Genetic Food Futures: Increasing participation with the Genetically Modified Organism Consortium

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Abstract

The aim of this article is to offer an answer to the question: How can we improve public engagement in the genetically modified organisms debate? It will describe the models of Public Understanding of Science and Public Engagement with Science. Public Understanding of Science dates back to the 1970s and is intended to create a relationship between science and people through education. The UK's House of Lords Select Committee on Science and Technology introduced the Public Engagement with Science model in 2000. Public Engagement with Science calls for a dialogue between scientists and society, enabling science to be questioned. These models have been used in the past with controversial issues such as GM organisms, although not always successfully. The article concludes by proposing the Genetically Modified Organism Consortium. This proposal is based on the idea of engaging more voices in the debate, and offers a global, national and local response.

Keywords: Genetically modified organisms; climate change; food security; environment; public engagement with science; public understanding of science; Genetically Modified Organism Consortium.

Introduction

The aim of this article is to offer an answer to the question: How can we improve public engagement in the genetically modified (GM) organisms debate? Before addressing this question, I briefly outline some of the current issues and problems facing the food system.

The environment is crucial for meeting our food needs. Growing inequalities, increasing urbanisation and exceeding the Earth's natural resources so they are no longer renewable, are all expected to contribute to food insecurity in the future. Whilst a growing global population needs to be mentioned because there will be more people to feed, this could be addressed by less waste, better distribution, and sustainable efficiencies in agriculture (**Lang, 2021**). However, tackling all of these issues will be challenging. As Godfray et al. explain:

> *A threefold challenge now faces the world: Match the rapidly changing demand for food from a larger and more affluent population to its supply; do so in ways that are environmentally and socially sustainable; and ensure that the world's poorest people are no longer hungry. This challenge requires changes in the way food is produced, stored, processed, distributed, and accessed that are as radical as those that occurred during the 18th- and 19th-century Industrial and Agricultural Revolutions and the 20th-century Green Revolution.* (**Godfray et al, 210: 812**).

As this statement illustrates, radical changes to the food system are required. These changes will need to take place whilst also dealing with stresses from climate change and environmental degradation. These two problems are fundamentally entangled with social justice as climate change and environmental degradation will disproportionately affect the poor (**Nixon, 2011**), along with indigenous communities (**Whyte, 2017**) and nonhuman animals (**Wright, 2017**). Natural hazards, extreme weather patterns, and shortages of food and water are threatening the lives of the poor and indigenous communities. With nonhuman animals, many of the world's most threatened species live in areas which are or will be severely affected by climate change. For these species, climate change is occurring too quickly for them to adapt. In responding to these threats, there is a need to look beyond science. This should not be impossible though as Duncan and Bailey (**2017a: 2**) suggest 'solutions to the myriad problems related to food systems are not only to be found in new scientific discoveries. They are being developed and implemented by people responding to challenges in their communities and in their countries'. As such, we need to reimagine and redesign the food system by drawing on the different knowledges available.

Climate change will bring new challenges for agriculture as more extreme weather conditions and patterns will increase crop yield volatility (**Roesch-McNally et al., 2017**). Farmers have always had to contend with some variability and volatility from year to year, but extreme weather events of recent years have heralded what is to come in the future (**Lang, 2016**). However, the problem with climate change is that it is speculative. Organisations such as the Intergovernmental Panel on Climate Change (IPCC) can make predictions as to what they believe will happen with climate change, but they can only do so with degrees of confidence (see **IPCC, 2019**). Other threats to the food system include environmental degradation from intensive agriculture [1], which has led to eroded, degraded and nutrient poor soil, and polluted and inadequate water supplies (**Lang & Heasman, 2015**). Science and technology is often turned to in order to address problems such as these. Rosi Braidotti uses the concept of the 'Fourth Industrial Revolution' to describe how biotechnology, nanotechnology, artificial intelligence, the Internet of Things[2], and robotics are increasingly being developed and used to solve problems that humanity faces (**Braidotti, 2019:2**). Braidotti goes on to explain how these technologies can create more problems than they solve by depleting the Earth's resources and creating social inequalities. Currently, we are positioned between the Fourth Industrial Revolution and the Sixth Extinction. Kolbert (**2014**) describes how the five extinctions which have gone before in the last half billion years, have occurred dramatically and suddenly. However, she explains that the Sixth Extinction is forecast to be more devastating and is a result of human activity. Humans are dependent on the Earth's biological and geochemical systems (**Kolbert, 2014; Wright, 2017**). As these systems are disrupted and altered through the cutting down of rainforests, the alteration of the composition of the atmosphere, and the acidification and warming of the oceans, the survival of humans and the more-than-human world are put at risk. By being positioned between the Fourth Industrial Revolution and the Sixth Extinction, we are subjected to the 'systemic accelerations of advanced capitalism and the great acceleration of climate change' (**Braidotti, 2019: 2**).

