



NGO perspectives on the social and ethical dimensions of plant genome-editing

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Abstract

Plant genome editing has the potential to become another chapter in the intractable debate that has dogged agricultural biotechnology. In 2016, 107 Nobel Laureates accused Greenpeace of emotional and dogmatic campaigning against agricultural biotechnology and called for governments to defy such campaigning. The Laureates invoke the authority of science to argue that Greenpeace is putting lives at risk by opposing agricultural biotechnology and Golden Rice and is notable in framing Greenpeace as unethical and its views as marginal. This paper examines environmental, food and farming NGOs' social and ethical concerns about genome editing, situating these concerns in comparison to alternative ethical assessments provided by the Nuffield Council on Bioethics, a key actor in this policy debate. In doing so, we show that participant NGOs and the Nuffield Council on Bioethics share considerable concerns about the social and ethical implications of genome editing. These concerns include choices over problem/solution framing and broader terminology, implications of regulatory and research choices on consumer choice and relations of power. However, GM-engaged NGOs and the Nuffield Council on Bioethics diverge on one important area: the NGOs seek to challenge the existing order and broaden the scope of debate to include deeply political questions regarding agricultural and technological choices. This distinction between the ethical positions means that NGOs provide valuable ethical insight and a useful lens to open up debate and discussion on the role of emerging technologies, such as genome editing, and the future of agriculture and food sovereignty.

Keywords Agricultural biotechnology · Plant genome editing · NGOs · Ethics · Nuffield council on bioethics

Abbreviations

BSE	Bovine spongiform encephalopathy	GM	Genetically modified
CRISPR	Clustered regularly interspersed short palindromic repeats	GMO	Genetically modified organism
ECNH	Federal ethics committee on non-human biotechnology	NBT	New breeding techniques
EU	European union	NGO	Non-governmental organisations
		NPBT	New plant breeding techniques
		TALEN	Transcription activator-like effector nucleases
		UK	United Kingdom of Great Britain and Northern Ireland
		ZFN	Zinc finger nucleases

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Introduction

Plant genome editing has the potential to become another chapter in the intractable debate that has dogged agricultural biotechnology. In 2016, 107 Nobel Laureates accused Greenpeace of emotional and dogmatic campaigning against agricultural biotechnology and called for governments to defy such campaigning (Helliwell et al. 2017). The Laureates invoke the authority of science to argue that Greenpeace is putting lives at risk by opposing agricultural

biotechnology and Golden Rice: “How many poor people in the world must die before we consider this a “crime against humanity”?” (emphasis original, Support Precision Agriculture 2016). The Laureates also suggest that such opposition to genome editing is divorced from a reality in which agricultural biotechnology products are widely accepted as useful and their adoption is in the public interest. The Nobel Laureates’ letter is notable in framing Greenpeace as unethical and its views as marginal. In response, Greenpeace notes the International Rice Research Institute admits that Golden Rice has not been proven to address Vitamin A deficiency, describing Golden Rice as an overhyped, unwanted and costly failure. Instead, Greenpeace argues the solution to Vitamin A deficiency is diverse diet, equitable access to food and eco-agriculture (Greenpeace International 2016). The exchange highlighted both the polarisation between some scientists and non-governmental organisations (NGOs) engaged with genetic modification (GM) developments, such as Greenpeace and a lack of clarity about the social and ethical dimensions of agricultural biotechnology.

In this article, we address these issues through an examination of the social and ethical issues raised by environmental, food and farming NGOs who have developed a position on agricultural biotechnology. In particular, we use the controversial case of plant genome editing to investigate relevant NGO positions on the social and ethical dimensions of agricultural biotechnology and test whether these positions are extreme or misaligned with current expert ethical assessment. The recent Nuffield Council on Bioethics (henceforth Nuffield) publication *Genome editing: An ethical review* (Nuffield Council on Bioethics 2016) presents an opportunity to compare the positions of participant NGOs with a prominent ethical authority. This article presents focus group, interview and document analysis in order to compare environmental, food and farming NGOs and Nuffield framings of the social and ethical dimensions of plant genome editing. Our analysis shows four themes underlying NGO opposition to plant genome editing: (1) power and control; (2) terminology; (3) consumer choice; and, (4) problem/solution framings.

Importantly, this paper shows that despite NGOs critical positions on GM developments being situated by pro-GM advocates as adopting an ethically and morally extreme position, the social and ethical concerns they raise are broadly akin to that of a mainstream ethical organisation such as Nuffield. The main exception to this being that the NGOs explicitly question what genome editing techniques mean for further increasing the scope of corporate power within agricultural systems. We argue it is the efforts of these NGOs to critically engage with questions of power which underlies the ‘scientised’ controversy over plant genome editing and is crucial for understanding the nature of the debate

about genome editing and agricultural biotechnology more broadly.

