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RESEARCH ARTICLE

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Perspectives on biotechnology: Public and corporate narratives in the GM archives

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Societal Impact Statement

The contentious debate over genetically modified (GM) crops in Britain has entered a new era following Brexit and the development of gene editing. At the same time, the events of the 1980s and 1990s are now entering historical archives, including the GM Archive at the Science Museum in London. This article explores how fears of unnaturalness and arguments from historical continuity informed the British GM controversy. It also analyses the limitations of these modern archives. The concerns surrounding the naturalness and continuity of biotechnology have recently been resurrected following suggestions that gene editing will be employed in plant breeding.

Summary

- This research examines the introduction of genetically modified (GM) crops to Britain, including the backlash from environmentalist groups and the public that led to a de facto government moratorium on their commercialisation in 1998.
- Harnessing archival materials from the Science Museum's GM Archive, this paper shows that GM was viewed as an alien or unnatural technology in Britain, while campaigns from Monsanto and scientific supporters of GM attempted to show how recombinant DNA technology was simply the latest step in a long history of plant breeding.
- By moving outside the archive, it becomes clear that the creation of this narrative from continuity was a standard industry strategy. Appeals to the history of plant breeding was a strategy adopted by Monsanto well before the British GM controversy, while twentieth-century food scares had already undermined public trust in government and industry.
- Public concern over the naturalness of biotechnology remains. Meanwhile, contemporary advocates of gene editing have begun to make similar arguments to those deployed in the 1990s, highlighting the similarity of gene editing to natural variation and selection.

KEYWORDS
genetic modification, genetic modification archive, history of science, plant breeding, science communication

1 | INTRODUCTION

Faced with growing public opposition to genetically modified (GM) crops in Britain, in the summer of 1998, chemical giant turned biotech firm Monsanto launched an advertising campaign to 'encourage a positive understanding of biotechnology' (Anderson, 1999, p. 115). The campaign failed, with controversy over GM persisting into the 21st century and even engaging members of the country's royal family. Genetic engineers, according to the outspoken Prince of Wales, started what could be the 'biggest disaster environmentally of all time' (Randall, 2008). His sister, the Princess Royal, has taken the opposite stance, arguing that 'GM is one of those things that divides people but surely if we are going to be better at producing food of the right value, then we have to accept that genetic technology is going to be part of that' (BBC Radio 4, 2017). More recently, advocates of gene editing in crop plants have sought to distance this new technology from past controversies. Huw Jones, a senior research scientist at Rothamsted Research, argued that likening genetic modification through recombinant DNA technology to the gene-editing technique CRISPR was like 'comparing chalk and cheese' (Ainsworth, 2016, pp. 515–516).

Scholars have traced the rise of recombinant DNA technology—the technique behind the creation of GM crops—and highlighted significant dates in its development, including the discovery of the structure of DNA by Watson and Crick in 1953, the creation of recombinant DNA molecules in 1972 and the first GM bacterium in 1973 (Wright, 1986). These developments took place within an atmosphere of close collaboration between academia and industry (Kleinman, 2003; Rasmussen, 2014). From an early stage, scientists were alert to the regulatory and safety risks of the new technology, with the Asilomar Conference on recombinant DNA technology taking place in 1975 (de Chadarevian, 2002). The first GM crop approved for production in the United States, the Flavr-Savr tomato, appeared in 1994. GM varieties have gone on to dominate key crop plants, such as soybeans and maize, in the United States. Such crops initially promised a whole range of benefits for farmers and consumers worldwide: higher yields, drought and disease resistance, and a reduced need for chemical fertilisers and pesticides. Britain was once regarded as one of the most promising markets for agricultural biotechnology outside the United States (Toke, 2004). Yet the British public turned against GM crops upon their introduction in the 1990s, with the labour government finally issuing a de facto moratorium upon the commercialisation of GM crops in 1998. A plethora of theories have subsequently arisen to explain why. Some see a 'witches' brew of anti-science agendas' (Lachmann, 2005, p. 153). Other theories focus upon regulatory differences across the Atlantic, technological pessimism and the effectiveness of the global anti-GM movement (Charles, 2001; Jasanoff, 2005; Schurman & Munro, 2010). Deeper questions of what we consider 'natural' and whether GM is seen to transgress natural boundaries have also been considered as factors in the British rejection of GM (Midgley, 2000; Shaw, 2002).

