmers, the ethnographic laboratory research with CNPSO (Embrapa Soja), and the focus group research with urban publics. The deliberative session was divided into small group work followed by a plenary presentation of each group's conclusions followed by plenary discussion. The workshop generally aimed to foster reflection and informal group deliberation on the research preliminary outcomes and to explore whether and how to 'open up' the debate on GM crops within current considerations of 'political economy'.

Participants were drawn from a range of governmental, civic and private organisations representing scientists, traders, social activists and smallholder 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).

Though basically considered as an issue that has been '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 were seen as revealing large gaps in public knowledge, disputed evidence as to the benefits of GM crops, and distinct social impacts arising from its pattern of adoption by smallholder farmers, women and consumers. With few exceptions, the 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 decision-making. Though the priorities and suggested actions were not directly equivalent across 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 to take responsibility to clarify issues on GM foods 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 crop and food debates. The suggested actions were to organise deliberative policy conferences (a participatory tool that has had significant impact in Brazil since the 1990s) on GM agriculture, to promote related mobilisations such as at agricultural fairs, to campaign for GM-free zones and to make activist use of social media. Group 3 prioritised educational activities, through the use of public events and the internet. In summary, educational activities were targeted as a way forward, with particular roles allocated for governments and for organised civil society. The state was seen as a major nodal point in the various recommendations, being asked to mediate, to promote informed debate and to provide participatory channels for public deliberation.

Despite a few disagreements during the discussions, some of which were sharp (particularly between scientists, farmers and anti-GM activists), the choice of priorities was developed without significant glitches. An underlying acknowledgement was that even though ordinary lay Brazilians had not shown explicit interest in the GM crop and food question, communication and education was needed to raise the public salience of the issue. This proposed action was seen as supported by the urban publics in the focus groups who while generally unknowledgeable on this issue, nevertheless called for rigorous and unbiased information on GM crops and foods, 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 was not enough, because of how the media was seen as likely to contribute to fragmented and disputed views, thus potentially contributing to further 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 necessary. 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.

Conclusions

The key findings from the Brazil case study are now summarised. 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 and governmental and legal actions. We found that the story of GM crops in Brazil had been 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 their 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 crop technologies had been adopted into local agricultural 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 smallholder farmers, as market rationale for cooperatives and producers, or as competitive innovation for scientists and technicians. Especially women and those working in organic agriculture 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 (CNPSO) of the state-owned agricultural research organisation Embrapa, located in the southern state of Paraná. We found clear and unqualified optimism among scientists on the role of GM crop technologies to provide significant future agricultural improvement, and to produce 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 crop technologies to provide 'improvements' and the necessity for agricultural 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 publics on Brazilian 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 industrialisation 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. Notwithstanding a general trust in expert systems, including science, participants adopted largely negative opinions to GM crops and foods in the discussions, not least because the technology was seen as benefiting the producer (not the consumer) and because they had not been consulted or clearly informed. 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.

Sixth, 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 organised 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 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 policy-making, which continues despite changes to the structure and culture of the Brazilian 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.

Acknowledgements

This chapter reports on empirical work that was carried out at the Institute of Research in Risk and Sustainability (IRIS) at the Federal University of Santa Catarina (UFSC). We are grateful to the wider IRIS team for their participation and support in conducting the research, and in particular to Adilson Alves, Naira Tomiello and Laura Guerrero. We are also grateful to Joanildo Burity for his insights for the review section and for help with the deliberative workshop.

Notes

1 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.

2 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).

3 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).

4 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 IDEC 2013).

5 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).

6 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).

7 This rises to 52 per cent when projected towards the future of agriculture and of the country in general.

8 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.

9 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.

10 We are very grateful to Adilson Alves, who conducted the lab ethnography and who wrote the initial analysis.

11 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 the interviewed researchers who observed these dynamics from the lab bench.

12 We are very grateful to Naira Tomeillo, who co-led the focus group research and who contributed to the initial analysis.

13 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.

14 We are very grateful to Joanildo Burity for his help in conducting the deliberative workshop and for contributing to this analysis.