Background

Plant genome editing

Genome editing has generated significant interest and excitement from the scientific community (Doudna and Charpentier 2014; Ledford 2015; Komaroff 2017). Supporters of this new technology argue that plant genome editing will benefit agriculture promising improved efficiency, greater productivity, a broader range of varieties and that environmental applications could lead to novel approaches to biodiversity protection, conservation, bioremediation, and the control of invasive species (Shukla-Jones et al. 2018). In practice, most plant genome modification and commercial development is focused on herbicide tolerance, insect resistance, fungal resistance and drought tolerance traits (Jones 2015). This article focuses on three genome editing techniques from a broader suit of New Plant Breeding Techniques (NPBT): Zinc Finger Nucleases (ZFNs), Transcription Activator-Like Effector Nucleases (TALENs) and Clustered Regularly Interspersed Short Palindromic Repeats (CRISPR) (Nuffield Council on Bioethics 2016). ZFNs and TALENs are proteins that are customised to target and cut DNA at a specific site. CRISPR is a viral defence mechanism found in bacteria and archaea which, when combined with CRISPR-associated protein 9 (Cas9), works in a similar fashion to ZFNs and TALENs, targeting and cutting DNA strands to allow edits and insertions. This new generation of genome editing technologies allow scientists to modify the genome more precisely than past transgenic tools and with fewer off-target effects (Urnov et al. 2010; Miller et al. 2011; Hwang et al. 2013; Nuffield Council on Bioethics 2016).

Plant genome editing is deeply politicised and questions of governance, particularly regulation, remain highly contested (Lusser and Davis 2013; Sarewitz 2015a; Kuzma 2016; Kuzma et al. 2016). In Europe, plant genome editing taps into existing controversies surrounding the deliberate release of genetically modified organisms (GMOs) (Schurman 2004). Since 2007, when it established a New Techniques Expert Working Group, the European Commission has examined whether products derived from NPBT fall under the scope of Directive 2001/18/EU on Deliberate Release of Genetically Modified Organisms. In 2011, a European Commission report recognised the prominent role of European researchers in NPBT research and development, concluding NPBT adoption faces two main challenges: regulatory uncertainty and the potentially high costs if products derived from NPBT are classified as GMOs (Lusser et al.

2011). In anticipation of a decision, GM-critical NGOs¹ published a number of joint statements outlining their position on NBPT, including an open letter lobbying the Commission to include NPBT in the Directive 2001/18/EU (Bee-Life et al. 2015). In 2016, in the absence of a European Commission position, the Conseil d'État (France) requested a preliminary ruling from the European Court of Justice (*Confédération paysanne and Others v Premier ministre and Ministre de l'agriculture, de l'agroalimentaire et de la forêt* Case C-528/16 2018) on whether a variety of herbicide-resistant rapeseed obtained through NPBTs should follow the GMO approval process. Finally, in July 2018, the European Court of Justice ruled that plant genome editing would fall under the GMO Directive meaning that plants developed through genome editing must go through the same regulatory approval pathway as GM plants, which biotechnology researchers and developers see as cumbersome and unnecessary. The decision was characterised in the journal *Nature* as a major setback, threatening genome editing research in Europe and halting commercialisation (Callaway 2018).

NGOs in the debate about agricultural biotechnology

GM-critical NGOs, such as Greenpeace, Friends of the Earth, GM Watch, GM Freeze, in tandem with consumer, agricultural and development organisations have had success in Europe and the UK galvanising public opinion in opposition to agricultural biotechnology through direct action and political pressure (Ansell et al. 2006). However, GM-critical NGOs' articulation of alternative normative commitments to those embedded in dominant agricultural biotechnology policy positions have also attracted hostility from various groups (Welsh and Wynne 2013), such as the 107 Nobel Laureates cited above. The targeted NGOs are often dismissed as being anti-science (Eden et al. 2006; Welsh and Wynne 2013), or discredited as 'partisan publics' contrasted with an imagined (supportive) 'pure public' (Braun and Schultz 2010). Although, as Welsh and Wynne (2013) argue, even these imagined 'pure', 'general' or 'silent majority' publics often share the normative commitments of more vocal NGO activists. In short there is a 'politics of the public' in terms of how different groups both claim to be the public and also imagine (and address) the public, so that "multiple publics ... jostle against each other" for legitimacy and recognition (Staeheli et al. 2009, p. 634).

The role of NGOs within controversial science and technology debates is multifaceted, in part due to the different ways NGOs define their function and mission, a situation often influenced by their size and resources. Considerable efforts have been made to 'scientise' agricultural biotechnology governance, constraining the policy debate and decision making to matters that can be adjudicated on the basis of scientific knowledge, privileging scientific experts, those in control of technical information and obscuring value-laden political decisions (Kinchy 2010). To engage in this scientised debate, NGOs routinely act as both consumers and producers of science, in the process in-advertently reinforcing the scientised terms of adjudication (Eden et al. 2006; Kinchy 2010). However, some NGOs also monitor and draw attention to ethical issues associated with emerging science and technology developments through campaigns (Smith 2016), and attempt to open up policy debates on agricultural biotechnology to include broader non-technical considerations.

The social and ethical dimensions of agricultural biotechnology

Underlying the debate about the governance of genome editing is a tension between science and values and what counts as 'science', (Wickson and Wynne 2012; Sarewitz 2015b; van Mil et al. 2017). Historically, the social and ethical dimensions of agricultural biotechnology have been subordinated to scientific matters and played a marginal role in the development of governance structures (Hartley 2016a, b). Agricultural biotechnology governance relies heavily on science-based risk assessment in regulatory frameworks (Hartley 2016b). Although over 40 countries have included consideration of social and ethical dimensions of agricultural biotechnology in their GMO biosafety legislation, there is little agreement on the definition of a social or ethical dimension, little research on these dimensions, and a reliance on conventional agriculture as a comparator (Catacora-Vargas et al. 2018).