Food production is strongly linked to factors such as climate change. There have been significant changes in extreme temperatures, droughts and floods since the middle of the twentieth century, resulting in failing crops and reduced yields (**Lesk et al., 2016**). Extreme weather events pose new levels of risk and volatility for farmers (**Lang, 2016**), potentially leading to the failure of crops. Genetically modified crops have been proposed as a potential solution for crops which need to be drought tolerant or flood resistant.

Genetic technologies use artificial techniques instead of natural crossing and recombination. Genetic modification is where a gene from one species is inserted into the genome of another species (**Phillips, 2008**). Gene editing is where a gene is inserted from the same species or removed from the genome (**Shew et al, 2018**). Both plants and animals can be genetically modified or gene edited. For the purposes of this article, genetically modified will refer to organisms which can be genetically modified or gene edited. The use of the term organism is used to denote plants or animals.

It is important to note that GM organisms are controversial. The controversy surrounding GM organisms exemplifies why there is a need to engage people with science. In the next section, I discuss the Public Understanding of Science model and the problems associated with it, before examining the Public Engagement with Science model. These two models can help us understand and make sense of the controversial nature of GM organisms. I then move on to discuss genetically modified organisms and the debates which have taken place in the UK and Mexico. In the final section, I examine the concept of observatories and consortiums before introducing the Genetically Modified Organism Consortium.

Public Understanding of Science

Attempts to assess levels of public understanding of science date back to the 1970s when the US National Science Foundation conducted surveys to determine people's knowledge of scientific facts (**Stilgoe & Wilsdon, 2009; Irwin & Michael, 2003**). Walter Bodmer's *The Public Understanding of Science* report (**The Royal Society, 1985**) was influential in the UK. With the Public Understanding of Science (PUS) model, the emphasis is placed on scientists to inform the public about the value of science. The model is based on the idea that the public are ignorant about science, and once they understand it, they will trust it (**Stilgoe & Wilsdon, 2009**). This assumption is at the heart of what has become known as the 'deficit model', and is how the Public Understanding of Science perspective came into being. Irwin (**2009: 7**) describes the deficit model

as the assumption on the part of institutions and their science communicators that the public is ignorant about science – but that it (for this is a singular presentation of 'the public') would accept science readily if it only knew more (with 'science' similarly being singular rather than plural or heterogeneous). The deficit perspective suggests one-way communication with a passive audience soaking up 'the facts'.

The ideas on which the Public Understanding of Science model were based were intended to create a relationship between science and people. The intention for 'the public' to have a greater comprehension of science was widely regarded as advantageous by the scientific community and Government agencies in the UK.

The Public Understanding of Science model meant both 'the public' and the level of understanding or ignorance about science had to be generalised. However, this approach did not work. Science means different things to individuals depending on the situation they find themselves in. As scientists cannot reach a consensus as to what science is (**Holliman & Scanlon, 2009; Irwin & Michael, 2003**), it is not surprising that people face the same dilemma. Brian Wynne's research found that 'public uptake (or not) of science is not based upon *intellectual capability* as much as social-institutional factors having to do with social access, trust, and negotiation as opposed to imposed authority. When these motivational factors are positive, people show a remarkable capability to assimilate and use science or other knowledge derived (inter alia) from science' (**Wynne, 1991: 116**, emphasis in original). People can be educated about science, but they are unlikely to accept this if they do not trust the science being conducted. Wynne also found that 'people do not use, assimilate, or experience science separate from other elements of knowledge, judgment, or advice' (**Ibid: 114**). Education in the *Public Understanding of Science* report by The Royal Society (**1985**), is defined as: formal education; the media; public lectures, children's activities, museums, libraries; and scientists learning to communicate better with people. If science education is dismissed by people, this could be because 'public nonreceptivity to scientific information is often based on judgment that it is not *useful* or does not match public or personal experience' (**Wynne, 1991: 116,** emphasis in original). People may be dismissive of scientific developments if they run counter to their previous experiences. It should also be acknowledged that people will decide what types and kinds of knowledge they wish to acquire (**Irwin, 2009**).

The problem with the Public Understanding of Science model is that it fails to recognise that non-scientific experts can be knowledgeable and informed about everyday conditions of life. 'Science might have as much to learn as to communicate' (**Irwin, 2009: 7**) when it comes to understanding the social realities of controversial subjects such as GM organisms.