References

Abrange (2014) Mission, vision and values www.abrange.org/english/abrange_missao_us.asp. (accessed 29 April 2014)

Akrich A, and Latour B, (1992) A summary of a convenient vocabulary for the semiotics of human and nonhuman assemblies in Bijker W, and Law J, (eds) *Shaping technology/ building society: studies in socio-technical change* MIT Press, Cambridge MA 259–264

Bauer M, (2006) The paradoxes of resistance in Brazil in Gaskell G, and Bauer M, (eds) *Genomics Society and its Public* Earthscan, London 228–249

Bijker W, and Law J, (eds) (1992) *Shaping technology/building society: studies in socio-technical change* MIT Press, Cambridge MA

Callon M, Lascoumes P, and Barthe Y, (2009) *Acting in an uncertain world: an essay on technological democracy* MIT Press, Boston MA

De Souza Z (2011) Gestão e sociabilidades do trabalho em rede – as relações de trabalho em novos formatos organizacionais http://gvpesquisa.fgv.br/sites/gvpesquisa.fgv.br/files/publicacoes/Zilma%20Borges%20de%20Souza%20-%20Relatorio%20projeto%20Gestao%20e%20Sociabilidades%20em%20Rede.pdf (accessed 10 April 2014)

Ferment G, and Zanoni M, (eds) (2007) *Plantas geneticamente modificadas: riscos e incertezas* NEAD Estudos – MDA, Brasília

Food and Water Europe (2012) *Cooking the books: a methodological critique of PG Economics 2011 global report on GM crops* issue brief February http://documents.foodandwaterwatch.org/doc/FWW_CookingTheBooks_WEB.pdf#_ga=1.196585516.1406295033.1416247627 (accessed 16 November 2014)

Guivant J, (2002) Heterogeneous and unconventional coalitions around global food risks: integrating Brazil into the debates *Journal of Environmental Policy Planning* 3 231–245

Guivant J, (2006) Transgénicos e percepção pública da ciência no Brasil *Ambiente e Sociedade* 9 81–103

Guivant J, (2009) Governance of GMOs and the constraints for a definition of the public arena in Dasgupta S, (ed.) *Understanding the global environment* Pierce Education, New Delhi 354–380

Guivant J, Capalbo D, Dusi A, Fontes E, Soares C, and Pires C, (2009a) Acima dos confrontos sobre os transgênicos: uma experiência piloto de consulta pública *Cadernos de Ciência & Tecnologia* 26 11–37

Guivant J, Capalbo D, Dusi A, Fontes E, Soares C, and Pires C, (2009b) Uma experiência de consulta a setores de interesse no caso do feijão transgênico in Costa M, and Costa F, (eds) *Biossegurança de ogm: uma visão integrada* Fiocruz/CNPq/IOC/Publit soluções editoriais, Rio de Janeiro 158–189

Hajer M, (1995) *The politics of environmental discourse: ecological modernization and the policy process* Clarendon Press, Oxford

Hochstetler K, (2007) The multi-level governance of GM Food in Mercosur in Falkner R, (ed.) *The international politics of genetically modified food: diplomacy, trade, and Law* Palgrave Macmillan, Basingstoke

Hochstetler K, and Keck M, (2007) *Greening Brazil: environmental activism in state and society* Duke University Press, Durham NC

IDEC (2013) *Audiência Pública no Ministério Público Federal sobre a liberação comercial de milho e soja transgênicos tolerantes ao herbicida 2,4-D* 11 December www.idec.org.br/em-acao/em-foco/audiencia-publica-no-ministerio-publico-federal-sobre-a-liberaco-comercial-de-milho-e-soja-transgenicos-tolerantes-ao-herbicida-2-4-d (accessed 16 November 2014)

ISAAA (2013) *Brazil: biotech facts and figures 2013* https://www.isaaa.org/resources/publications/biotech_country_facts_and_trends/download/Facts%20and%20Trends%20-%20Brazil.pdf (accessed 29 April 2014)

