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Framing GM crops as a food security solution

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A B S T R A C T

The spectre of a food security crisis has raised important questions about future directions for agriculture and given fresh impetus to a long-standing debate about the potential contribution of agricultural biotechnology to food security. This paper considers the discursive foundations for promotion of agricultural biotechnology, arguing that notions of progress and 'science-based' risk assessment act as 'anti-political' strategies to remove consideration of genetically modified organisms (GMOs) from the cut and thrust of politics, while the concept of 'food security' reconstitutes agricultural biotechnology as a moral imperative. We argue that a debate ostensibly focussed on developing countries in fact largely arises from discordant views about the future of farming and rural areas in the developed countries where these arguments are taking place. These debates are examined through a comparative study of the UK and Australia. Whereas acceptance of GM crops and foods at government and industry level has not led to commercial adoption in the UK due to consumer resistance and the influence of EU regulations, Australian governments at federal and state level have increasingly embraced GM crops, potentially locking Australia into a food and farming trajectory based on agricultural biotechnology.

1. Introduction

Food security has recently re-emerged as an issue globally, following a decline in food stocks and associated sharp rises in food prices in 2007/08. While this crisis appears to have passed for the present, awareness remains of the potential fragility of global food provisioning under the combined pressures of population growth, increasing demand from more affluent population sectors and climate change, which threaten to reduce food production and disrupt supply chains. This understanding of food *insufficiency* as an impending problem is perceived differently both between developed and developing countries, and also between those developed countries predominantly dependent on imported foods, such as the United Kingdom (UK), compared with those that are food exporters. Thus, for a food exporting country such as Australia, the impact of the food crisis was mainly positive (higher export prices for Australian producers), while the high proportion of food produced domestically cushioned Australian consumers from major price escalation. Even so, for the first time for many decades, food security came to public attention as an emerging problem for Australia. For European countries such as the UK, the debate has not only been about ensuring domestic food security, given reliance on imports for many foodstuffs, but also about the prospective contribution of the UK – particularly British biotechnology research – to global food security (see, e.g., Royal Society, 2009; Tait and Barker, 2011).

The spectre of a food security crisis raises important questions about future directions for agriculture and has given fresh impetus to a long-standing debate about the potential contribution of agricultural biotechnology to food security. Proponents of genetically modified organisms (GMOs) – particularly GM crops – argue that the technology can make a vital contribution to increasing agricultural production, improving livelihoods, and enhancing food quality in the developing world. In contrast, critics believe agricultural biotechnology undermines food security.

The remainder of this paper is structured as follows. In the next section, we consider the discursive foundations for the embrace of agricultural biotechnology. Whereas notions of progress and 'science-based' risk assessment act as 'anti-political' strategies to remove GMOs from the cut and thrust of politics, the concept of 'food security' reconstitutes agricultural biotechnology as a moral imperative. We then outline the arguments and counter-arguments concerning the role of biotechnology in relation to global food production and security in developing countries. Feeding into this conflict are disagreements about the use of science and

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probabilistic assessments to approve risks which have societal and moral implications, and the perceived dominance in policy-making of business and technological solutions over considerations of social welfare. In Section 3, we argue that a debate ostensibly focussed on *developing* countries, in fact, largely arises from discordant views about the future of farming and rural areas in *developed* countries. These divergent views are represented as alternative paradigms, contrasting high-input, high technology farming, in which transgenic technology plays a vital role, with an agro-ecological approach which views this technology as both unnecessary and risky.

This establishes the theoretical context for an exploration (in Section 4) of how biotechnology governance plays out within the specific national contexts of Australia and the UK, and raises questions about the feasibility of maintaining alternative paradigms in these two countries. While the outcome is still uncertain in the UK, we argue that the permissive regulatory environment and strong government support for GM crops risk locking Australian agriculture into a food and farming trajectory dominated by agricultural biotechnology interests.

These two countries have been selected as case studies because they share similar systems of neoliberal governance and regulation, but have adopted different paths towards adoption of agricultural biotechnology. This combination of similarity and difference provides insights into the mixed influences which contribute to national policy formation. Differences between the two countries arising from their geographic locations and different historical paths, and the importance of agriculture in their economies, will be considered in detail below. Precedents for undertaking a cross-national analysis of this kind are provided by the comparative studies by Wright (1993) and Jasanoff (2005)[1] of the UK and the United States in relation to adoption and regulation of genetic engineering.

This paper draws on research undertaken by the authors since 1999 on regulation of agricultural biotechnology in Australia and the UK (Cocklin et al., 2008; Gibbs et al., 2008), on the influence of global 'harmonisation' initiatives (Dibden et al., 2011) and, since early 2010, on food security and the part it plays as a discursive concept in GM debates. This research has consisted primarily of an examination of documentary evidence (such as government reports and websites; media releases, newsletters, reports and websites of anti-GM groups; public enquiries and news items).[2] In addition to investigating Australian and UK policies and debates, primary and secondary sources on EU policies and regulations were also examined in order to tackle what Jasanoff (2005, p. 39) describes as "a central methodological problem confronting a comparative analysis" of one nation state (in this case, Australia) with an EU member-state, namely, "what to do about the role of the European Union."

In examining the policies and actions of government and corporate players, we pay heed to Roff's (2008, p. 1424) contention that work centred on the "strategies used to legitimise or oppose biotechnology's advance" has tended to focus "largely on dominant discursive justifications and has not yet grappled with the multiple ways in which the present regime is contested and stabilized." In our account of the mobilisation of food security discourses in relation to contested agricultural futures in the UK and Australia, we consider the means by which agricultural biotechnology has been introduced and entrenched or resisted. In particular, we are interested in the struggles over the on-going rollout of permissive regulations expediting the commercialisation of GM products and legitimised partly by the supposed necessity to 'feed the world'.

2. Constructions of agricultural biotechnology

Underlying much of the support for agricultural biotechnology is its identification with the notion of 'progress' – that is, with "universal, a historical claims that genomic technology and transgenic crops represent 'progress for humanity'" (Bridge et al., 2003, p. 165). Following Latour, Bingham (2008) argues that the notion of progress involves a "politics of time" – indeed, "time passes as if it were really abolishing the past behind it" (Latour, 1993, p. 68). Thus, from the modernist viewpoint, progress has only one alternative, 'craving' or yearning for the past or what Latour (1993) calls 'decadence'. Such hegemonic constructions of progress cancel out the possibility of alternative trajectories, whether from the past or the future. The concept can therefore, Bingham (2008) suggests, be described as 'anti-political'. This term, coined by Barry (2001), refers to practices of framing political activity in ways which may be seen as "suppressing potential spaces of contestation" and "placing limits on the possibilities for debate and confrontation" (Barry, 2002, p. 270). Practices of this kind are viewed by Swyngedouw (2010, p. 214) as a feature of recent decades, which have been marked by:

> … deepening processes of de-politicization characterised by the increasing evacuation of the proper political dimension from the public terrain as technocratic management and consensual policy-making has sutured the spaces of democratic politics. … This post-political frame is structured around the perceived inevitability of capitalism and a market economy as the basic organizational structure of the social and economic order, for which there is no alternative.