Public Engagement with Science

Publics still questioned and mistrusted science even though they were being informed by scientists. The assumption that to 'know science was to love science' was directly undermined by certain events during the 1990s (**Stilgoe & Wilsdon, 2009: 19**). This started with the crisis surrounding bovine spongiform encephalopathy (BSE) in cattle and the link to new variant Creutzfeldt-Jakob disease (nvCJD) in humans, and continued with GM crops, risks surrounding mobile phones, and concerns about the measles, mumps and rubella (MMR) vaccination (**Stilgoe & Wilsdon, 2009**). The 'people's relationship with science was far more active and sceptical than previously thought. People wanted to be able to ask questions of science and have their voices heard' (**Ibid: 20**). Even the then UK Chief Scientific Adviser, Sir Robert May, called Public Understanding of Science, 'a rather backward-looking vision' (**House of Lords Select Committee on Science and Society, 2000: paragraph 3.9**). Following the release of the *Science and Society* report by the UK's House of Lords Select Committee on Science and Technology (**Ibid**), non-experts were to be brought into the policy-making process surrounding scientific issues. The Select Committee introduced the Public Engagement with Science model.

Public Engagement with Science calls for a dialogue between scientists and society. Science should be questioned by society and there should be broader engagement with other experts, stakeholders and people. Irwin (**2015: 25**) argues that at the 'core of what has come to be defined as 'public engagement' there is generally an attempt to 'broaden' discussion, to identify new issues and to consult groups which might not otherwise be heard'. The aim is to bring science and people closer together.

According to Stilgoe and Wilsdon (**2009: 29**), 'public engagement provides a lens through which policy-makers can see issues differently, focusing on contexts, uncertainties, alternatives and local concerns'. Jasanoff (**2003: 239**) contends 'what is lacking is not just knowledge to fill the gaps, but also processes and methods to elicit what the public wants, and to use what is already known'. In the case of GM foods, there can be a number of responses. For example, some people perceive the manipulation of genes as unethical (**Shiva, 2016; Fitting, 2014**), whilst others perceive genetic modification as a means of addressing food security (**Lang, 2016; Cook, 2004**). If people are actively engaged with the development of a new area of science or a particular technology as opposed to being passive receivers of information, the dialogue can be shaped to consider the majority of people's values and beliefs. Obviously, this takes into account more than risk, but this type of conversation between science and society enables progress to occur in a more informed manner. A meaningful and productive dialogue between science and society can be achieved by:

- Undertaking deliberative activities with people
- Scientists improving the communication surrounding risk and uncertainty
- Ensuring it becomes normal to bring science and people into dialogue about new scientific developments at an early stage (**Irwin & Michael, 2003**)

For Jasanoff (**2003: 226**), the 'wider public responsibilities of science, as well as changes in modes of knowledge-making, demand new forms of public justification'. This may be ethics in genetic technologies or precaution in environmental assessments. Here, the questions we need to ask include: 'what is the purpose; who will be hurt; who benefits; and how can we know?' (**Ibid: 240**). Approaches to asking these questions include:

- Stakeholder dialogues
- Focus groups
- Citizens' juries
- Consultations at national level
- Consultations at local level
- Deliberative polling
- Standing consultative panels
- Consensus conferences
- Internet dialogues (**House of Lords Select Committee on Science and Society, 2000**).

By asking these questions, dialogue opens up and this allows people to talk about the issues they feel are important. People can have well-reasoned opinions even if they have limited scientific literacy as knowledge can be obtained from lived experience (**Horning-Priest, 2009; Irwin, 2009; Irwin & Michael, 2003**). The knowledge gained from lived experience is based on 'collective, culturally mediated' experiences, and as such, local knowledges are intertwined and are part of local cultural identities (**Irwin & Michael, 2003: 34**). Lived experiences can complement scientific knowledges. However, in order for public engagement to be effective, it has to become part of routine practice (**Stilgoe & Wilsdon, 2009**).

Having discussed the Public Understanding of Science and the Public Engagement with Science models, I now return to genetically modified organisms.

Genetically Modified Organisms

Genetic modification has been used commercially in agriculture since the 1990s, and has met with widespread resistance since (**Lang, 2016**). In part, some of this controversy has arisen from the ‘control over the intellectual property of seeds, the regulatory approval needed (especially in terms of their environmental or human health impacts) in global markets and finally the corporate control over the GMOs and hence market power’ (**Lang & Heasman 2015: 205**). Additionally, there have been competing claims in connection with the benefits and problems associated with genetic modification. The benefits can be described as follows: an increase in crop yields; a reduction in chemical use (pesticides, herbicides, and insecticides) on crops; the cultivation of crops able to withstand environmental stresses such as floods, pests and drought; an improvement in the nutritional qualities of foods; and the improved taste, appearance and texture of foods (adapted from **Lang & Heasman, 2015: 205**). The problems can be described as follows: GM plants might cause unforeseen issues and become invasive species; there may be unintended gene flows from GM plants into other crops and wild relatives; GM plants modified to be toxic may cause harm to biodiversity; and there may be unintended health impacts for humans (adapted from **Lang & Heasman, 2015: 205**).

