TITLE: Why are NGOs sceptical of genome editing?

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In 2016, 107 Nobel Laureates signed an open letter calling on Greenpeace to desist from campaigning against agricultural biotechnology and for governments to reject and resist such campaigning, arguing that "[o]pposition based on emotion and dogma contradicted by data must be stopped" (Support Precision Agriculture, 2016). The letter marked the latest chapter in a long-running, heated and apparently intractable debate around agricultural biotechnology (Burke, 2004; Kuntz, 2012; Tagliabue, 2016). Yet, while the arguments by Greenpeace and other non-governmental organisations (NGOs) against agricultural biotechnology are frequently dismissed as based on emotion and dogma, their opposition is often grounded on more general skepticisms concerning the framing of the problem and its solutions and the motivations of actors to employ biotechnology in agriculture.

Genome editing is an important case of agricultural biotechnology. In Europe, however, the European Commission has been delaying a decision on the regulation of genome editing and New Plant Breeding Techniques (NPBT) for use in agriculture. In the meantime, numerous groups are attempting to influence the debate, including biotechnology companies, scientists and NGOs. Scientists and their representations have been particularly prominent in these debates in contrast to a more muted position from commercial interests as companies have adopted a 'wait and see' strategy with regards to the pending regulatory decision on genome editing (Nuffield Council on Bioethics, 2016). As with earlier debates on genetically modified (GM) crops, NGOs have become the subject of intense criticism from leading scientists who support genome editing in agriculture. The subsequent debates have aroused

passions on all sides, but rarely led to greater mutual understanding. In this paper, we use the case of genome editing to argue that the Nobel Laureate letter may have mischaracterised opposition to agricultural biotechnology as rooted in emotion and dogma. Rather, our results suggest that this opposition is grounded in three specific types of scepticism concerning the problem framing of food security; the focus on intensive agriculture and technological solutions to the problem of food security; and the motivations for adopting agricultural biotechnology. Below, we describe our methods for analysing NGO scepticism, before providing more detail on each of three types of scepticism.

Frame analysis

Our findings are based on a one-day focus group and nine semi-structured interviews involving fourteen participants from UK and EU-based NGOs with an interest in genome editing in agriculture: Beyond GM, Compassion in World Farming, Corporate Europe Observatory, Econexus, FARM, Food Ethics Council, Friends of the Earth, GeneWatch UK, GM Freeze, GM Watch, Greenpeace, Logos Environmental, Sustain, and Permaculture Association. Owing to the small size of several 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.

We draw on the concept of framing to clarify understanding of NGO scepticism towards agricultural biotechnology. Framing is a process through which some aspect of a perceived reality is emphasised so as to promote a particular problem definition, motivation for action or solution (Entman, 1993). Frame analysis is therefore a tool to analyse how groups articulate and promote a particular understanding of an issue, and why they exclude alternatives. To identify NGO framings of agricultural biotechnology, we focused on delineating key framing tasks: diagnostic framing (identification of problem and its cause/attribution of blame), motivational framing (impetus for action), and prognosis framing (presentation of solutions) (Morris, et al., 2016) by the participants when constructing their arguments. Following this approach, we identified how NGO participants expressed an alternative framing of agricultural biotechnology that was sceptical of the dominant problem and solution framing and articulated their motivations for rejecting agricultural

biotechnologies. The analysis highlighted a large amount of consensus between the NGOs although some areas of divergence exist.

The focus group and interviews further examined the social and ethical issues raised by NGOs in the context of agricultural biotechnology with a specific focus on genome editing. The interviews highlighted that NGOs are not a homogenous or unified group. They have different roles dependent on their organisational structure and mission statement, and placed varying emphases on the different issues at stake. We report the most prominent themes expressed by NGOs related to their scepticism of the problem and solution framing and the anticipated outcomes. Quotes represent key messages from the wider data set and have been lightly edited for clarity.

Contesting problem framing

Food security frames the problem of hunger as a lack of sufficient quantities of food to feed all people, now and in the future. Consequently, farmers need to produce more crops and genome editing is offered as one technology to increase crop yield. However, the majority of NGO participants contested this framing, arguing that the problem is not one of quantities but one of access and control. A smaller number of NGOs outlined an alternative framing, that of food sovereignty. "We more and more promote food sovereignty, so it's about farmers being in control of the system and consumers having a safe, fair food supply to buy or to grow themselves" (Interview Participant 4). "[T]o me it's about, food sovereignty is about giving people the right to own food systems, it's about preserving the genetic heritage we have, it's about giving control to farmers to grow the way they need to grow …" (Interview Participant 8).