For states and regions, progress is equated with technological innovation and economic competitiveness. For agriculture, progress has been equated with technologically sophisticated solutions to pressures to produce more food and fibre: these solutions were represented initially, in relation to developing countries, by the so-called 'Green Revolution', but more recently by a biotechnology-driven 'Gene Revolution' (Thompson and Scoones, 2009). This new approach is primarily funded by private capital and underpinned by notions of scientific advancement and competitive advantage. As McAfee (2003, p. 215) comments, in debates about the supposed benefits of agricultural biotechnology, "the ideas of market-based management and scientific progress are so entrenched that it is difficult to muster the discursive resources to challenge them". In Australia, these notions have resulted in the belief that Australia will be 'left behind' by competitors adopting this new technology unless it moves quickly to facilitate the development and commercialisation of GM crops (Dibden et al., 2011).

The narrative of progress also underpins the optimistic approach to agricultural biotechnology expressed in the risk assessment procedures adopted by the United States and subsequently promoted through the WTO – a model followed by the Australian government. In order to meet WTO requirements, risk assessment must be 'science-based' and confined purely to a consideration of risks to human, animal or environmental health. As Donaldson (2008, p. 1557) argues: "Talking of a situation in terms of risk is a way of shifting it away from the political – away from open debate – and towards the technical, calculative practices of risk management … So risk politics has an 'anti-political' dimension" (see also Barry, 2002).

[1] Jasanoff's comparative study of science policy cultures also includes Germany.

[2] More in-depth research, including extensive interviews with key informants, has been undertaken in Australia. This has provided insights into the Australian situation but is not drawn on directly for this paper.

In this approach, zero risk is not seen as achievable. However, the level of *acceptable* risk depends on social, cultural and ethical considerations which tend to differ between countries, yet (with the exception of certain economic consequences) these are considered *political* matters which are excluded from WTO-approved risk assessment procedures. These procedures rely solely on supposedly value-free, science-based evidence, although the objectivity of both the scientific evidence and regulators has been questioned (see, e.g., Millstone, 2007). As Bridge et al. (2003, p. 170) argue: "Biotechnology … encapsulates the paradoxes of Beck's risk society: born of the modernist impulse to modify and control nature, the processes of control over nature developed by biotechnology nonetheless create new risks and challenges that prove increasingly difficult to regulate, mitigate or legitimate within conventional institutions".

In the UK, the failure of government regulation to protect the public against an outbreak of BSE eroded public trust both in risk assessment and in government reassurances, which in turn engendered suspicion and hostility towards attempts to admit genetically modified maize to Europe in 1996 (Dibden et al., 2011). Observing this response, De Marchi and Ravetz (1999, p. 755) commented that: "The simple idea of progress through scientific conquest no longer commands assent." Thus we see that, while the various strategies outlined above – associating agricultural biotechnology with progress, and scientific assessment of risks – have attempted to depoliticise the issue, this attempt has been a signal failure. As Zerbe (2007, p. 420) asserts, "as a wicked problem, decisions concerning the scope and nature of regulation of agricultural biotechnology evoke normative dimensions that escape traditional scientific analysis but which nevertheless must be addressed" if the scepticism of the public is to be overcome. Citizens and consumers have shown an unwillingness to accept that societal and ethical concerns are irrelevant to decisions about introducing GM crops and foods. The result in many countries has been a consumer backlash which, particularly in Europe, has led to delays in regulatory approval of GM foods and crops, and financial losses for agricultural biotechnology corporations. The latter have responded to these moral and values-based criticisms by presenting a moral argument of their own – that GM food production is needed to feed a hungry world. This is by no means a new discursive device. Winston (2002, p. 215) describes Monsanto's decision in the early 1990s to deflect criticism of "bioengineered plants" by emphasising their "enormous potential to feed the poor, improve human health, and provide direct benefits for developing countries." Similarly, Nestle (2003, p. 140) reports on a 2001 agricultural biotechnology conference sponsored by major biotechnology corporations, where speakers "were intoning the mantra of the food biotechnology industry, the *theoretical* promise that its products will solve world food problems by creating a more abundant, more nutritious, and less expensive food supply."

The spectre of a food security crisis in 2008 gave fresh impetus to this debate. Food (in)security – and particularly the notion of a food crisis – can be seen as an apocalyptic imaginary similar to those identified with climate change.[3] Swyngedouw (2010, p. 219) argues that "sustaining and nurturing apocalyptic imaginaries is an integral and vital part of the new cultural politics of capitalism", which forecloses political debate:

> … the presentation of climate change as a global humanitarian cause produces a thoroughly depoliticized imaginary, one that does not revolve around choosing one trajectory rather than another, one that is not articulated with specific political programs or socio-ecological project or revolutions.

A similar analysis can be applied to food security as a representation of unchecked population growth, poverty and hunger. Indeed, visions of food security and climate change have frequently been connected as a joint bleak future in public discourses, with food supplies seen as prospectively threatened by climate change.

Since food security is evoked primarily with reference to developing countries, it is less immediately powerful or relevant to consumers (and others) in developed countries. However, it is supported by other emotive and guilt-provoking terms such as 'world hunger' which are likely to resonate with ethically minded consumers and citizens. Deployment of this trope by biotechnology proponents could therefore be seen as both a response and a rebuttal to the claims of advocates of fair trade and other ethical consumption practices (Brom, 2000; Clarke et al., 2007; Eden et al., 2008), and particularly to opponents on cultural and moral grounds of GM organisms and foods (Beekman and Brom, 2007; Devos et al., 2008). Food security thus provides a new discursive pivot for the debate about agricultural biotechnology, enabling issues surrounding GMOs to be transposed to a different spatial arena (the Third World) and a higher moral plane. Biotech corporations have used the needs of people in developing countries to assert the moral imperative both to increase productivity of agriculture (i.e. the quantity of food) and enhance the nutritional characteristics of food crops, thus overcoming the dietary deficits of the poor.[4] Opponents of GM technology have responded by casting doubt on the benefits of GM crops for the poor, and the motives of the corporations in pushing this justification for the technology.

What is most important for our argument in this paper is the way in which debates within developed countries have drawn upon the actual or potential benefits (or disadvantages) of agricultural biotechnology for meeting the food security needs of the Third World (domestic food security is a secondary consideration.) We are interested in the divergent positions adopted by actors and their relative influence on government policies. Arguments in favour of agricultural biotechnology come primarily from corporations, scientists and governments of countries seeking competitive advantage through developing, producing and exporting GM crops. Arguments against are expressed by non-government organisations, particularly those with an interest in environmental or social justice issues, consumers, retailers sensitive to consumer concerns, and governments of countries where public opinion is strongly opposed to GM crops and foods, industrial agriculture or to corporate control of food production.