A new resource for researchers on the British reception of GM crops, the GM Archive at the Science Museum in London, began to be assembled in 2008. Its compilation was instigated by Vivian Moses (2016, p. 139), a professor of Biotechnology at University College London, 'when it became clear that the GM crop and food phenomenon would be a useful way to study societal reactions to new technologies'. Moses (2015, p. 7) was a supporter of agricultural biotechnology, arguing for the global benefits of GM and labelling those who thought that GM foods were unsafe as deniers of 'scientific reality'. The GM Archive largely consists of material gathered from supporters of GM crops, government figures and farmers who allowed GM trials to be conducted in their fields.[1] Of particular interest for this paper are a series of interviews conducted by Professor Joyce Tait during the early 1990s as part of the 'Regulating the Risks of Biotechnology' project, funded by the Economic and Social Research Council (ESRC). This project examined the use of the 'precautionary principle' during the passage of part IV of the Environmental Protection Act (EPA) in Britain. In addition to interviews with industry officials, Tait gathered 'public-interest viewpoints' through interviews with members of the Green Alliance, Trades Union Congress and Greenpeace among others (Levidow & Tait, 1992, p. 94). Tait would later contribute to a pro-GM 'Sense about Science' report and stated that publications 'that do not take an anti-GM perspective regularly come under attack' (Tait, 2009, p. 518). The archive is therefore not immune to accusations of bias.

This paper harnesses the GM Archives to make two arguments. The first is that concern over the 'naturalness' or novelty of GM crops was prevalent in Britain upon their introduction, with Monsanto and its supporters seeking to overcome public opposition to GM by presenting the technology as the natural successor to the crop selection of the earliest farmers and the hybrid crosses of Mendel. This was not a new strategy when it came to selling agricultural change to a public audience. The landscape-altering bulldozer in post-war Britain, for instance, was 'narrated [by the industry and its supporters] in such a manner as to emphasise historical continuity rather than disruptive change' (Harrington, 2018, p. 46). This paper's secondary argument, however, is that the organisation and selection of sources in the GM Archive, combined with the tendency of historians to seek antecedents to recent events, can create an overly simplistic narrative of the complex relationship between plants and people.[2] In this case, the presentation of archival interviews and corporate materials in the Archive suggests that Monsanto and its supporters' use of historical narrative came about to counter public fears of 'unnaturalness'. In fact, appealing to the long history of plant breeding was a strategy adopted by Monsanto well before the British GM controversy, while earlier food scares in Britain had already undermined public trust in government and industry.

This paper discusses naturalness and continuity in the GM Archive in two parts. First, we dig into the sociological data contained in the archives, including surveys, interviews and published reports. This material appears to confirm concerns within the food industry that earlier plant breeding technologies had made little impact on

[1]Short biographies of contributors to the GM Archive can be found in the Science Museum catalogue (https://collection.sciencemuseumgroup.org.uk) Accessed 09/05/2022.
[2]On the tendency of historians to reject 'discontinuity' in the development of modern biotechnology; see Gaudillière (2009, pp. 22–23). On the use of narratives, see Currie and Sterelny (2017).

public consciousness. We examine interviews with members of environmental organisations, who focused on the 'unnatural' or 'alien' nature of GM crops. Second, we see how plant scientists and biotech firms attempted to overcome public resistance by creating a grand narrative of gradual progression in plant breeding technology, of which GM was just the latest incarnation. This strategy was largely superficial and reached its peak just before the British de facto moratorium on GM crops. These two bodies of material imply that Monsanto and its supporters were responding to fears over the novelty of GM by emphasising its historical roots. Yet the argument from continuity was already a standard narrative within the biotech industry. Nor does the archive consider other factors: most importantly the impact of the BSE (bovine spongiform encephalopathy) crisis on public faith in food producers and regulators.