Since the 1990s, a body of literature has explored the significance of social and ethical issues in emerging agricultural biotechnology (Bunton and Peterson 2005; Brunk and Hartley 2012; Federal Ethics Committee on Non-Human Biotechnology (ECNH) 2012; Nuffield Council on Bioethics 2012; Thompson 2015). These issues include the distribution of risks and benefits, the social and economic impact on agricultural production systems and communities, transparency, corporate control of the food production system, inequalities between the Global north and the Global south, food insecurity, biodiversity loss, the role and direction of technological progress, and, ultimately, the desirability of the technology (Dowdeswell et al. 2005; Phillips et al. 2010; Hartley 2016a; van Mil et al. 2017). The marginalisation

¹ Arche Noah, EcoNexus, Friends of the Earth Europe, Friends of the Earth Germany, IG Saatgut, GM Freeze, GM Watch, Greenpeace, Global 2000, Réseau Semences Paysannes, Slow Food, Test Biotech, Via Campesina.

Table 1 Participant NGOs

	Name	Organisational goal
1	Beyond GM	Public awareness initiative
2	Corporate Europe observatory	Not-for-profit corporate lobbying research and campaign group
3	Econexus	Not-for-profit public interest research organisation analysing developments in science and technology
4	FARM	Independent campaign organisation that represents sustainable farming within the UK
5	Food ethics council	Charity advising on food and farming ethics
6	Friends of the earth	International environmental campaigning group concerned with environmental issues
7	GeneWatch UK	Not-for-profit group monitoring developments in genetic technologies
8	GM freeze	Not-for-profit company campaigning for GM moratorium
9	GM watch	Organisation providing news and commentary on genetic technology developments
10	Greenpeace	International environmental campaigning group concerned with environmental issues
11	Logos environmental	Environmental research consultancy and advocacy organisation for environmental NGOs
12	Soil association	Food and farming charity and organic certification body
13	Sustain	Charity advocating for better food and farming policies
14	Permaculture association	Membership association designing and supporting the development of permaculture practices

of these issues remains a significant tension in agricultural biotechnology governance that challenges the legitimacy of governance institutions (Hartley and Millar 2014; Hartley 2016a, b). However, in addition to the exclusion of social and ethical considerations, a narrow scientific emphasis on molecular biology has also resulted in the marginalisation of other disciplines which have resulted in less available funding to explore alternatives such as agroecology (Vanloqueren and Baret 2009) and led some members of the scientific community to challenge claims of a consensus on the safety of GM plants (Hilbeck et al. 2015).

Methods and research design

We employ a comparative multi-method approach combining qualitative document, focus group and interview analysis. Documents were compiled from environmental, food and farming NGO websites and other published materials to identify their positions on the social and ethical issues related to plant genome editing. This search identified 64 relevant documents, 61 webpages and 3 joint publications. In total 10 GM-engaged NGOs were represented within this document database, however, just over half (31) of the webpages were from a single NGO (GM Watch) website. The over-representation of a single NGO within this corpus, alongside the limited articulation of the social and ethical issues of primary interest to this study meant the collection of focus group and interviews data was deemed essential in order to adequately understand the social and ethical issues raised by NGOs engaged with developments in genome editing as an emerging agricultural biotechnology.

We collaborated with GM Freeze, a GM-critical UK-based NGO to identify relevant UK-based NGOs. GM

Freeze facilitated access to research participants who have traditionally been hard to reach. We approached all NGOs active in the UK who had developed a position on plant genome editing. Subsequently, one focus group with five participants from different NGOs was held in June 2016. To ensure full coverage of the UK-based NGOs identified, semi-structured interviews were held with participants unable to attend the focus group in July 2016, to build upon the breadth of knowledge gained from the focus group interactions.² In total the research involved fourteen UK and EU-based NGOs with an interest in genome editing: Beyond GM, Corporate Europe Observatory, Econexus, FARM, Food Ethics Council, Friends of the Earth, GeneWatch UK, GM Freeze, GM Watch, Greenpeace, Logos Environmental, Soil Association, Sustain, and Permaculture Association (see Table 1). Due to the small nature of several participant NGOs, to remain consistent with the consent provided by participants at the start of the project, and in accordance with the ethical procedure approve by the host institution (University of Nottingham), all quotes have been anonymised. This group represents a wide range of organisations interested in GM developments with considerable differences in size, resources, campaign reach and goals. The breadth of NGOs (see Table 1) includes small UK based initiatives aiming to raise public awareness and broaden the scope of public debates on GM, to mass membership organisations with national and international campaigns on environmental and agricultural issues.

Individuals participated in either the focus group or the interviews but not both. Focus groups are a useful tool to

² It proved impossible to get all relevant participants together in the UK at the same time. Combining interviews with the focus group allowed to us to expand the number of participants.

generate discussion between participants, give participants greater control over the content than in an interview situation, and provide the opportunity for issues to emerge that are unanticipated by the research team (Krueger and Casey 2014). An experienced moderator (SH) led the focus group which consisted of two 2 h discussion sessions and teased out a range of responses to provide a greater understanding of the ethical reasoning, attitudes, opinions and/or perceptions of participants that would be less accessible without group interaction (Hennink 2007). Semi-structured interviews with participants that did not attend the focus group were conducted via telephone and lasted between 30 and 60 min. Focus group discussions and all interviews were audio recorded and transcribed. The interviews and the focus groups were guided by the same topic areas which aimed to explicitly disentangle scientific from social and ethical issues. These areas included a participant's understanding of; (1) the term New Plant Breeding Techniques and genome editing; (2) social and ethical issues; (3) social and ethical issues raised by genome editing; (4) the degree to which genome editing introduces social and ethical issues distinct from those raised by more established GM techniques; (5) the position of social and ethical issues in public and policy discussions regarding GM and genome editing.