Food security tends to be represented primarily as a matter of ensuring sufficient food supplies. In other words, the emphasis is on *quantity* of food. However, the definition adopted by the World Food Summit in 1996, and widely used since, holds that: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). In other words, in debating the prospective contribution of GMOs to food security, it is important to consider dimensions of the concept beyond basic food sufficiency: production must be sustainable, increases in production must be distributed equitably, and the food produced must be affordable and consistent with consumers' perceived needs. Broader understandings of food security thus include questions about access and utilisation as well

[3] See also Cloke (2010)'s comparison of food security to other meme' such as the 'war-on-terror' and the 'war-on-drugs'.

[4] 'Golden Rice', which contains Vitamin A, is regularly held up as the prime example of the prospective health benefits of GM technology. These benefits are contested by critics.

Table 1
Contribution of agricultural biotechnology to food security.

Components of food security	Claims of agricultural biotechnology proponents	Counter-critiques
Availability: is there enough food available through domestic production or imports to meet the immediate needs? Is production environmentally sustainable to meet long-term demands? Are the distribution systems effective in reaching low-income and rural communities?	Agricultural biotechnology represents a new Green Revolution. Promise of: • increased yields • crops adapted to different conditions: drought resistance, etc. Decreased use of agricultural chemicals.	The earlier Green Revolution had mixed results. Currently only agronomic traits (herbicide and pesticide resistance) are available. Increased yields and adaptability remain promises. Initial decreases in chemical use havebeen followed by increases as resistant crops and 'super weeds' emerge. Biodiversity and landrace crops have been damaged.
Accessibility: do the vulnerable in society have the purchasing power to attain food security? Can they afford the minimum basic diet of 2100 calories per day required for an active and productive life?	Increased yields will lead to lower prices.	Ignores inequality. Corporate control increases cost of seed purchases. Seeds cannot be saved by farmers. Small farmers cannot afford the technology.
Adequacy: does the food supply provide for the differing nutritional needs, i.e. a balanced diet, offering the necessary variety of food at all times? Is the food properly processed, stored and prepared?	Nutritionally enhanced crops, e.g., Golden Rice, will meet the nutritional needs of the poor in developing countries.	Improved nutritional benefits have not been realised. Ignores the need for a more balanced diet and socio-economic barriers to more adequate diets for poor people.

Source for 'Components of food security': WHO (2005, p. 35).

as simple availability (Ericksen, 2008; WHO, 2005). Proponents and opponents of agricultural biotechnology are sharply divided with regard to all of these aspects of food security, as outlined in Table 1. Different interpretations of the value of biotechnology for food production in less-developed countries are linked to the espousal of alternative agri-food futures for developed countries. This debate thus underpins alternative visions for future food production, what Lang and Heasman (2004) have referred to as the 'Food Wars'.

3. Alternative visions for food and farming

Conflicting discourses around agricultural biotechnology have become associated in the academic literature with divergent representations of trends in food production, supply, access and distribution. Focussing on frames for agricultural policy and practice, Thompson and Scoones (2009, p. 389) contrast a dominant "production-innovation narrative", which "relates to the application of scientific knowledge to agriculture, linked to a linear view of modernisation", with alternative narratives, such as agro-ecological approaches, which integrate farming with environmental management. A broader set of paradigms (which includes food distribution and nutritional impacts), developed by Lang and Heasman (2004, p. 21), begins with what they call the 'productionist' food supply paradigm dominant since the 1930s. This paradigm, they argue, is currently being challenged, and is likely to be replaced, by either (or both) of two competing paradigms: the 'Life Sciences Integrated' paradigm – which includes biotechnology, and the 'Ecologically Integrated' paradigm – which consists of ecologically sensitive forms of production, such as agro-ecology, organics, etc. These paradigms are both "science-informed" but very different in their implications for both food production and health (see Fig. 1).

A similar set of paradigms has been developed by Horlings and Marsden (2011), who view contrasting farming systems through the lens of ecological modernisation (see also Marsden's paper in this themed issue). In their conceptualisation, an approach oriented towards productivity and technological innovations is identified with *weak* ecological modernisation, while *strong* ecological modernisation is represented by agro-ecological practices and a "place-based eco-economy". In their view, the rise of food security concerns has predominantly been mobilised to provide an "impetus and justification for … a renewed intensive productivist model" rather than a strong agro-ecological system.

In recent debates, conflicts over alternative food futures have been related to the concept of "food regimes" – "constellations of class relations, geographical specialization, and inter-state power" (Friedmann, 2009, p. 335). In this account, struggles within nation states have revolved around a new regulatory style, promoted by the WTO, based on science and formalised risk assessment procedures which opponents view as exposing public health, consumer preferences, the environment, the reputation of farming, and the economic future of rural areas to unacceptable risks. These struggles have been seen by some scholars as indicating the emergence of the third and latest in a series of food regimes. This latest manifestation has been variously referred to as a "neoliberal", "financialized" or "corporate" food regime. Friedmann (2005) has described it as a "corporate-environmental" food regime in which corporate interests – food manufacturers and increasingly retailers – respond in divergent ways to the demands of environmental and consumer groups concerned about the safety and quality of food. For some firms, these consumer concerns represent a marketing opportunity. The result is the emergence of alternative food supply chains catering variously for rich and poor consumers. Campbell (2009) has labelled the products of these chains 'food from somewhere' – environmentally and socially responsible, privately certified foods, identified with a particular place – and 'food from nowhere' – food produced according to lower standards enforced by WTO standards organisations,[5] which could come from anywhere (and may include GM products). Campbell points out that 'food from somewhere' depends for its appeal on the existence of 'food from nowhere'. Both are therefore likely to continue as parallel food supply chains.

Other studies have contrasted intensive 'high-tech' and high-input agriculture, epitomised by agricultural biotechnology, with alternative constructions of rural futures based on multifunctional or 'quality' production (including organics), and alternative agri-food networks (e.g., Buller and Morris, 2004; Maye et al., 2007; McCarthy, 2005; Sonnino and Marsden, 2006). Biotechnology is seen as posing a threat to these alternative directions because of the risk of accidental contamination and cross-fertilisation; in

[5] The three international standards organisations are Codex Alimentarius (Codex), the International Plant Protection Convention (IPPC) and the International Office of Epizootics (OIE). The OIE was later renamed the World Organization for Animal Health but retained its original acronym.