In contrast to food security, food sovereignty draws attention to who controls the way food is produced and the implications in terms of access to food and arable land, and decision-making (Mooney & Hunt, 2009). NGOs suggest further potential problems of increased corporate control of agriculture through patents and diminished consumer control through de-regulation of labeling requirements. Consequently, NGOs predict that adoption of genome editing to generate new crop varieties will diminish food sovereignty and thus exacerbate the underlying issue of access to food and control of food production.

NGO participants repeatedly questioned whether framing food security as a crisis, which often constitutes a justification for genome editing, should be taken at face value. The most prominent example was the pressing need to achieve food security in the context of emerging global threats, including climate change and population growth. Participants were sceptical of the motives for declaring a food security crisis and thus questioned the alleged urgent need for genome-edited crops to increase yields. For example: "… 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 R1).

Participants argued that the use of 'crisis' or 'emergency' frames to justify genome editing was not simply a declaration of fact, but a political claim used for political means. They suggested that declarations of a global crisis were used to silence critics, with proponents of genome editing claiming the moral high ground and opposition framed as unethical. NGO participants argued that this would steer publics into accepting controversial technological trajectories, obscuring a political choice behind a façade of necessity.

Contesting solution framings

NGO participants argued that genome editing fails to address the inherent unsustainability of monoculture-based agriculture. They saw genome editing as a managerial solution by providing new avenues of control through modifying specific plant traits, most notably insect and herbicide resistance. "[I]n a sense genetic modification is a response to how do we solve the problem of monoculture. … new plant breeding techniques are still trying to solve problems that actually we don't really need to have in the first place" (Interview Participant 8).

As some participants noted, even if new genome editing techniques help to generate plants that solve the managerial problems of intensive monocultures, they cannot solve the negative externalities that intensive monocultures produce. These externalities include biodiversity loss, displacement of local populations, land tenure disputes, environmental degradation and pollution, many of which contribute to wider human and environmental problems of food vulnerability. Participants argued that previous agricultural biotechnologies such as GM

crops have been developed with neither the intention nor the capacity to address these issues. Intensive agriculture would therefore propagate many of the problems that NGOs argue cause systemic food vulnerability. If intensive monocultures are the problem, then genome editing is not the solution. Instead, NGO participants argued for the need to consider alternative forms of agricultural production, which were perceived as more sustainable and equitable.

All participants argued that commercial and government responses to the problem of food security rely heavily on technological solutions such as genome editing. Although some alternative agriculture NGOs saw this as a necessary part of sustainable transitions in agriculture, all NGOs regarded this continued reliance on scientific and technological solutions as crowding out much needed discussion of alternative means of addressing global food vulnerabilities. "I think there will be a significant body of people out there who don't think it'll be worth the bother really and that there are other ways that we can tackle the problems that the technologies purport to solve" (Interview P1).

The majority of participants argued that because agricultural biotechnology was entangled with intensive agriculture, it closed down discussions of alternative systems of agricultural production that, in the long term, might be more socially, environmentally and economically sustainable. "So whilst new plant breeding techniques can offer some potentially really significant breakthroughs … I think it's the small scale, diversified agro-ecological farming systems which are actually mostly the future of farming in the world" (Interview P8).

Overall, investments in agricultural biotechnology were seen as out of step with these alternatives systems. Rather, emergent interest in genome editing was regarded as drawing on research funding that could be better spent elsewhere, if the debate was opened up to discuss alternatives. NGO participants argued that this reliance on scientific and technological solutions to foods security was shaped by special interests capturing policy-making and the reliance on technology for economic growth. "[P]rogress is always good and growth is driven by technology and any kind of debate about which technology we want to choose as a society is seen as a barrier to growth" (Interview P5).

The reliance on scientific and technological solutions was therefore linked strongly to commercial and national interests. Participants argued that one major consequence of this linkage between technology and economic growth was that public engagement did not

function to discuss publicly acceptable solutions, but instead to persuade the public that the chosen technologies were the right ones, and were safe and useful.

All participants were sceptical about claims that genome editing was a novel and sufficiently different solution to established techniques and the extent to which it requires de-regulation. In particular, they argue that advocates of genome editing attempt to create a rhetorical space between genome editing and 'traditional' genetic modification, through the use of categories such as New Plant Breeding Techniques. "Industry basically planned the name to divorce the new techniques from what people generally see as a bad old GM story" (Focus Group P5). "And they describe this technology as very precise … But they were describing that as meaning it's going to be so much better" (Interview P4). Participants argued that the goal of this use of language was to de-stigmatise genome editing and separate it from first-generation GM technologies, thereby increasing its acceptability to policy makers and the public.