The topic of GM organisms is inherently international with the European Union (EU) restricting their use (**Lang, 2021**), whilst countries such as the USA, Canada and Argentina were early adopters (**Macnaghten et al., 2015**). Different countries have very different experiences of GM organisms (**Ibid**). There is extensive literature on agricultural biotechnology and GM organisms, and how the controversy has unfolded in different nation states (for examples see **Burke, 2012; Durant et al., 1998; Grove-White, 2001; Harper, 2004; Jasanoff, 2000; Marris et al., 2001; Murcott, 2001; Shaw, 2002**). I will be exploring the controversies in the UK and Mexico in the following section. Both of these countries have had an unstable and unpredictable historical relationship with GM organisms (**Macnaghten et al., 2015**), but for different reasons.

The GM Organism Debate in the UK

In the UK, the debate about GM crops has been particularly heated, with the government pulled between differences at the national level as well as between European countries and the USA (Cook, 2004). No GM crops have ever been grown commercially in the UK, and as of April 2021, this continues to be the case (**UK Government, 2021**).

June 1998 saw the publication of a letter by Prince Charles in the *Daily Telegraph* in which he raised doubts about the safety of GM foods and questioned its expansion (**Howarth, 2012**). This was followed by a television documentary in August 1998 which included preliminary research by Dr A. Pusztai. He claimed rats fed on GM potatoes suffered from reduced immunity and stunted growth (**Burke, 2012; Howarth 2012**). The claims of harm by Dr Pusztai were more strongly voiced in the spring of 1999, although scientists from other institutions along with the Royal Society, strenuously criticised his experiments and analysis. Media coverage of these events spiralled, and the newspapers, the *Daily Mail*, the *Daily Express*, the *Independent on Sunday* and *The Mirror*, started campaigning against GM food as they were opposed to its introduction (**Howarth, 2012**). Howarth (**Ibid: 219**) describes these campaigns as 'a deliberate and self-conscious shift on the part of editors from classic liberal assumptions about ''impartial reporting'' to participatory arguments about the legitimacy of seeking to mobilize the public and influence policy in conditions of acute uncertainty, overwhelming public interest and the undemocratic tendencies of the government'. During this period, whilst the Government used the Public Understanding of Science model to discuss the introduction of GM crops, the newspapers appeared to be pushing for a more dialogic approach based on the Public Engagement with Science model. The campaigning stance by the news organisations was to encourage people to resist the introduction of GM crop cultivation and the sales of GM foods by retailers. An example is GM tomato paste which is described by Burke (**2012**). The tomato had been genetically modified by reducing levels of a pectin-degrading enzyme which decreased rates of rotting and enabled tomatoes to be picked ripe rather than green. These tomatoes were grown and processed into puree in California and then shipped to the UK. The tomato puree was clearly labelled as GM, and was sold by Safeway and Sainsbury's for 29p a can, outselling the non-GM equivalent by 2:1. As the campaigning by the newspapers reached its height, people stopped purchasing the GM tomato paste and retailers removed it from their shelves.

Along with the campaigning, it is useful to note the two terms which have been used by journalists to describe GM foods: 'Frankenfood' and 'Frankenstein foods'. The term 'Frankenfood' was coined by Paul Lewis, a professor in English at Boston College, USA, to describe GM food (**Lang, 2016**), whilst 'Frankenstein foods' was first used by the *Daily Mail* on 28 January 1999 (**Cook, 2004**). This terminology has been used extensively by news organisations campaigning against the introduction of GM crops. Journalists draw upon the 'Frankenfood' terminology because it often reflects consumer anxiety about the use of GM technology in food production, and the risk to the integrity of natural ecosystems by transferring genes from one species to another (**Fitting, 2014**). 'Frankenstein food' and 'Frankenfood' implies a connection between Frankenstein's monster and GM crops due to the potential for them to escape into the wider countryside, cause damage, and become out of control (**Cook, 2004**).

During the summer of 2003, the UK Government's public consultation of *GM Nation?* took place. This was to be based on the Public Engagement with Science model. For Barbagallo and Nelson (**2005**), the purpose of this debate was to determine whether GM crops should be commercially grown in the UK by enabling the public to participate in the discussion. In addition to the public strand of the debate, there were also official expert forms of consultation in the economic and scientific strands. The economic strand provided an assessment of the costs and benefits of GM crops, whilst the science strand reviewed all available research concerning genetic modification. As Irwin (**2009**) explains, the economic and science strands fed into the decision-making process, whilst the opinions and viewpoints from the public strand were considered but effectively ignored. The UK Government's decision to proceed with GM crops on a case by case basis fitted more easily with the economic and science strands. He also states that one particular criticism of the debate was it came too late as GM crops were already close to coming to market. Furthermore, Burke (**2012**), who was present at some meetings, describes how the pro-GM and anti-GM groups talked past each other so no agreement could be reached. Additionally, he explains how a second attempt of this type of debate was made by the UK Government in 2009. The panel consisted of scientists, social scientists and members of environmental NGOs, but once again, no consensus was reached so the project ceased in 2010.