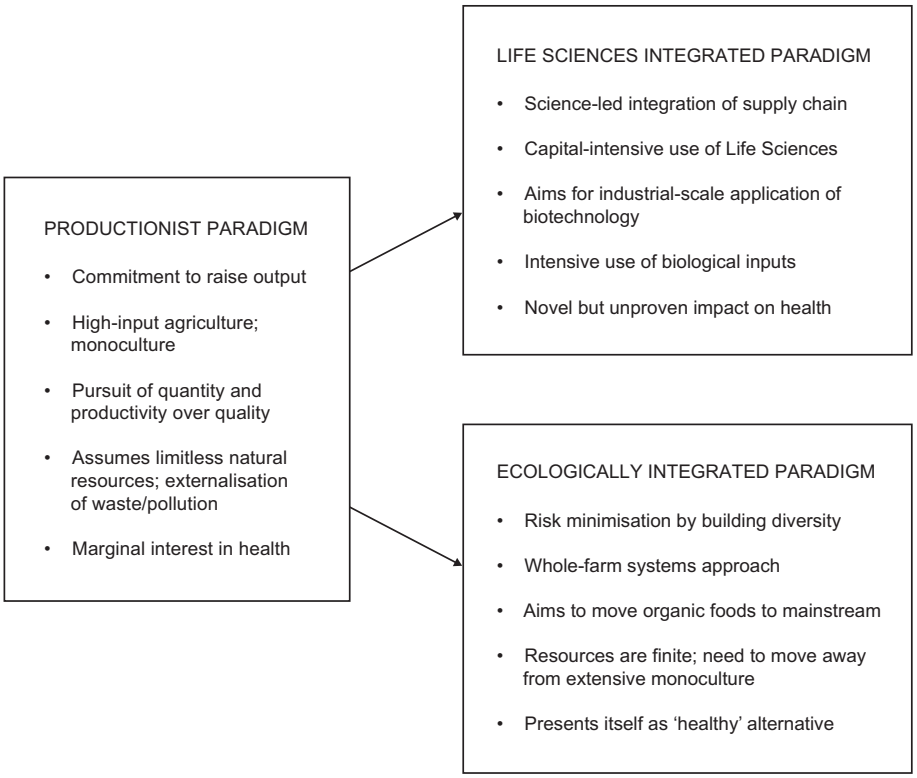

Fig. 1. Food supply paradigms. Source: Based on Lang and Heasman (2004).

consequence, "the prospective irreversibility of agricultural biotechnology means that any decisions have temporally indefinite consequences" (Gibbs et al., 2008, p. 145). Indeed Levidow and Boschert (2008, p. 188) have suggested that the question of coexistence of GM, conventional and organic crops has "become a new battlefield for contending policy agendas: between an agrarian-based rural development versus a neoliberal agri-industrial paradigm".

How do the debates outlined above relate to the question of food security? Whereas these alternative paradigms can be viewed as merely *lifestyle choices* for producers and consumers in the developed worlds of the UK and Australia, this is not the case when claims about the benefits or disadvantages of these paradigms are transposed to the developing world, where they may be represented graphically as *choices for life*, or between life and death. Both sides represent their preferred paradigm as the best direction for ensuring food security and view the alternative approach as undermining and precluding effective means of meeting the food needs of the poor. The conflicting arguments hold that, on the one hand, the biosciences paradigm will be unable to achieve its full potential if consumer and citizen resistance persists in Europe and many developing countries while, on the other hand, the GM-free alternative is unlikely to survive if predictions of irreversible contamination are correct. While both sides in this debate may have genuine concerns for the poor of Third World countries, they are equally – or more – concerned about the impact on their own developed country of promoting one paradigm over the other. The developing world becomes the virtual terrain on which the 'Food Wars' are fought out (Table 1 above; see also Ericksen, 2008).

Several groups motivated by environmental and health concerns not only refute arguments that this technology can enable more food to be produced and improve its nutritional value, but also argue against other aspects of industrial agriculture both for developing and developed countries. Anti-GM (or GM-free) activist groups in Australia and the UK draw extensively on accounts of the responses to GM foods and the experiences – especially failures – of farmers growing GM crops in developing countries and in the heartland of agricultural biotechnology in North America to illustrate their arguments about the risks attendant on adoption of this technology (see, e.g., FoEE, 2011; FoEI, 2011; Hewlett and Melchett, 2008; Hubbard, 2009).

In Australia, several activist organisations (or segments of existing NGOs) sprang up to contest the importation of GM technology. However, these organisations (e.g., GeneEthics, MADGE, Greenpeace's True Food campaign and the Network of Concerned Farmers) are not solely devoted to refuting the claims for agricultural biotechnology. They also publicise the existence and successes of alternative approaches, such as development of non-GM crops with desired characteristics (e.g., drought resistance), sophisticated techniques for expediting plant breeding which do not involve genetic modification (e.g., marker-assisted technology),[6] and less intensive farming methods (e.g., agro-ecology and organic farming). Activist groups in both the UK and Australia frequently draw upon a major international report from the International Assessment of Agricultural Science and Technology for Development (IAASTD), initiated by the World Bank and FAO in 2002, to demonstrate that agricultural biotechnology is not universally accepted by scientists as the answer to food insecurity. This report (which was not approved by Australia, Canada and the US) advocated multifunctional agriculture, supported agro-ecological methods, and expressed reservations about the potential of agricultural biotechnology to meet the food security needs of developing countries, asserting that: "some plant scientists are indicating that the rate at which transgenic plants will contribute to

[6] Marker Assisted Breeding (MAB) is a means of speeding up conventional breeding by utilising knowledge of genes and DNA to select desired traits.

a sustained increase in future global food yields is exaggerated" (IAASTD, 2008, p. 393). More recently, considerable prominence has been given to a new report by De Schutter (2011), the UN Human Rights Council's Special Rapporteur on the right to food, which favours agro-ecology as the solution to global food security problems.

4. Biotechnology and food security in developed countries: Australia and the UK

We turn now to a consideration of the ways in which food security has entered into debates about rural futures in developed countries through a comparative study of the UK and Australia – two countries which share a commitment to neoliberal forms of governing and a preference for trade liberalisation, although Australia has gone much farther down this path than the UK. Both countries are key players in the WTO process, but the UK's free market approach has been tempered by EU membership whereby EU political and regulatory influences often privilege social and environmental concerns over the market. Whereas the UK (albeit reluctantly as a member-state within the EU) has sought to maintain trade barriers to protect marginal agriculture and shore up the market advantages of a heavily subsidised, productivist agriculture, Australia has relied on 'competitive productivism' – unsubsidised and highly productive agriculture – to win markets (Dibden et al., 2009).

Australia and the UK also differ in the importance of agriculture for their economies, food production capacities, attitudes to food safety and supply, and willingness to promote multifunctional agriculture, which is viewed as a protectionist policy by Australia (Dibden and Cocklin, 2009; Dibden et al., 2009). Differences relate to the relative importance of production versus consumption issues, reflecting the sizes of their domestic markets and Australia's history as an export-oriented settler society. Whereas the UK has become increasingly dependent on imported food, Australia is a major exporter of food and remains largely self-sufficient domestically, although this status has lately been seen as under threat, as we discuss below (see also Lawrence et al. forthcoming).