While the use of both focus groups and interviews can be justified for pragmatic reasons (expanding the range of participants), careful combination of the methods and iteration between their results during analysis, can help to identify the structure and context of particular phenomena (Lambert and Loisel 2008). For example, the focus group revealed the terminology of plant genome editing to be a key concern by participant NGOs, in a way that could not have emerged in individual interview. While acknowledging that the participant NGOs hold a broad range of interests, we found considerable agreement between participants around the social and ethical dimensions of plant genome editing across the focus group and interview data. In this article, we have focused on these commonalities and compared them to the published position of Nuffield.

Nuffield is the most prominent UK bioethics institution which has intervened within social and ethical debates surrounding agricultural biotechnology. Funded since 1994 by the Nuffield Foundation, the Medical Research Council and the Wellcome Trust, (Nuffield Council on Bioethics 2018), Nuffield operates independently from the UK government although, in practice, is treated by the government as a quasi-official body addressing matters of public interest that would be difficult for policymakers to handle directly (Jasanoff 2005). Nuffield is primarily constituted of a main council which selects topics of interest. Upon determining a topic, the council appoints a working group independent of the council (Nuffield Council on Bioethics 2017). The working group is usually made up of senior academics and

professionals from a range of disciplines and backgrounds with personal expertise in the relevant domain³ (Nuffield Council on Bioethics 2017). Subsequently, the group is tasked with gathering evidence and drafting the report, with the council responsible for accepting the final report (Nuffield Council on Bioethics 2017). It is the final report, once approved, which represents Nuffield's position.

Documents including the report *Genome editing: An ethical review* (Nuffield Council on Bioethics 2016), the call for evidence and the evidence submissions, were compiled totalling 46 documents. This was reduced to 15 by excluding evidence submissions that had no mention of genome editing in plants for commercial agricultural production. The inclusion of the evidence was useful in demarcating the Nuffield's conclusions from the wider pool of evidence submissions. The final report is the principle document of reference throughout. This report was authored by a working group that included Andy Greenfield (Chair, and Council member, Programme Leader in Developmental Genetics at the Medical Research Council's Harwell Institute, and a member of the Human Fertilisation and Embryology Authority), Tony Perry (Department of Biology and Biochemistry, University of Bath), Christine Watson (Council member, University of Cambridge), David Lawrence (Council member, Chair of the UK Knowledge Transfer Network and Non-Executive Director at Syngenta AG), Charis Thompson (Professor of Sociology, London School of Economics and Political Science and Chancellor's Professor of Gender and Women's Studies, University of California, Berkeley), John Dupré (Professor of Philosophy of Science, Exeter University and Director of Egenis, the Centre for the Study of Life Sciences), Richard Ashcroft (Professor of Bioethics, School of Law, Queen Mary University of London), Karen Yeung (Professor of Law and Director of the Centre for Technology, Ethics and Law in Society (TELOS), King's College London).

Our comparison between GM-engaged NGO perspectives and the Nuffield text involved two stages. First, we conducted a thematic analysis of the data to identify the prominent social and ethical issues regarding genome editing discussed by participant NGOs and Nuffield to identify areas of cohesion and disjuncture. Second, we employed the concept of framing. As opposed to themes which are descriptive, frame analysis examines how discussion of said themes is organised and what elements are emphasised. Frame analysis has been used in a variety of contexts relating to salient policy governance issues such as food security (Mooney and Hunt 2009; Kirwan and Maye 2013), emerging animal and

³ Nuffield does not make clear its criteria for exclusion on the basis of conflicts of interest, however, all working parties publish a register of interests and do not represent the organisations to which they are affiliated.

human health issues such as antimicrobial resistance (Morris et al. 2016), and public controversies such as the BSE crisis (Miller 1999; Washer 2006). Framing is described as the means of structuring experience of the world through discursive practices and frame analysis is situated as a means of interrogating this organisation (Goffman 1974; Entman 1993). More specifically, different groups are positioned as likely to adopt different ways of framing issues, which may lead to deeply entrenched differences in perspective on what the problem is and how it should be governed. Our analysis aimed to identify these framing differences. We used the published text of the Nuffield report as our point of reference due to the symbolic power of that text in ethical debates (Jasanoff 2005). Our research interest is in how GM-engaged NGO perspectives compare to the ‘received wisdom’ from Nuffield. Further research could investigate in greater detail the processes of inclusion and exclusion during the writing of the Nuffield report. However, this is beyond the scope and interest of the current article.

Results

The results of the analysis are summarised in Table 2 which compares the frames identified in participant NGO and Nuffield positions on the social and ethical dimensions of plant genome editing in relation to each of four identified themes. We then go on to detail and compare the social and ethical themes and frames identified from the participant NGOs and the Nuffield report on genome editing.