In the UK, GM organisms are likely to be considered as part of the technological solution to addressing food security in the time of climate uncertainties. Boris Johnson, the UK Prime Minister, has already suggested he will support GM organisms when he stated in a speech, 'let's liberate the UK's extraordinary bioscience sector from anti-GM rules. Let's develop the blight-resistant crops that will feed the world' (**Farmers Weekly, 2019**). On 7 January 2021, the UK Government's Department for Environment, Food and Rural Affairs (Defra) launched a 10 week long online public consultation in England only, into the deregulation of plants and animals using gene editing. At the time of writing, (**April 2021**), Defra is yet to report. The public consultation has received criticism from civil society groups such as Beyond GM and the Landworkers' Alliance. Both of these civil society groups believe Defra have already decided to proceed with the deregulation of gene editing, and they have raised concerns that the online consultation was too technical and inaccessible for people to respond to (**Beyond GM, 2021; Landworkers' Alliance, 2021**). The Food

Ethics Council also wrote an open letter to George Eustice, the Secretary of State for Environment, Food and Rural Affairs. In this, they state that:

The consultation is presented in a one-sided way, which is not desirable or appropriate, as it feels to lots of civil society organisations like a *fait accompli*. This is likely to lead to further polarisation. It also excludes a number of important aspects of the technology, as well as moral perspectives. Much of the consultation document uses technical language that is not appropriate for a non-specialist audience (**Food Ethics Council, 2021**).

Instead of using this as an opportunity to engage in a meaningful dialogue with the public, Defra have returned to the deficit approach and the Public Understanding of Science model.

The GM Organism Debate in Mexico

The situation in Mexico surrounding GM crops is different. The controversy largely focuses on GM maize with other genetically modified crops largely excluded from the debate (**Carro-Ripalda et al., 2015; Fitting, 2014**). This is because of the importance of maize to the Mexican people. Maize originated from Mexico and there is believed to be around 60 landraces and thousands of native varieties (**Carro-Ripalda et al., 2015**). Maize is cultivated on 20 million acres (**Fitting, 2014**) by around 2 million traditional smallholder farmers (**Carro-Ripalda et al., 2015**). It is cultivated on a small scale, the crop is rain-fed and is mainly grown for subsistence (**Carro-Ripalda et al., 2015; Fitting, 2014**). For Mexicans, maize is a fundamental component of rural and urban people's diets (**Carro-Ripalda et al., 2015; Fitting, 2014; Fitting 2006**). As maize is culturally important as a crop and food, the debate is highly polarised (**Carro-Ripalda & Astier, 2014**).

In 1998, a moratorium was placed on GM maize trials in Mexico by the General Directorate of Plant Health. There were two reasons for this. Firstly, GM maize was considered to be of little economic benefit to Mexico, and secondly, there were concerns about the mixing of GM maize with native landraces (**Carro-Ripalda et al., 2015**). In 1999, Greenpeace discovered GM maize in a shipment of maize from the USA to Veracruz. In response, Greenpeace launched a high-profile anti-GM campaign (**Carro-Ripalda et al., 2015; Fitting, 2014**). At the same time, concerned scientists called for greater regulation of GM crops, and this led to the establishment of the Inter-Ministerial Committee on Biosafety (**Carro-Ripalda et al., 2015**). Ignacio Quist and David Chapela published an article in *Nature* in 2001, and this claimed they had discovered cauliflower mosaic virus (used in most transgenic maize) in native maize fields in Oaxaca, Mexico (**Carro-Ripalda et al., 2015**). It was thought this originated in maize imported from the USA (**Fitting, 2014**). This unintended gene flow was seen as a threat to the native maize varieties found in Mexico (**Carro-Ripalda et al., 2015; Fitting, 2014**) and to the culture of the Mexican people. In response to this, in 2002, the anti-GMO campaign and network, *In Defence of Maize* was established. Membership of the network consists of over 300 food activist, environmental, indigenous rights and peasant organisations, along with academics and scientists (**Fitting, 2014; Fitting, 2006**). With the scientists, Fitting (**2014: 181**, emphasis in original) explains that those 'who were involved in the network emphasised that they were not against agricultural biotechnology per se but rather against the testing and cultivation of transgenic corn *in Mexico*, where it is unsuitable and even a risk'. There were deep divisions over GM maize between the Government, the scientific community and the public. With little engagement during this period, the Public Understanding of Science model was used by the Mexican Government to discuss the introduction of GM maize.