Governments in both countries have been persuaded of the competitive benefits of biotechnology, but have diverged in their readiness to adopt *agricultural* biotechnology. Because of the greater importance of agricultural exports and environmental threats (such as drought), Australia has been more readily convinced of the potential benefits of GM crops. Consumer resistance has also been stronger and more effective in the UK, giving pause to both governments and retailers. The greater sensitivity of UK consumers can be attributed to concerns about the healthiness of food and risks of industrialised agriculture due to food scares (BSE, FMD) (see, e.g., Hinchliffe, 2007; Hobbs et al., 2002; Jasanoff, 1997). Disease outbreaks associated with intensive agricultural practices have been avoided in Australia due to stringent biosecurity regulations (Dibden et al., 2011; Maye et al., forthcoming), although consumer groups express fears about the willingness and ability of retailers and regulators to protect consumer interests (Lockie and Salem, 2005). There is also a concern by some (but not all) Australian farmers about loss of markets in countries where consumer resistance to GM foods is strong. Because of these different orientations to agricultural production and food safety, there is relatively greater government (as well as consumer, retailer and media) support for alternative foods and production methods in the UK compared with government neglect of quality, local foods in Australia (Andrée et al., 2010).

Both countries have adopted similar risk assessment procedures, but the UK has (perforce) been obliged to follow the more precautionary approach advocated by both the EU and its own citizens. This is reflected in a greater willingness to adopt quite strict GM/non-GM coexistence regulations (Levidow and Boschert, 2008) compared with the lax voluntary rules applying to Australian farmers. Australia has approved commercial release of (some) GM crops at federal level and several states have permitted cultivation, whereas the UK has not yet proceeded towards commercial cultivation of any GM crops.

What effect is the emergence of food security as an issue likely to have on decisions in both countries? The 2008 food crisis has shaped attitudes towards food security, and receptiveness to biotechnology, in different ways. Because of past experiences of food scarcity associated with wartime shortages, food security is a term with more relevance in Europe, where the notion of 'multifunctionality' includes food security as one of the benefits of a multifunctional farming system (Dibden et al., 2009; McCarthy, 2005). By contrast, the notion of food security has, until recently, had virtually no resonance in Australia, which has never experienced more than occasional, localised food shortages. In the UK and elsewhere in Europe, rising prices, particularly for animal feed, have led to accusations that the EU's regulatory policies, and member-state restrictions on GM crops, are to blame for inadequate production to meet escalating global need. In Australia, the supposed threat of anti-GM attitudes to food security has been deployed through claims that gene technology represents the best answer to the problems confronting Australian farming as climate change increases the frequency and severity of drought and crop failure.

4.1. United Kingdom

The system for regulating GM in the UK and elsewhere in the EU was aimed at allowing 'choice' between GM and non-GM by both farmers and consumers, "leaving the (increasingly retailer-led) private sector responsible for implementation and market acceptance" (Marsden, 2008, p. 199). However, public opposition to the development of GMOs was so strong that major food retailers quickly announced that they would sell only food that was GM-free, in some cases even including a ban on use of GM animal feed for their meat products (Levidow and Bijman, 2002). Introducing GM crops proved equally contentious. Attempts to ascertain the views of the public, and inform them about the technology, resulted in acrimonious and deeply polarised debates between supporters and opponents. The *GM Nation?* debate in 2003 was followed by a contentious (and ultimately abortive) government decision in March 2004 to approve cultivation of a herbicide tolerant maize, which would have been the first GM crop to be grown commercially in the UK.[7] In a Parliamentary statement, the government conceded that, while there was "no scientific case for a blanket ban on the cultivation of GM crops in the UK", they would "continue to take a precautionary approach and only agree to the commercial release of a GM crop if the evidence shows that it does not pose an unacceptable risk to human health and the environment."[8] In 2006, the Department for the Environment, Food and Rural Affairs (DEFRA) issued a consultation paper on proposed coexistence measures for England to which over 11,000 responses were received from stakeholder groups and members of the public (DEFRA, 2007). All the UK administrations agreed to enact coexistence measures before any commercial cultivation of GM crops takes place in the UK.

[7] Bayer CropScience considered the conditions attached to be so onerous that they decided not to proceed.

[8] http://www.defra.gov.uk/environment/quality/gm/crops/.

Food security had already been linked to the prospective benefits of GM technology in the late 1990s, when a report by the Nuffield Council on Bioethics (1999) claimed that there was an ethical obligation to explore these potential benefits responsibly, in order to contribute to the reduction of poverty, and to improve food security and profitable agriculture in developing countries. Media representations of GM foods and crops in debates in 2004 included an early example of use of the food security trope in a feature article by a 'genetics expert', who "emphasized the potential of GM technology to combat food shortages and hunger in the developing world. In this way, the development and application of GM farming by Western industrialised societies like Britain was constructed positively as a moral obligation for the alleviation of hunger in the Third World" (Augoustinos et al., 2010, p. 103).

A striking feature of these debates was the way public opinion became pitted against science, with the media and NGOs blamed for whipping up consumer concerns (although this was disputed by Mayer and Stirling, 2004). As Augoustinos et al. (2010, p. 111) show, the GM issue was constructed in the media as "highly problematic and divisive – a 'battleground' of competing interests between the British public, the government, the scientific community and the biotechnology industry. … As such, the debate over GM foods was inextricably linked to public confidence and trust in both the British government and expert scientific opinion." Thus, the emergence of two alternative and conflicting paradigms for food production can be linked to the public's experiences of the failure of both governments and scientists to recognise or communicate the risks of the BSE outbreak. Scientists quickly rallied to defend science against these onslaughts, with Burke (2004, p. 435; emphasis added) arguing that they should present 'good news stories' about the benefits of new technology for the public and consumers:

> [Scientists] have to get the message across that change is necessary if, to take but one example, we want *to feed the burgeoning world population without changes in agriculture*. Without such initiatives, scientific research is endangered, for it is very easy now to persuade the public that science for its own sake is risky, even dangerous, and that society does not need it.

Following the failure to introduce GM maize in 2004, subsequent governments adopted a cautious attitude towards introduction of GM crops until mid-2009, when the emergence of food insufficiency as a global issue led to a series of consultations and reports re-appraising the domestic food system. A Chatham House report on food security observed that the "acceptance, or not, of imported GM crops will be a significant issue" and that the EU's reluctance to accept GM technology was "unlikely to be sustainable in the longer term" (Ambler-Edwards et al., 2009, p. 24). An attempt to overcome consumer mistrust through a public dialogue on the use of genetic modification was launched by the Food Standards Agency in 2009 (UKFSA, 2010). The government was said to be "keen to understand current consumer attitudes towards GM food because *the food industry has warned that it might not be able to maintain a GM-free supply chain in the future*" (Perkins, 2009; emphasis added), suggesting an underlying agenda of persuasion, reinforced by two high-profile resignations from the steering group.[9]

A series of reports in 2009 explicitly linked agricultural biotechnology to food security concerns and framed GM as a moral imperative to 'feed the world'. The UK's first *Food Security Assessment* (DEFRA, 2009) warned of the specific threat to domestic food supplies and called for a radical rethink of the UK's food policy. In addition, reports from expert bodies, such as the Royal Society's (2009) *Reaping the Benefits* and the Biotechnology and Biological Sciences Research Council (BBSRC)'s 2009 consultation on *Future Directions in Research Related to Food Security*, increasingly included the GM option as a component part of a wider approach to food security and as a potential source of increased food production in a global context of greater demand for food supplies.