Power and control

For participant NGOs, questions about power and control were a substantive component of their critique of genome editing and its ethical consequences, both in their own right, but also as the subtext to wider discussions on intensive agriculture. Participants positioned genome editing, not as a neutral technology, but as expanding the power agricultural biotechnology corporations hold over industrial agricultural systems, and thus farmers and consumers. Participant NGOs argued that genome editing would perpetuate the proliferation of intensive systems of production which they understood to be deeply harmful to the environment, human health, people’s livelihoods and access to food. One participant argued:

This is likely to be a technique that will deliver for largescale monocultures and farming systems that undermine farmers’ ability to control what they grow ... and big agri-business being in control of the seed and genetics. (Interview 4)

Table 2 Themes and frames in participant NGO and Nuffield positions on the social and ethical dimensions of plant genome editing

Theme	Participant NGO frames	Nuffield council on bioethics frames
1. Power and control	Genome editing increases corporate power through patenting regimes and support for intensive agriculture. Corporate power and control must be challenged	Genome editing may either enhance corporate power or democratise GM
2. Terminology	Terminology has been designed to distance genome editing from GM in order to avoid conflict and secure public acceptance. Terminology must be contested	Terminology has social and ethical consequences and may be confusing for publics. Terminology must be examined
3. Consumer choice	De-regulation of genome edited plants and food is a strategic attempt to undermine and limit consumer. Consumer choice must be defended	Outlines consumer choice implications as a result of genome editing challenging regulatory and tracing regimes. No judgement on genome editing as a GM technology or not
4. Problem/solution framings	Contesting dominant framings. Highlights strategic use of crisis framings justify GM, to undermine regulation and silence NGO opponents	Balance. Examines different framings. Warns against premature lock in. No final value judgement on different framings

Central to this theme was the patenting regime which creates a different set of legal requirements for farmers using the products of agricultural biotechnology than the royalties regime employed in traditional plant breeding. Patenting was key to increased corporate power and control, one participant argued:

So it would include corporate control via patenting and the impact of that on farming communities, such as being locked into a particular technology, what's known at the transgenic treadmill, where you have to pay more and more [for] seeds and more input; impact on the scale of farming, so the trend towards larger rather than smaller farms, monopolies in commercial companies ... (Interview 5) The application of genome editing techniques in agriculture and food production is likely to extend the penetration of patented products and techniques, ... This will increase the power of multinational corporations at the expense of those who work the land. (GM Freeze 2016)

Participant NGOs highlighted that genome editing does not disrupt this established trend, instead further facilitating corporations' efforts to expand that network of control through enabling new product lines which further threatened farmers' decision making capacity regarding land management.

In contrast, Nuffield highlights but does not challenge the status quo of intensive agriculture and corporate power. Furthermore, these issues are addressed generically in Section 2 of the report *Science in Context*:

... the costs associated with ... these discoveries can, in practice, only be borne by the major corporate firms ... with potential consequences for global development, access and distribution, and distributive justice (Nuffield Council on Bioethics 2016, p. 17)

This signposts the NGOs position that the adoption of genome editing benefits major corporate firms over farmers and consumers. An explicit discussion of who gains market power from these developments is only mentioned once in the plant section, in a footnote, quoting an evidence submission from the British Society of Plant Breeders. It notes how the existing situation has "enhanced the global market power of breeding companies from outside the EU." (Nuffield Council on Bioethics 2016, p. 69). Suggesting that a major problem with first generation GM technologies and existing regulation is that power has shifted to the 'wrong' non-EU companies, a consequence that would presumably be resolved by EU companies getting in on the action.

In contrast to NGO participants, Nuffield also notes how genome editing holds promises for democratising science. Section 7 *Other Uses* outlines the potential for CRISPR to open up genetic engineering to non-elite discourse and

practice, a key promise and risk posed by these technologies. Whether this can be replicated in agriculture remains to be seen, but CRISPR may hold promise as a means for small and medium size companies to reap the benefits of genome editing. This topic is not broached by NGO participants, instead they are focused on challenging the present realities of power inequality in agricultural systems which genome editing is positioned as re-enforcing not disrupting.

Terminology

NGO participants contested the terminology invoked by the technology developers in the genome editing debate. They were highly critical of the use of technical language to discuss the practices of genomic manipulation in general and were particularly concerned with the strategic use of language to achieve political goals. Terminology of concern included: the metaphor of 'editing', the inclusion of genome editing in the broader category of NPBT, and the language of 'precision' used to describe the practice of genome editing. Participants argued that such technical terminology made the debate impenetrable to lay audiences, sanitising the controversy through the use of more palatable language, particularly its inclusion in the broader category of NPBT. The political motives for using these terms generated significant discussion in the focus group. For example:

... that with the name it is meant to not only bamboozle or hoodwink the public so they will not recognise it, but also the legislators ... it's been a real strategy with the new name to pretend that it is not GM (Focus group P4)

Industry basically planned the name to divorce the new GM techniques from what people generally see as a bad old GM story. (Focus group P5)

Rebranding new genetic engineering as "new breeding techniques" (NBTs) was industry's first step in making this new generation of GM appear friendly and kindred to classical plant breeding. (GM Watch 2016)

Language is used to suggest that appreciable space exists between GM (which remains unpopular) and these new technologies, thus implying that genome editing is publicly and politically acceptable to adopt outside of existing regulatory frameworks. NGO participants recognised that terminology is important and value-laden and challenged what they perceived as deliberate rhetorical choices by GM advocates to distance these new technologies from past controversies, whilst reassuring and persuading publics and politicians that they are desirable.