In order to better understand the GM crop debate in Mexico, Carro-Ripalda et al. (**2015**) conducted a study, and they identified six issues. 1) Maize is an important crop for Mexican identity and culture. Communities claimed the introduction of GM maize was a form of imposed globalisation. Decisions taken by regulatory organisations about the introduction of the crop were viewed as compromised and lacking transparency. 2) Maize production was sustained by local community exchange and GM maize was viewed as an intrusion into traditional practices. GM maize was considered a threat to smallholder production, as well as being artificial and avoidable. 3) There was division between different groups. Smallholders, environmental NGOs, consumers and social scientists viewed traditional maize production as highly significant for Mexican culture and history. Large producers and seed companies claimed the introduction of GM maize would transform Mexican agricultural production. 4) There was division between scientists. Senior scientists were in favour of introducing GM maize, whilst junior scientists were cautious about its introduction. 5) Consumers negatively perceived GM maize and other GM crops. Issues raised included a lack of labelling, unreliable information, unknown dangers, a lack of proven need, and a lack of trust in the motives of those introducing GM crops. 6) There was a need to open up debate by giving smallholders a voice, as well as the need for a wider conversation about the production of native maize and food security. What these six points illustrate, was the lack of dialogue. This could have been addressed by deploying the Public Engagement with Science model.

On 31 December 2020, the Mexican Government banned the planting of GM maize along with the use of the chemical, glyphosate (**Greenpeace, 2021**). This is seen as a victory for the Mexican people. However, whilst there is also a ban on imports from the USA of GM maize for human consumption, livestock feed containing GM maize is still allowed (**Farm Journal, 2021**). It remains to be seen if imported livestock feed containing GM maize causes problems for Mexico, such as with the unintended gene flow into native maize in 2001.

Where Next?

In order to be successful in the sense that a consensus is reached, all types of actors will need to be involved in the public engagement process. So how do we achieve this? One possibility is the introduction of an observatory or coordinating body for genetic modification. Three propositions have already been put forward for gene editing by Jasanoff and Hurlbut (**2018**), Burrall (**2018**), and Kofler et al. (**2018**), and these are described briefly.

Sheila Jasanoff and Benjamin Hurlbut (**2018**) propose a global observatory for gene editing. This will be an international network bringing together academics and organisations. The observatory will fulfil three roles: 1) global ethical and policy responses to genome editing and associated technologies will be made accessible to all; 2) tracking and analysis of the developments, conflicts, and consensus around gene editing will be conducted; and 3) international meetings will be convened to discuss results from the analysis. For Jasanoff and Hurlbut (**2018: 437**), deliberation is 'insufficient if the conversation is too quickly boxed into judgements of the pros and cons, risks and benefits, the permissibility or impermissibility of germline genome editing, and so on. Such an approach neglects important background questions – who sits at the table, what questions and concerns are sidelined, and what power asymmetrics are shaping the terms of the debate'. By bringing more voices to the table, a more diverse and enriched debate can occur. This will be achieved by the network of academics and organisations gathering information from scattered and dispersed sources. Neglected issues are also brought to the fore and are just as prominent as those which may remake our futures. Here, Jasanoff and Hurlbut (**2018: 437**) argue, that 'consensus might even mean agreeing not to proceed with some research until a more equitable approach to setting the terms of debate is achieved'. The observatory will allow the limits and directions of research to be established. However, it is not clear from the literature how the observatory will have the authority to do this.

Simon Burrall (**2018**) suggests a consortium requiring government support and input from ten to fifteen organisations, with a coordinating body. He suggests including organisations such as research institutes, national farmers unions, agricultural and pharmaceutical companies, activist groups, and civil society groups concerned about the environment. The consortium will fulfil two roles: 1) connect people to debates concerning science and policy; and 2) connect scientists and policymakers to people. The consortium will both facilitate and promote debate.

Kofler et al. (**2018**) also propose a coordinating body to oversee gene editing. In their framework, the coordinating body will act as a neutral third party, and will include local communities, government, civil society groups, and NGOs. The coordinating body will fulfil four roles: 1) create a deliberative framework which includes diverse expertise including those from local, affected communities; 2) deliberation activities which feed into reports and produce recommendations; 3) the sharing of information to connect deliberation from around the world; and 4) reporting on the outcomes of deliberation to inform global governance of gene editing. Marginalised voices (women, children, ethnic minorities, and indigenous communities) and the needs of ecosystems will be included in deliberation activities.