The Royal Society (2009) report had food security as one of its key foci. Despite criticism from anti-GM groups for its narrow terms of reference on "biological approaches to enhance food crop production" (GeneWatch, 2008), the report in fact examined in some detail the potential range of technologies to enhance production (advanced biotechnology, improved conventional practices, low-input methods), concluding that a diversity of approaches would be needed. The report called for "scientific solutions to mitigate potential food shortages" (Royal Society, 2009, p. 47), but did not argue in favour of any one approach. While an important role was envisaged for GM crops, they would need to be combined with more conventional techniques and methods. Similarly, DEFRA's (2010, p. 61) report *Food 2030* states:

> GM, like nanotechnology, is not a technological panacea for meeting the varied and complex challenges of food security, but could have some potential to help meet future challenges. Safety must remain our top priority and the Government will continue to be led by science when assessing the safety of GM technologies.

The Foresight report, *The Future of Food and Farming*,[10] prepared by a global team of "around 400 leading experts and stakeholders" (Foresight, 2011, p. 11), also does not provide overt support for technological solutions, presenting GM as one component part of the food security solution and the broader food system. Thus the report states "new technologies (such as the genetic modification of living organisms and the use of cloned livestock and nanotechnology) should not be excluded *a priori* on ethical or moral grounds, though there is a need to respect the views of people who take a contrary view" and that "any claims that a single or particular new technology is a panacea are foolish" (Foresight, 2011, p. 11).

A significant feature of the Royal Society and Foresight reports is their emphasis on 'sustainable intensification', a concept originally applied to developing countries (Collette et al., 2011; Driver, 2011) and characterised by an agro-ecological perspective (FAO, 2004; IFAD, 2011). The Foresight report states that:

> A key argument of this Report is that the global food supply will need to increase without the use of substantially more land and with diminishing impact on the environment: *sustainable intensification is a necessity*. Pursuit of this agenda requires a much better understanding of how different policy options, both within and outside the food system, affect biodiversity and ecosystem services. (Foresight, 2011, p. 31; emphasis added)

The concept of sustainable intensification as used in the Royal Society and Foresight reports attempts to bridge the gap between the agri-industrial/biotech and agro-ecological paradigms by drawing on aspects of both. Thus, Jules Pretty, a member of the Foresight projects' lead expert group, was reported as calling for "a move away from the 'binary opposition' between high-tech and low-tech approaches … We need both biotechnology and organic

[9] The objectivity of the Steering Group was called into question when Dr Helen Wallace, director of the think tank GeneWatch UK, and Professor Brian Wynne resigned in protest against the consultation's perceived bias in favour of GM technology. The process was discontinued soon after by the new Conservative-Liberal Democrat coalition government.

[10] The report was sponsored by DEFRA and the Department for International Development (DfID).

approaches" (Tatalović, 2011). Effectively, however, this approach opens the door to GM crops.

Public pronouncements from government representatives have tended to undermine efforts by expert bodies to appear even-handed in assessing the merits of GM. In August 2009, the then Environment Secretary, Hilary Benn, signalled on the BBC Radio 4 *Today* programme that any future UK food policy could include support for GM crops (Murray, 2009), while John Beddington (UK Government Chief Scientist), speaking at a farming conference in Oxford in January 2010, drew on images of GM as constituting both a 'revolution' and the answer to the food crisis:

> Britain must embrace genetically modified crops and cutting-edge developments such as nanotechnology to avoid catastrophic food shortages and future climate change … UK scientists need to urgently develop 'a new and greener revolution' to increase food production in a world changed by global warming and expected to have an extra three billion people to feed by 2040 … the revolution is needed primarily to counter climate change and help provide food for the nine billion people worldwide expected within 30 years (Vidal and Lawrence, 2010).

Anti-GM activists remained unconvinced by these claims. For instance, the Soil Association (2011) argued that the De Schutter (2011) report, which advocated agro-ecological measures for providing improved food security, dealt a "major blow to the GM industry and supporters of greater industrialisation of agriculture, including those behind the recent UK Government Foresight report". Furthermore:

> Unlike the Government chief scientist and the others involved in the Foresight report, the UN is promoting an approach it says is of benefit to farmers in developing countries, which improves their resilience to climate change, and which increases farm productivity, food security and rural incomes …

The election of a coalition government in 2010 saw continued or even increased support by the UK government for lifting the GM moratorium in the European Union. Indeed, Caroline Spelman, the new Environment Minister committed the government to be the UK's most pro-GM to date (Vidal, 2010).[11] However, recent approvals of trials of GM potatoes and wheat have been hotly contested, suggesting that neither the discourse of sustainable intensification nor the moral claims of food security have been effective in allaying public disquiet.

4.2. Australia

While acceptance of GM crops has also been strongly contested in Australia, both government and opposition at the federal level accept the benefits of biotechnology to Australia's economic competitiveness. After initial resistance by several state governments on economic grounds, the technology has now been approved for commercial release by most states, with GM cotton grown commercially in Queensland and New South Wales (NSW) since 2000, and GM canola in NSW and Victoria since 2003, followed – after a change of government – by Western Australia (WA) in 2010.[12] WA represents a compelling example of the 'food wars' provoked by adoption of GM crops. Under the former Labor government, WA had been strongly opposed to GM technology, maintaining a moratorium on growing GM canola and even commissioning independent testing of its safety as a food – something which is not required by the federal regulator. This all changed after an election reversal. The incoming Liberal government quickly moved to lift the ban despite strong opposition: 27,000 people signed a petition against the commercialisation of GM canola and 90% of submissions to a review of the GM-free Areas Act wanted the GM ban to continue. The Agriculture Minister Terry Redman nonetheless decided to lift the ban using the familiar rhetoric of choice: farmers should have the choice to grow GM canola and he was confident grain segregation would ensure 'non-GM' markets could be protected. Since this time, an active GM-free campaign by farmer, community and consumer groups not only continues to resist further expansion of GM crops but seeks to roll back acceptance of GM foods. Thus a struggle which is still largely hypothetical in the UK is already being played out on the ground in Australia. As in the UK, food security has emerged as an element in this debate.

Until recently, food security has been viewed primarily in relation to developing countries. It is difficult to create a feeling of panic about food security when Australia is still, in general, producing a surplus for export (Kim, 2009).[13] However, from 2000, persistent severe drought conditions in southern parts of the country led to a growing awareness of climate change as a potential threat to food production. This was reinforced in 2007/08, when drought-related poor harvests in Australia were listed among the causes of the global food crisis. Evidence of a food crisis emerging globally gave rise to fears that Australian food supplies might be less secure than had been assumed. Concerns were raised in the press about consolidation and foreign ownership of agri-food companies and a 'land grab' – unregulated purchases of farming land – by overseas interests. These resulted in a Senate inquiry into Australia's food production in 2008–10 (Senate, 2010), and statements by both sides of politics during the 2009 federal election about the importance of food security and the need for a national food plan (Mottram, 2010).