2 | NATURAL VERSUS UNNATURAL? EARLY PERSPECTIVES ON GM

In 1987, the UK's Economic and Social Research Council (ESRC) submitted a report to the Royal Commission on Environmental Pollution. The Commission, chaired by Lord Lewis of Newnham, was considering the impact of GM organisms (GMOs) on the environment for its latest report. The ESRC had attempted to gauge public attitudes to the release of GMOs by collating a series of surveys and studies: All provided unambiguous results. A qualitative study had discovered that participants 'invoked profound moral judgements' against scientific 'interference' with nature (Economic and Social Research Council, 1985). Responses ranged from GM being cast as 'unnatural' to 'I do not think you should mix science things with food'. Quantitative surveys found the same objections. Of some 200 interviewees, 70% thought genetic engineering is morally wrong, and 62% thought it is unnatural: By contrast, only 27% found the technology 'frightening'. The ESRC summarised its findings:

> It would seem that genetic engineering is not yet a major issue of popular public concern. Levels of knowledge are likely to be low—positive attitudes [towards GM] are related to the desire to explore potential benefits, negative attitudes are associated with unfamiliarity, beliefs about unnaturalness and novelty. (Economic and Social Research Council, 1985)

This statement provides us with a glimpse of some British attitudes to GM just prior to the controversies of the 1990s. Participants in the ESRC studies clearly thought GM was unnatural. Fewer were concerned about potential dangers to consumers or the environment. The Royal Commission on Environmental Pollution, which released its completed report on GM in 1989, compared GMOs to 'alien' or 'exotic' species.[3] To imagine the potential environmental impact of a GM plant or animal in the British countryside, the Commission considered the known effects of introduced plants and animals around the globe. Although these did 'not necessarily provide an exact analogy', their 'effects help [us] in understanding and anticipating the potential impact of GEOs [genetically engineered organisms] on the environment' (Royal Commission on Environmental Pollution, 1988/89, p. 20). The resulting roll call of damaging introductions produced by the Committee was not likely to inspire confidence in introduced GM crops:

> 4.17 An example of a controversial exotic which has altered the landscape is the spread of *Rhododendron ponticum* in woodlands and on heaths in the UK … threatening many native species and bringing about a loss of diversity of native plants and animals.
> 4.18 Another example is Dutch elm disease. The introduction of a particularly virulent strain of this fungus, probably from America, has progressively killed most of the UK's large elm trees (*Ulmus* species). The loss of these elms has markedly affected the appearance of much of the British landscape. (Royal Commission on Environmental Pollution, 1988/89, p. 21)

The list of ecological villains went on and on: the predatory Nile perch (*Lates niloticus*) in Lake Victoria, rabbits in Australia and parasitic wasps in Hawaii. The juxtaposition of GM plants and animals with invasive species also provided an attractive, if hardly flawless, model for British ecologists. A short booklet published by the British Ecological Society in 1993 considered the environmental implications of GM crops. Possibly, the new arrivals would act similarly to 'traditional agricultural varieties, and pose little new risk to the environment', or perhaps GM crops would possess 'sufficiently different phenotypes that they cannot be regarded as varieties of native species, but rather as exotics' (Shorrocks & Coates, 1993, p. 9).[4] The society argued that if GMOs were sufficiently different, they could well act as another wave of invasive species. GM crops could persist in fields as 'arable weeds', displace wild plants or transfer genes to 'related crops or wild species' (Shorrocks and Coates, 1993, p. 24). Some government bodies, plus the long-established British Ecological Society, were satisfied to label GM crops as exotic, possibly invasive, species. Such connotations would likely have reinforced public ideas of GM crops as an unnatural presence in the countryside, with the potential to dramatically alter the pastoral landscape.

Concern that GM was somehow unnatural could also be found among members of leading environmentalist organisations during the late 1980s and early 1990s, including Greenpeace and Friends of the Earth. From 1989 to 1991, an ESRC-funded project entitled 'Risks of Biotechnology and their Regulation' ran under the management of Professor Joyce Tait. Academics on the project interviewed members of Greenpeace and Friends of the Earth in the Edinburgh area. From

[3]On the history of the concept of alien species, see Smout (2011, p. 61).