All three propositions are different but their overarching aim is to engage more voices in the debate. However, there are some potential pitfalls. Sheila Jasanoff and Benjamin Hurlbut (**2018**), and Simon Burrall (**2018**) highlight the same issue which may be problematic with an observatory or consortium. There is a possibility that participants are those with dominant views which are often competing. These participants split into camps which are either for or against gene editing, and they start talking past one another without being heard. As inaudible voices are lacking, the range of debate is restricted and the richness in deliberation is not fulfilled. Burrall's (**2018: 439**) suggestion to address this problem is to ensure key stakeholders produce a 'statement of intent', so that the consortium has a specific role which members support. A further issue which Burrall (**2018**) highlights, is the significant investment in time and money. He estimates that funding for a consortium would be in the region of US$700,000 to $1.5 million per year. This is a significant hurdle which would need to be overcome. Kofler et al. (**2018**) suggest financing their coordinating body through a trust fund with contributions from governments, NGOs, and intergovernmental organisations. Both Burrall (2018) and Kofler et al. (**2018**) suggest that upfront investments are likely to be more cost effective than the improper use of gene editing.

As we have seen, the three suggestions put forward by Jasanoff and Hurlbut (**2018**), Burrall (**2018**), and Kofler et al. (**2018**), are slightly different in their approaches. In order to be effective, I argue that an organisation needs to be developed which incorporates aspects from all three propositions.

The Genetically Modified Organism Consortium

The Genetically Modified Organism Consortium needs to be global, national and local. By being global, responses to genetic modification can be compared from around the world. Each country will respond to the GM organism debate differently because each has its own particular set of circumstances. The GM organism debates particular to the UK and Mexico were described earlier in this article. A national network of observatories overseen by a global observatory, will enable each country to respond to its own individual needs with deliberative activities. Local deliberative activities with communities will feed into the national observatories, ensuring marginalised voices are heard. For example, in Mexico, the anti-GMO campaign and network, *In Defence of Maize* already exists. Involving a network such as this which is already established and aware of the issues facing its members, will be essential if public engagement is to be successful. Public engagement will be acknowledged as being successful if a consensus is reached. Consensus can mean *not* proceeding with research into GM organisms or the introduction of a GM organism, if this is the agreed course of action by participants.

In trying to reach a consensus, care needs to be taken when engaging local communities. If care is not taken, responsibility for the outcomes of the deliberative interventions is placed on the participating community as opposed to the organising consortium (**Henkel & Stirrat, 2001**). However, citizen engagement is important 'as it can elucidate certain aspects of the problem that have not been clarified through scientific evaluation. Analyses based strictly on science exclude certain social dimensions of risk, such as identity issues and societal choices – precisely the factors that lie at the heart of social controversies and conflicts' (**Poulain, 2017: 69**). Food and eating are central to subjectivity and our sense of self, so it is important that these aspects of identity are also considered. The earlier discussion about the importance of maize to Mexicans illustrates why care needs to be taken and why the debate needs to be widened out beyond science. As Duncan and Bailey (**2017b: 209**) argue, this 'does not mean that we reject science … It does mean that if we accept that all solution interventions are also social interventions, then we must find ways of ensuring that people, especially those most affected by these changes, can participate in decision-making'. Understanding societal impact becomes the main aim of the research because it involves those who will be affected by the research. It is important to acknowledge that in reality, some people will have a very sophisticated understanding of the science of genetic modification, whilst others have a more limited knowledge (**Burrall, 2018**). These different levels of knowledges should not be viewed as a barrier, but instead, should be seen as an opportunity to understand different perspectives. As the example with the UK illustrates, this is where the opportunity has been missed with the latest gene editing consultation. Instead of deliberation activities, an inaccessible online consultation has taken place.

We need to move away from scientists such as those working for the large agri-biotechnology companies governing genetic modification. These scientists are those who will gain the most, as their livelihoods and legitimacy depend on the advancement of genetic modification (**Montenegro de Wit, 2019**). Stone (**2017**) argues that scientists are urgently needed as 'honest brokers' to help educate, to enrich and deepen debates, and to inform policy. Stone (**2017: 585**) defines 'honest brokers' as 'providing information to expand and clarify a scope of choice, but allowing others to make decisions according to their own values'. There are democratic, ecological and economic questions which need asking of genetic modification. By including scientists who are willing to be 'honest brokers' in the consortium, we may move towards receiving honest scientific answers about GM organisms. As the example with Mexico shows, there were scientists who were aware of the importance of maize, and understood why the introduction of GM maize was problematic. These scientists were already part of the *In Defence of Maize* network. Including scientists such as these, who are part of existing networks and who understand why there are concerns about genetic modification, will be invaluable to the engagement process. Scientists like these, will be able to put forward and discuss scientific perspectives, but at the same time, will not be dismissive of valid concerns.