Thus, the issue of food security has increasingly come to public attention but, in contrast with the UK, GMOs have not been an integral component of the debate, with a wide range of threats to food security gaining more attention. However, agricultural biotechnology has increasingly been presented by proponents as playing an important and altruistic role in enabling Australia to produce more food, not for domestic consumption but for supply through trade and aid to less fortunate countries. A more self-interested motive for adopting this technology was proposed in a government-commissioned report (Abdalla et al., 2003), which argued that adoption of GM technology in developing countries to meet their food security needs will result in large increases in productivity and in cheaper exports: to avoid loss of markets, Australia will have to adopt GM crops or risk losing its competitive edge.

This argument feeds into another discursive theme commonly employed in relation to adoption of modern technology – that Australia must progress or risk being 'left behind'. Hindmarsh (2008, p. 36) argues that "at the heart of the strategic language framing such visions was that of the inevitability of biotechnological change as conditioned by a 'technology text' of desirable and unstoppable scientific progress." In a report on *Global Food Security*

[11] Accessed 7.3.11 on: http://www.guardian.co.uk/environment/2010/jun/04/gm-crops-caroline-spelman.

[12] Two states, South Australia and Tasmania, continue to uphold moratoria on introduction of GM crops to protect their GM-free reputations.

[13] Although recently Australia's previous trade surplus of horticultural produce has reversed, giving rise to fears of diminished food security. See Lawrence et al. (forthcoming).

and Australia, Kim (2009, p. 13) draws a direct association between food security and progress:

> … the development of GM crops is a 21st century response to an old idea of using biotechnology to decrease world famine. Large scale development and adoption of GM crops could herald the next great leap forward in agricultural productivity, following on from the 'green revolution' of the 1960s to 1980s.

Discourses of both 'progress' and 'food security' have moved from the hypothetical to the concrete in Australia as barriers to adoption of GM crops have been dismantled. Food security was raised as an issue by opponents after the approval of genetically modified canola for commercial cultivation by the federal government regulator in July 2003 – "the first such GM food crop to be approved in Australia", with a leading GM-free advocacy group, GeneEthics, arguing that the decision ignored "the fragile Australian environment and the urgent need to make Australian farming sustainable, to protect the environment and food security" (Cauchi, 2003). The debate sharpened again in late 2007 when the Victorian and New South Wales governments announced that farmers would be allowed to grow GM canola from March 2008 – the first avowedly GM *food* crops to be grown in Australia.[14] A media report when the first GM canola was harvested revealed the divergent ways in which the issues were framed by the opposing sides (Lewis, 2008):

> For supporters of genetic engineering, the harvest represents a victory for scientific commonsense that will help farmers stay competitive and feed an increasingly hungry world. For opponents, it is as dangerous as the introduction of cane toads in the 1930s to control pests that were troubling the sugar cane industry.

Following the food crisis of 2008, rhetoric from the federal government – and Monsanto – emphasised the need to adopt GM technology in order to meet Australia's responsibility to 'feed the world'. This argument acts to legitimise government approval and promotion of GM crops and also provides grounds for an attack on opponents of the technology. For example, in a speech on World Food Day 2009, the Minister for Agriculture stated:

> … the only way we can meet what the world will demand is by following every possible path of scientific research … I don't see how anyone can mount a moral argument against genetically modified food when we're facing these sorts of projections on global hunger (Burke, 2009).

GM-free groups responded angrily, with MADGE (2009) asking, in a media release entitled "We won't embrace GM foods Guilt Campaign":

> Is Minister Burke putting forward the idea that global hunger could be solved by GM food? Is he inferring that GM crops are higher yielding and could thus feed more people? Does he know that there aren't any high yielding GM crops?

MADGE pointed to the comparatively low yields of GM canola in Victorian trials and to a report from the Union of Concerned Scientists (2009) on the 'Failure to Yield' of global GM crops. Thus while farmers are enticed to grow GM crops by the promise that they will be adapted to extreme Australian conditions in the not-too-distant future, opponents dispute claims that GM crops are (at least to date) more productive or able to overcome problems such as drought and salinity. They also express doubts that resistance by consumers at home and abroad will be readily overcome.

A report by the Prime Minister's Science, Engineering and Innovation Council (PMSEIC, 2010) used the imperatives of food security to attack restraints on development of GM technology: these include the ability of states to impose moratoria on GM crops. The PMSEIC (2010, p. 46) contends that:

> As food security issues continue to emerge, the regulatory environment in Australia will need to be more flexible and responsive. This will ensure that innovations which underpin productivity and efficiency improvements are delivered effectively.

Thus we see that – yet again – the identification of GM technology with progress and competitiveness is reinforced by the moral suasion of GM's promise to feed the hungry in order to overcome doubts about the safety, ethics and socio-economic impacts of GMOs.

Due to the permissive nature of the regulatory environment, and the enthusiastic embrace of biotechnology by federal and (most) state governments, crop-growing areas may become locked into a GM trajectory which forecloses alternative possibilities, whether conventional (but GM-free) or organic. This process occurs in two ways, through: (1) contamination of non-GM by GM crops; and (2) increasing control of seeds by agricultural biotechnology corporations.

Ways to ensure that GM crops do not contaminate other crops have been the subject of much debate and extensive research in Europe (Binimelis, 2008; Levidow and Boschert, 2008). Before commercial cultivation of GM canola was approved in Victoria and NSW in 2008, government and grains industry studies argued that GM and non-GM crops could quite easily be segregated but, in practice, there is little indication that this is being seriously attempted. Secrecy about the location of farms growing GM crops and lack of state government regulation means non-GM farmers may incur increased costs for segregation of grain. There is no statutory requirement for farmers to maintain minimum (and minimal) recommended separation distances. State regulators have ignored protests from organic farmers – and other non-GM farmers – that their crops are at risk of contamination. This has in fact occurred: an organic farmer in WA has lost his certification as a result of a neighbour's GM canola straw blowing onto his land, while in Victoria floods swept GM canola onto a conventional farmer's fields. In each of these recent examples of GM contamination, court cases are threatened. Opponents of GM technology include farmers who simply want to grow non-GM crops for a number of reasons: fear of loss of markets because of consumer resistance overseas, fear of increased costs because of corporate control, fear of being sued by Monsanto. Contamination is an issue for farmers because significant price premiums are being paid for GM-free canola for the European market. Where contamination occurs, this forecloses the possibility of alternative trajectories.