Similarly, the Nuffield report identifies terminology as an important topic. It argues that current terminology excludes publics from the framing of risks, expressing their concerns, and the debate more generally. Furthermore, Nuffield

acknowledge that terminology can shape publics' perceptions. Specific attention is drawn to the problems with the technical and expert driven nature of the discussion around genetic engineering:

The technical language in which genomic manipulation is discussed by specialists in all disciplines... is frequently impenetrable to common understanding. (Nuffield Council on Bioethics 2016, p. 65)

By necessity, participant NGOs were often well versed in the terminology and science. Some felt more comfortable contesting the science than articulating and critiquing the political commitments of genome editing. However, as Nuffield goes on to note, this terminology is used to dismiss the concerns of publics who are unable to use the correct technical language, whilst creating space that can be exploited to sow uncertainty. Here we see a considerable level of agreement between the Nuffield report and the participant NGO's positions. Yet, in contrast to NGO participants asking 'why' questions, Nuffield asks the 'what' questions. What are the potential issues raised by opaque technical language and by particular phrases and words?

Such divergence is clear in Nuffield's description of conflicting positions on the semantic use of 'precision' in biotechnology:

they [NGOs] point to the mistake of equating 'precision' in the ability to manipulate nucleotide sequence with precision in the prediction or control of consequences or in terms of gene function. Biotechnology researchers typically respond to these claims by alleging that NGOs are overstating the risks and exploiting uncertainties for political ends. (Nuffield Council on Bioethics 2016, p. 68)

Questions of why precision has been adopted as the term with which to describe genome editing, and whom it is being used by, remain unexplored. Therefore, terminology is recognised as having ethical consequences encoding different values, but the interrogation of why these choices have been and are being made is outside the boundaries of Nuffield's analysis. In contrast these questions are central to participant NGO interrogation of terminology.

Consumer choice

NGO participants repeatedly identified consumers' right to choose non-GM foods as a salient concern. If products produced through genome editing fall outside of existing EU directives on GMOs consumers would not be able to select against them. Participants argued strongly that people have a right to information and should be enabled to make food choices on their own terms regardless of the nature of their objection. For example:

... some people would take very strong objection to manipulation of genetic systems in a way that cannot happen naturally without interference in the lab. It is a legitimate position for people to take and if we're not careful, that choice will be denied to them. (Interview 1)

Consumer choice was entangled with the theme of power and control and participants argued that industry proponents of genome editing saw consumer choice as a threat to their power and control so sought to limit it. De-regulation was therefore positioned as central to limiting consumer choice by seeking to have genome edited plants and food free of the regulatory requirements that constrained GM products, in particular labelling. For example:

The debate right now is about that the industry is trying to get all of these techniques completely deregulated, which means taking away any chance for society to control, to label, to know, to have access to information. (Interview 6)

If they [GM advocates] succeed, these GM products won't carry a GM label and citizens and consumers will never know what they are growing in their fields, or feeding their families. (Beyond GM 2016)

The de-regulation of genome editing is therefore positioned as making them invisible to the public, severely limiting consumer choice, whether that choice was made on grounds of scientific, emotional, cultural, or religious objections.

Nuffield does not attempt to answer the political question of whether genome editing techniques should be covered or not by existing EU directives that require explicit GMO food labelling. Instead the report examines what decisions need to be made if genome editing did fall outside of the existing regime of GMO regulation. For example,

... what information consumers should be able to receive. If it is right that consumers should be able to make such a choice on grounds that they themselves choose, labelling may be particularly important ... (Nuffield Council on Bioethics 2016, p. 68)

Nuffield does not attach a value judgement to this decision, in contrast to the stronger position held by participant NGOs about the right to make food choices regardless of the criteria on which those choices were made. However, the Nuffield report notes how this is potentially not so simple:

these 'edits' need not leave any tell-tale trace of their origin in the genome, in the sense that subsequent genome analysis is able to tell whether they have been introduced intentionally or arisen through common or garden random mutation." (Nuffield Council on Bioethics 2016, p. 113)

The inherent capacity of the technology changes the bounds of what can be made visible to regulators and consumers creating issues regarding traceability. As a result, the Nuffield report frames the disruption of consumer choices as emerging from techno-scientific advance creating inherent difficulties for tracing genome edited plants. Thus, technological progress re-opens past regulatory decisions surrounding the division of GMO and non-GMO plants. This contrasts with the previously described NGO position framing this as an explicit effort to circumvent consumer choices which are implicitly assumed to prefer non-GMO foods.

Problem/solution framings

NGO participants were sceptical about the problem/solution framings used to justify the need for genome editing. This problem of food security is framed as an impending food crisis due to population growth, climate change and changing diets, which invites genome editing as a solution. One participant observed:

... a guaranteed phrase whenever I read a paper, it always starts off, there are so many billion people in the world, by 2020, we need to feed them. If an article starts like that, I can guarantee ... it's going to tell me I should be developing GM. (Focus group P1)

Participants argued that this crisis framing is not a simple passive declaration of fact about a global reality but deeply political and used for political means. Within a highly charged debate an impending crisis provides urgency and a claim to the moral high ground. Opposing these techniques is unethical given the pressing needs of the world. The Laureates' Letter being a clear example of such a claim. NGO participants challenged this problem framing along two lines.