Contesting motivations

NGO participants made repeated reference to the commercial dimension of genome editing and were highly sceptical of the way in which this matter was routinely marginalised in debates. "[O]ur primary concerns were that these technologies were being used to make rich people richer, not to make the world less hungry or more bio-diverse or more resilient to climate change" (Interview P8). Specifically, they argued that crops produced through genome editing will be commercial products and continue to offer ambiguous benefits to the people, places and systems that are most vulnerable, particular farmers in the South. Consequently, NGO participants perceived public and private research as creating opportunities for increased corporate capture of the agricultural and food system at the expense of farmers, citizens and consumers. Ultimately, the scientific advancement of genome editing could not be disentangled from commercial interests within agricultural regimes.

NGO participants argued that this dynamic also played out through narrowing the debate to scientific assessments of risk and safety. Rather than engaging with this commercial dimension, advocates for genome editing support risk assessment as the sole basis upon which to make decisions about genome editing (Support Precision Agriculture, 2016). "Well there's a vested interest in those that are trying to promote the technology to not talk about

those wider issues and they are more complex … they are about power…. It's much easier to talk about whether it's safe or not" (Interview P4).

NGO participants argued that the sole reliance on scientific risk assessment came at the expense of social, economic and political considerations, something they found deeply frustrating and self-defeating. For them, it was not possible to disentangle the science of genome editing from these political dimensions. Even if genome-edited plants were proven safe, current regulations cannot demonstrate that these broader concerns have been resolved.

An opportunity to build understanding?

Our research suggests that opposition to agricultural biotechnology cannot be dismissed as being solely emotional or dogmatic as the Noble Laureate Letter contends. Instead, NGO participants' opposition to genome editing is rooted in three areas of scepticism: how the problem is defined as a lack of food rather than a lack of access to food, and the urgency of this crisis which closes down alternative solutions; the solutions, particularly whether further entrenching intensive agriculture through science and technology can address political and socio-economic inequalities; and the motivations for removing genome editing from GM regulations.

Frame analysis draws attention to an important characteristic of environmental controversies: that they cannot always be reduced to matters of fact. In adopting frames, individuals and organisations inevitably emphasise some issues and downplay others, thereby excluding 'uncomfortable knowledge' (Rayner, 2012) which does not correspond with a given frame. The exclusion, for example by the Nobel Laureates, of uncomfortable knowledge pertains to the poor practical efficacy of crops produced through agricultural biotechnology. Despite nearly 30 years of research and development, the fruits of agricultural biotechnology remain largely promissory (Nuffield Council on Bioethics, 2012). Long-standing promises of more stress-resistant or nitrogen-fixing plants have not been delivered (Nuffield Council on Bioethics, 2016). Conversely, for NGOs, uncomfortable knowledge includes the potential of genome editing to 'democratise' science owing to is increased accessibility, relative ease of use, and 'off the shelf' characteristics (Nuffield Council on Bioethics, 2016), which undermines their framing of corporate control over the food chain. The NGOs did not discuss the democratising potential of genome-editing technologies such as CRISPR/Cas, but focused

on the current state of ownership regarding the products and proceeds of agricultural biotechnology without considerations of how genome editing may challenge this *status quo*. The way to cope with this uncomfortable knowledge is to ensure diversity in decision-making processes, otherwise decisions will lack robustness (Rayner, 2012) and will get challenged. The history of agricultural biotechnology provides a powerful illustration of such social dynamics.

Sceptical NGOs present alternative problem and solution framings with different outcomes, as part of a broader political discussion about policy impacts within society. An age-old political question underpins all the scepticisms described above: who gets what, when and how (Lasswell, 1936). Increasing food production through agricultural biotechnology to meet imagined future demand is a political choice with political consequences for access to food, land and control over how food is produced.

There is ample evidence from the social sciences that environmental controversies cannot be adequately addressed through science alone, and that political issues and the values underpinning them must be acknowledged (Sarewitz, 2004). Yet, there is a danger that this evidence is being ignored, miring genome editing in a similarly polarised and intractable debate as the wider field of agricultural biotechnology. Understanding and accommodating different positions is vital (Hartley, et al., 2016). Opportunities are needed for considering alternative technologies, agricultural practice and political solutions to food vulnerability. Open and constructive debate building mutual understanding of opposing positions is needed if the goal is to truly assess the potential for genome-edited crops to play a role in addressing the problem of global food vulnerability.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest. LO'N's position as co-author represents her key role facilitating contact with research participants who have been traditionally hard to access. LO'N was a focus group participant, was not interviewed and played no part in research design or data analysis. WP and SH designed the research, conducted data analysis and contributed to writing the paper. RH conducted data analysis and led the writing of the paper.

ACKNOWLEDGEMENTS

This work was supported by funding from the following sources: the Governance and Public Policy Research Priority Area Award, University of Nottingham; the Business, Institutions and Policy Research Cluster Award, University of Exeter; the Research Development Fund, Department of Sociological Studies, University of Sheffield. We would like to thank Penny Polson (University of Manchester) for her assistance in data collection.

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