Along with the scientific perspective, it is also important to consider how genetic modification interacts 'with other ideas in sustainable agriculture like agroecology or regenerative farming and what that will mean for future agricultural and food systems' (**Klerkx & Rose, 2020: 5**). There are different pathways for the future of agriculture (**Anderson & Maughan, 2021; Klerkx and Rose, 2020**), and genetic modification may or may not play a role. With the latest UK consultation, if deliberative activities had taken place, there could have been discussion between different actors about how they wished to see agriculture move forward in the UK. This could have also included a discussion about the role of GM organisms in that future.

The knowledge of indigenous peoples also needs to be brought into the deliberative activities of the consortium. This will be through both science and indigenous knowledge. As Kim TallBear contends, it is important to acknowledge that we 'live in a world in which nations govern through science. Indigenous peoples are no exception. Therefore science must be governed to ensure that it is ethical and that its benefits are distributed to wider sectors of society' (**TallBear, 2014: 189**). This is similar to Arun

Agrawal's thinking, in that we need to look beyond the supposed divide between indigenous knowledge and science for two reasons. Firstly, there are many domains and types of knowledges and the 'same knowledge can be classified one way or the other depending on the interests it serves, the purposes for which it is harnessed, or the manner in which it is generated' (**Agrawal, 1995: 31**). Secondly, a productive dialogue which safeguards all interests can only be achieved once scientific and indigenous knowledge are acknowledged and used simultaneously (**Agrawal, 1995**). Indigenous knowledges are important because indigenous peoples 'often see themselves as participating in cultural and political systems that, from hundreds even thousands of years of experience, are explicitly designed to adapt to environmental change' (**Whyte, 2017: 102**). Indigenous peoples work directly with ecosystems, adapting to the changing seasons. Using these types of knowledges in food production is essential, if we are to deal with the stresses from climate change and environmental degradation.

The Genetically Modified Organism Consortium is a starting point for better public engagement. There is a need to create robust organisations which create meaningful dialogue and consensus between all types of actors in the GM organism debate. I acknowledge that there are likely to be unanswered questions about the setting up and organising of a consortium such as this. These should be seen as a sign of the proposal potentially working. As Irwin (**2009: 12**, emphasis in original) argues, 'openness, transparency and engagement are beguiling concepts but they also provoke (or rather *should* provoke) profound questions about their meaning, formulation and practice (especially when applied to specific contexts and situations)'. If the Genetically Modified Organism Consortium provokes questions, then we are at a useful starting point.

Conclusion

What I propose with the Genetically Modified Organism Consortium will be difficult. But it is a start. Moving to a sustainable food future means making the food system more resilient. This is not easy and I believe this means acknowledging food knowledge as 'knots of contradictions' (**Braidotti 2019: 15**). Contradictions often appear as binaries. The binaries which relate to food and the food system include local/global; small-scale farming/industrial farming; consumer/producer; and organic/GMO. For many 'good food would be organic, local, small-scale food production. The opposite would be framed as bad. Yet for others, industrial farming of genetically modified foods to feed a growing global population is what defines a good food system' (**Duncan & Bailey, 2017b: 207**). Only when we acknowledge and debate these contradictions can we move forward in addressing the problems we are collectively facing with the food system, especially in the light of climate change. If we are to achieve sustainable food futures, then our solutions also need to be forward-thinking and this requires 'diligent and creative route planning' (**Duncan and Bailey, 2017a: 9**). Making our food system secure is important for the challenges which lie ahead with climate change and environmental degradation. GM organisms may provide one of the technological solutions. That said, it may be a technological solution too far, especially as technology is not always a silver-bullet. The Genetically Modified Organism Consortium is a starting point for better public engagement. There is a need to create robust organisations such as this, which create meaningful dialogue and consensus between all types of actors in the GM organism debate.

The question I set out to answer was: How can we improve public engagement in the genetically modified organisms debate? Here, I have shown how the concepts of observatories and consortiums can open up the spaces for debate in relation to genetically modified organisms. I also introduced the Genetically Modified Organism Consortium to illustrate how science and alternative knowledges can be drawn upon and used together. The Genetically Modified Organism Consortium is one approach in which we can decide how we collectively wish to proceed with GM organisms. It is time to draw on collective imaginations.

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Endnotes

[1] Intensive agriculture aims to maximise yields from the available land through various means including the use of chemical fertilisers and pesticides, monoculture crops, and highly technical and mechanised machinery and implements (Pell, 2019).

[2] The Internet of Things (IoT) is used to describe the 'things' that communicate 'with other machines through the internet without a user issuing a direct command' (**Dauvergne, 2020: 26**). An example is farm equipment sending data about soil to a smartphone app.

[3] See https://anthropoceneandthemorethanhumanworldwritingworkshop.com/.