First, NGO participants contested the nature of the problem. They recognised population growth and increased food demands but questioned whether these demands constitute the crisis depicted by pro-GM advocates.

So you know the whole crisis narrative thing needs to be interrupted, ...decide whether there really is a problem, and if there is a problem, what the sensible solution is that's going to keep a majority of the stakeholders happy. (Focus group P5)

Second, NGOs argued genome editing further exacerbates the problems of intensive systems of agricultural production which are in many local and regional contexts the source of food insecurity due to the displacement of local people, increased environmental pollution and degradation. Participants argued that genome editing offers very little to the majority of subsistence farmers in the global South, therefore doing little to resolve food insecurity in these regions:

The other [subsistence] food system which is under tremendous threat indeed from the spreading industrial food system ... using probably only about 30% of the world's ... food production resources, delivers food for about 70% of people in the world. And that's the system which needs to be supported. (Interview 2)

In contrast, participants situated genome editing in the context of modern intensive agriculture and the hegemonic role technology plays in supporting economic growth. They noted the disjuncture between the needs of populations and agriculture in the Global South which are largely unaddressed and may be exacerbated by genome edited and industrial agriculture. For example:

Agriculture is the money-making enterprise. And we were saying the R+D is to make a profit from agricultures, it wasn't about feeding ourselves and food security, it's about making money. (Focus group P3)

Nuffield similarly engages with these problem/solution framings, in Section 5 *Contending Imaginaries*. The section begins by painting a significant global challenge comparable to the one critiqued by the NGO participants.

The Food and Agriculture organisation estimates that we need to increase food production by as much as 70% in the next 35 years. (Nuffield Council on Bioethics 2016, p. 69)

With the gauntlet laid down, genome editing promises potential solutions to alleviate this issue. In contrast, NGO participants argue that these problem framings are strategic rhetorical tools which seek to justify genome editing whilst seizing the moral high ground from which to discredit opponents. Nuffield notes a potential disjuncture between the nature of this challenge and the solutions provided by agricultural biotechnology. For example:

These [EU economic] interests sit starkly beside another important set of considerations ... in the discussion of global food security, namely the interests and agency of resource-poor communities, which are not natural markets for purely commercial products ... Here, too, the impact of genome editing is potentially ambiguous and the response to it is a matter of political debate. (Nuffield Council on Bioethics 2016, p. 70)

Therefore, both Nuffield and participant NGOs recognise that there is a spatial and political dimension to positioning genome editing techniques as the supposed solution to global food insecurity.

Additionally, the Nuffield report catalogues alternative future visions for agriculture. This is motivated by the argument that it is important that a particular problem/solution framing does not result in premature decisions about which

technologies to pursue. Lock-in is a risk to be avoided. NGOs, industry and scientist groups are all key proponents of competing framings and solutions to emerging challenges to agricultural and food systems and this is reflected in the report. Nuffield interrogates these different competing visions by juxtaposing them side by side. For example.

Compassion in World Farming argue, for example, that genome editing might aggravate food insecurity if genome edited animals are used in industrial systems where animals are fed human edible cereals and that contribute to environmental degradation.... The vision promoted by the UK's Royal Society, on the other hand, is one of 'sustainable intensification' that harnesses biotechnologies to address the multiple constraints of increasing population, water shortages, degradation of farmland and climate change. (Nuffield Council on Bioethics 2016, p. 71)

Both visions are presented together, but there is no reflection of the relative influence of the Royal Society in comparison to Compassion in World Farming or even which vision currently holds dominance in research policy. Furthermore, despite a reference to the 'opportunity cost' inherent in picking one vision over another there is limited reflection on who stands to gain or lose from such choices.

Discussion

Our analysis suggests that NGOs' GM-critical stance on plant genome editing is thematically aligned with expert ethical assessment. NGOs and Nuffield both draw attention to a similar cross section of social and ethical issues as outlined above. However, in contrast to formal ethical assessment which functions to scope the boundaries of the conflict, the participant NGOs consistently sought to challenge the status quo, attempting to expand the boundaries of discussion to include explicit questions about power and its dynamics, particularly with regard to the perceived increase in corporate influence within agricultural systems from the adoption of genome editing techniques. Consequently, NGO participants framed their engagement through 'who' and 'why' questions, drawing attention to who is instigating these debates and with what intentions.

Our interview and focus group data reveal a consistent position on plant genome editing which was not identifiable through the NGOs' on-line material, although it was considerably clearer in expert testimony to Nuffield and in other calls for evidence. The reasons for this disjoint between on-line material and expert testimony is unclear and deserves more investigation because it has important implications for NGOs and for public debate on plant genome editing more generally.

Participant NGOs actively bring key political questions into the foreground by challenging the existing order. We argue it is this challenge and associated discussions about alternative innovation paths in agricultural biotechnology, which raise the ire of GM proponents by challenging their position as beneficiaries of the status quo. The Nobel Laureates attempted to foreground NGOs' interests and values, in this case Greenpeace's, while dismissing them as being overly emotional and dogmatic. Simultaneously, the Laureates minimised their own interests and values by attempting to veil them in the language of science and evidence while advocating for a political choice regarding the expansion of agricultural biotechnology within agriculture.