This loss of alternatives may also occur as the result of a parallel process, the expansion in control of seeds by agricultural biotechnology corporations. Partnerships between bioscience corporations and government, university or industry bodies are increasingly common and include development of a GM wheat by the CSIRO, Australia's national science agency, in collaboration with the giant French seed and biotechnology company Limagrain. Even the Chief Economist of the WA government, which is strongly pro-GM, has expressed concern "that the future supply of GM crops could be dominated by a handful of large multinational biotechnology companies" (Kingwell, 2011: 7). Nonetheless, in WA, the state government has allowed Monsanto to buy 26% of InterGrain – "one of Australia's leading cereal breeding companies with successful

[14] It is not generally known that GM cotton, widely grown in northern Australia, is a source of edible oil commonly used for fast foods.

wheat and barley breeding programs" – which was formed when "the wheat breeding activities of the Department of Agriculture and Food Western Australia were transformed from a government based operation into a commercial company structure" (Farm Weekly, 2010). The partnership thus gives Monsanto access to seed varieties developed with public funds. Gene Ethics' Bob Phelps (2011, p. 78) argues that: "This deal would allow Monsanto to insert its GM traits into the best Australian wheat varieties and claim ownership of the GM varieties."

Development of GM wheat is likely to cause concern even amongst previously disengaged consumers. The CSIRO field trials of GM wheat were destroyed by Greenpeace activists in an action that stimulated a highly polarised debate (Condon, 2011; Keane, 2011). If GM wheat is commercialised, Australia will be the first country in the world to allow this development. The US and Canada decided some years ago not to go down this path because of strong consumer resistance[15] to genetic modification of wheat, the main ingredient in a staple food – bread – with emotional connotations (Greenpeace, 2010). Apart from the likelihood of unfavourable consumer reactions in Australia, there is the strong possibility that Australia would lose market share for its second largest agricultural export. Other groups argue that Australia's food sovereignty is at risk, since Australian farmers could lose access to non-GM varieties (as has happened in Canada and the US). This possibility contributes to a growing concern that domestic food security could be undermined by increasing control of agricultural land, agribusinesses and now seed by foreign-owned corporations and sovereign capital.

5. Conclusion

In recent years, food security has arisen as a major concern for both developing and developed countries. It has also become a major discursive element in debates about the appropriate place of the biosciences in agricultural policy. Agricultural biotechnology has been presented by its supporters as a valuable tool for overcoming threats to food security by enabling more productive or resilient food crops to be grown. GM crops are constructed by biotechnology corporations, supportive scientists and policy-makers as providing technological solutions to the limits of natural systems, while other aspects of an adequate food supply (such as equitable distribution and farmer control of production) are downplayed. Opposition to agricultural biotechnology is framed as being morally irresponsible, condemning farmers to reduced or static production and the poor in developing countries to starvation. However, an alternative viewpoint frames GM technology as reducing the prospects of food security by contaminating alternative forms of production and enabling control of the food supply system to pass into the hands of giant corporations ruled by the profit motive, while promising, low-cost 'agro-ecological' technologies are allowed to languish (Phelps, 2011). Allowing GM foods to dominate the food supply is perceived to threaten aspects of food security beyond quantity of food available, challenging the right to choose food which the consumer judges to be safe and healthy. Representations of food shortage and food security hence provide discursive support for opposing sides in debates about future directions for agriculture in the UK and Australia.

Within the GM debate linked to farming futures, conflicting discourses have become crystallised as discrete paradigms, despite the fact that in practice a range of views and courses of action exist – from total rejection of agricultural technology to acceptance of some GM crops with safeguards, to continued practice of conventional, high-input agriculture, to the eschewal of all industrialised agricultural practices by organic farmers. Why has this happened? We propose that this polarisation has occurred, at least discursively, because both pro- and anti-GM actors perceive an existential threat from the other. On the one hand, pro-GM actors see the anti-GM movement as preventing 'progress', delaying and possibly reversing the introduction of agricultural biotechnology, thus closing off a vital avenue towards greater global food security through their construction of GM farming and foods as too risky to be allowed. On the other hand, opponents of GM technology fear that alternative ways of farming and 'quality', 'safer' and 'greener' foods will be precluded because of the likelihood – or even certainty – of GM contamination of crops and control of seeds by large biotechnology corporations and their partners. In the UK, the concept of sustainable intensification has been constructed as a means to depoliticise the issue by attempting to merge or bridge opposing paradigms, but is likely to be dismissed as 'spin' by opponents.

Our comparative study of Australia and the UK reveals contrasts in their acceptance of agricultural biotechnology related to differences in the decision-making context. Despite a belief by governments in both countries in the competitive advantages of adopting biotechnology of all kinds, and adoption of science-based risk assessment as an anti-political strategy, the UK's embrace of GM crops and foods at government and industry level has been impeded by consumer resistance, mistrust of science, and the influence of EU regulations, while Australian governments at federal and state level have a strong orientation to bulk exports rather than 'quality' domestic production and have increasingly welcomed commercial cultivation of GM crops. The result is that alternative food production and supply initiatives remain strong in the UK, whereas – with notable exceptions and despite active opposition – substantial areas of Australia appear to be moving towards an ultra-productionist farming trajectory based on agricultural biotechnology.

However, the sticking point for concerned citizens, consumers and farmers in both countries may be unresolved doubts about the healthfulness of GM foods and the increasing evidence of influence of giant seed and biotechnology corporations on agricultural and food policy. Corporate control of seeds has been widely viewed by critics as threatening food security and food sovereignty – i.e. control of domestic food production (Hubbard, 2009; Mascarenhas and Busch, 2006). An additional concern is that GM crops could gradually displace conventional crops as access to non-GM seed becomes increasingly difficult.[16] One of the complaints made by organic and other alternative or 'niche' farmers in Australia is that government funding and producer levies are used almost entirely for research on improving productivity of high-input 'industrial' farming. In the UK too, the assumption that biotechnology is the way of the future has resulted in large amounts of government funds being channelled into breeding patentable GM crops, often in partnership with biotechnology corporations (Wallace, 2010).

Rather than this conflict resulting in the triumph of one paradigm over the other, Friedmann (2005) has forecast a bifurcation of food provision and consumption, with less affluent consumers obliged to purchase cheaper food produced by industrialised agriculture. This will increasingly be GM food, which is likely to be cheaper than non-GM food to *buy* (though not necessarily cheaper to *produce*) if non-GM producers are obliged to bear the costs of segregating and certifying the integrity of GM-free food and then pass these costs on to the consumer. This has implications for the

[15] In the case of Canada, farmers and supply chain partners were concerned primarily about potential loss of *overseas* markets because of resistance by consumers in Europe and Asia (Andrée and Sharratt, 2009; Eaton, 2009).

[16] Cf. the US, where a ban on growing GM beetroot has left growers without access to seed, since non-GM beetroot seed is no longer available.

developing world, where the demand for certified produce already represents a barrier to participation in higher value markets for many poor farmers (Hatanaka et al., 2005). These farmers also risk losing control of seeds to private interests and may miss out on access to the potential benefits of the agro-ecological paradigm if research funding continues to pour into agricultural biotechnology to the exclusion of other approaches. The contribution of agricultural biotechnology to food security, whether as benefactor or threat, thus remains as hotly contested as ever.

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