Jasanoff S, (2011) Constitutional moments in governing science and technology *Science and Engineering Ethics* 17 621–638

Lajolo F, and Nutti M, (2003) *Transgênicos: bases científicas da sua segurança* Sociedade Brasileira de Alimentação e Nutrição, São Paulo

Macnaghten P, and Guivant J, (2011) Converging citizens? Nanotechnology and the political imaginary of public engagement in Brazil and the UK *Public Understanding of Science* 20 207–220

Master Z, and Resnik D, (2013) Hype and public trust in science *Science and Engineering Ethics* 19 321–335

Nelkin D, (1995) Science controversies: the dynamics of public disputes in the United States in Jasanoff S, Markle G, Petersen J, and Pinch T, (eds) *Handbook of science and technology studies* Sage, Thousand Oaks CA

Pacheco M, (2012) *Entrevista com Maria Emília Lisboa Pacheco – Presidente do CONSEA* http://coleciona.mma.gov.br/wp-content/uploads/2013/05/maria-emilia-pacheco_13_05.pdf. (accessed 29 April 2014)

Pinto Vieira A, and Vieira Jr P, (2005) *Direitos dos consumidores e produtos transgênicos: uma questão polêmica para a bioética e o Biodireito* Jaruá, Curitiba

Riffel C, (2002) *Comunicação na Ação das ONGs: A Experiência da AS-PTA – Assessoria e Serviços a Projetos em Agricultura Alternativa na Região Centro-Sul do Paraná* Paper presented at the XXV Brazilian Congress on Communication Sciences (Intercom) Salvador BA 1–5 September 2002

Rogers E, (1962) *Diffusion of innovations* Free Press, Glencoe IL

Rover O, (2011) Agroecologia, mercado e inovação social: o caso da Rede Ecovida de *Agroecologia, Ciências Sociais Unisinos* 47 56–63

Santilli J, (2009) *Agrobiodiversidade e direitos dos agricultores* Editora Peirópolis, São Paulo

Winner L, (1986) *The whale and the reactor: a search for limits in an age of high technology* Chicago University Press, Chicago IL

Zanoni M, and Ferment G, (eds) (2011) *Transgênicos para quem?* Ministério de Desenvolvimento Agrário, Brasília

4

AN ANALYSIS OF THE GM CROP DEBATE IN INDIA

Yulia Egorova, Rajeswari S. Raina and Kamminthang Mantuong

A review of the debate in India

The debate in India on GM crops draws on a complex mix of agrarian, environmental, legal and development discourses, woven together by pro- and anti-GM actors within a wider set of narratives on modernisation, globalisation and nationalism. Before we enter the arena of agricultural GM debates, we provide a brief introduction to locate the debate in the challenges faced by contemporary Indian agriculture. A key and ongoing political challenge in India is how to feed a population of 1.1 billion (and growing). Given that this population will bring with it the demographic dividend of a young workforce, the demand for food as a condition for sustained industrial growth is a key driver of India's macro-economic policies. According to global development data collected by the World Bank, unlike Brazil and Mexico, where agriculture accounted for 11 per cent and 9 per cent of the national GDP in 1980, and 6 per cent and 4 per cent in 2010, the figures in India were 36 per cent in 1980 and 19 per cent in 2010. If this presents a hopeful sign of sequential development, as countries progress from agrarian to industrial economies, the problem of structural unemployment in India denies that hope. With the share of the rural population in the country at just over 70 per cent of the total population in 2010 (compared with 14 per cent in Brazil and 22 per cent in Mexico), India's population remains predominantly agrarian and rural, constituting in 2011 around 55 per cent of the total workforce, or a total of 263 million farmers and labourers. Of these 85 per cent are marginal or smallholder farmers (i.e. they cultivate less than 2 hectares of land) who farm 44 per cent of the total acreage under cultivation (Ministry of Home Affairs 2011; DoAC 2011). Indian agriculture is indeed the 'last bastion' of the peasant farmer (Hobsbawm 2007).

India is one of 17 megadiverse countries, as defined by the environmental organisation Conversation International, and home to four of the largest