Our results suggest the debate about genome editing has little to do with science and evidence or emotion and dogma and more to do with the politics of technology. Within this contestation over the role of genome editing in shaping the future of agriculture, all parties are jostling to put forward a set of interests and values, but NGOs engaging with GM are attempting to challenge the existing parameters of the debate. Specifically, they try to open up a narrow technical debate to broader questions about relations of power, research priorities and the future of technology in agriculture. In doing so they seek to politicise genome editing. In contrast, Nuffield follows an institutional imperative towards balanced scoping which does not explicitly raise or seek to resolve issues of conflict and power.

Finally, the lack of space in which to meaningfully discuss political questions of agricultural technologies raises broader questions about the involvement of NGOs within current processes of public bioethical deliberation and public engagement more generally, both in the UK and broader European context. For example, in the UK a recent select committee hearing on GM insects failed to gain the involvement of GM-critical NGO groups (House of Lords Select Committee on Science and Technology 2015). In the EU, research has shown how risk decision making for genome editing science contains a range of ethical and social concerns which are often closed to public scrutiny within narrow science-based risk regulatory processes (Wickson and Wynne 2012; Wynne and Wickson 2012; Hartley and Millar 2014; Hartley 2016b). Our findings highlight another factor that may be stimulating the observed shift in NGO engagement from upstream inputs into the policy and regulatory process to focusing on downstream reactions to policy and regulatory outputs (Hartley et al. 2017). Specifically, that when engaging with such institutionalised processes of deliberation, NGO critiques are shaped to conform to specific institutional framings and logics, in this case Nuffield's. Given that Nuffield follows an institutional imperative towards balanced scoping and does not explicitly raise or seek to resolve issues of power, the consequence for NGOs is that their core concerns and questions regarding who wins

and why are framed out of Nuffield's report. With such a central part of their critique made absent in the outputs of bodies such as Nuffield, the value of continued NGO engagement with such processes are arguably diminished.

Conclusion

Our investigation and comparison of current expert ethical and GM-engaged NGO assessments on the social and ethical dimensions of agricultural biotechnology through the controversial case of plant genome editing has highlighted a large degree of convergence between the different groups. Both Nuffield and participant NGOs drew attention to similar set of issues regarding genome editing; the problem/solution framings, terminology, impacts on consumer choices and its implications for relations of power and control. Whereas participant NGOs put forward arguments for and against particular ethical positions, Nuffield's ethical assessment functioned to scope a discussion whilst drawing short of arguing for or against any position.

This finding mirrors the work of Hedgecoe (2010), who similarly notes, in the context of pharmacogenetics, that professional bioethics tends to avoid putting forward arguments for or against ethical positions. Furthermore, Hedgecoe goes on to argue that "bioethicists are no longer questioning the 'ideologies and technical fantasies of the professional', but have largely bought into their claims, both technical and ethical" (Hedgecoe 2010, p. 180). Such dynamics are likewise apparent in this domain of agricultural biotechnology. For example, regarding regulatory traceability and its implications for consumer choice, Nuffield discussion is predicated on an acceptance of academic scientists and industry claims and future expectations pertaining to the precision and control achievable through genome editing techniques, expectations upon which it is assumed that tracing and differentiating genome edits against naturally occurring genetic changes will be potentially impossible. In doing so, bioethical assessment is enrolled in the co-construction and stabilisation of future technological expectations rather than critically responding to it (Hedgecoe and Martin 2003). However, more fundamentally, whether we *should* develop technologies that present such a major challenge to the ability of people to make choices over food on their own terms remains unaddressed. By ducking such questions bioethics is arguably failing to provide a rigorous and critical engagement with genome editing that enables thinking about the kind of futures we want to live in (Hedgecoe 2010).

Yet this is not to argue simplistically that NGOs fulfil such aspirations. As we have shown, NGOs articulate a clear, critical position on genome editing based upon critical engagement with relations of power and scepticism of scientific and industry claims, and propose alternative food

and agricultural futures. However, such positionality is not without its limitations. For example, it remains a pertinent point that genome editing potentially offers opportunities to 'democratise genetic engineering' (Tauxe 2015). Through articulating a deeply sceptical position towards genome editing technologies, the GM-critical NGOs are poorly positioned to engage with alternative futures opened up by these technologies, such as the potential to disrupt the concentration of power within agricultural biotechnology and redistribute benefits amongst a wider range of industry actors. As a result, genome editing may also disrupt some of the established NGO critiques surrounding power dynamics in the sector. This is an area of ethical reflection that Nuffield is able to open up and GM-critical NGOs have yet to grapple with. Alternatively, the NGOs are able to interrogate the context of corporate power and industrial agricultural systems with a level of depth that Nuffield may be unable to achieve. In short, NGOs and Nuffield bring different value (and values) to the table that are important in shaping their ethical gaze and the ethical gaze of others.

Public involvement, of which NGOs constitute one such public, is an important component of governance for emerging techno-science. There is a need to recognise that ethical expertise is not just held by professional ethical experts but also by those outside formal institutional contexts. The conclusion is not that Nuffield needs to become an issue advocate (Pielke 2007), but to recognise that both Nuffield and NGOs engaged with GM, due to their different roles, institutional contexts, and positions in the UK polity, *both* provide valuable ethical insights and offer different resources from which draw ethical expertise. Potentially, environmental, food and farming NGOs provide a useful lens to open up debate and discussion on the role of emerging technologies, such as genome editing, in agricultural and environmental policy-making. This politicisation should be welcomed and engaged with by political institutions and public research bodies if they are committed to wider public dialogue and involvement.

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