[4]Intriguingly, the authors of the British Ecological Society booklet were not against the concept of genetic engineering. In fact, they did not concern themselves much with genes at all. When releasing new organisms into an environment, 'it is the phenotype of the organism that matters, not how it was made'.

the outset of these interviews, it was clear that neither organisation had yet considered GM as a major environmental issue. When questioned, a member of Greenpeace stated that GM was 'not something people would see as a priority environmentally' (Greenpeace Interview, 1991). A member of Friends of the Earth noted a 'curious absence of comment at least in Friends of the Earth magazines that I've read in England and Wales or Scotland on any reference to biotechnology or genetic engineering' (Transcript of Meeting with Edinburgh Area Members of Friends of the Earth, 1991). There were even hopes from one member of Greenpeace that GM could be used to help the environment:

> I can see one of the advantages of having genetically engineered crops … the idea is that you do not need to use chemicals to combat pests. A crop that is genetically engineered aught [sic] not to suffer from pests and diseases or whatever so that's obviously as far as Greenpeace might be concerned a good point. (Greenpeace Interview, 1991)

Yet the unnaturalness of GM crops and their introduction to the British landscape proved a sticking point. As one interviewee described it, 'I think the main worry is that they are not natural, they have not evolved like everything else has, it does not fit in'. The alien nature of GMOs to ecosystems was a matter of concern, just as it had been a few years earlier in the Royal Commission on Environmental Pollution's report. One Greenpeace member felt that predicting the environmental impact of GM was problematic. As history had shown, 'introducing different species to different areas of the world, like rabbits to Australia' could be disastrous, as 'you cannot foresee the consequences. It's the same for genetically engineered things, is not it?' (Greenpeace Interview, 1991).

Among some British environmentalist and nature enthusiasts, GM crops were clearly linked to wider concerns about invasive species. Food safety, environmental contamination and other factors we typically associate with public mistrust of GM crops had not materialised as a significant force by the early 1990s. To the Royal Society for the Protection of Birds (RSPB) and the British Trust for Ornithology (BTO), the environmental hazards posed by GM would simply 'be painted onto a biodiversity landscape that is already severely damaged by the intensification of agriculture'. The 'introduction of new crop types' could pose a danger to British wildlife but was listed on equal footing with activities such as 'Land drainage' and 'Hedgerow removal' (Krebs, et al., 1999, p. 611). Instead, early arguments made against the use of GM in British agriculture drew upon a longer tradition of wariness regarding the unpredictable effects of introduced species. Environmental historian Coates (2006, pp. 25–26) has compared 'saboteurs snapping the stalks of genetically modified corn' to 'parties of native plant enthusiasts … bashing away at Himalayan balsam along British riverbanks'.

The limits of the GM Archives, however, cause us to miss other food controversies of late-twentieth century Britain. The country had been rocked by a series of food scares in the run-up to the GM controversy, most prominently an outbreak of BSE—known as mad cow disease—in beef cattle in the late 1980s. The crisis knocked consumer confidence in those charged with food production and the regulatory ability of government and scientists (Petts et al., 2001). Strange and unsettling scenes of British scientists and politicians in action proliferated. Their ineptitude at reassuring other European nations that the disease was under control led to 'bizarre personal reassurances that they had not stopped eating beef' for domestic audiences: most infamously when John Gummer, Secretary of State for the Environment, fed a hamburger to his daughter in front of the media (Jasanoff, 1997, p. 224). This chaos, both around the BSE crisis and an earlier problem with salmonella in eggs, led to the crumbling of the 'managerial myth' that British politicians or regulatory institutions could be trusted to deliver safe food to the public (Pence, 2001, p. 51).[5] A subsequent study of consumers by the Media Research Unit at the University of Glasgow, the same research group which ran 'Risks of Biotechnology and their Regulation', concluded that the BSE crisis 'was perceived as being a problem of industrialised agriculture' (Reilly, 2006, p. 223). A member of a Bristol-based focus group interviewed for the study summarised participants' feelings: 'Nothing will ever be the same again, I think, we are now in a post-BSE world and that means that what you may have ignored or not thought much about before has become central' (Reilly, 2006, p. 216).

Another set of interviews, conducted with residents of the Vale of the White Horse in Oxfordshire in 1991, also revealed a fundamental mistrust of government and institutions in general. They alluded to historical missteps, one resident declaring that 'Technology may go faster than peoples' wisdom, there is danger for horrendous mistakes have been made'. Another resident remarked that GM had potential but expressed concern that 'there might be some big mistakes … remembering thalidomide'. The idea that genetic engineering could be weaponised had also taken hold. 'Given a bit of Ministry of Defence money', quipped one resident, 'one could probably create some effective biological weapons, that's a down side' (Compiled Statements from Individual Interviews with Residents of the Vale of the White Horse, 1991).

The GM Archive reveals that early concerns regarding GM crops in Britain arose because such organisms were unnatural or alien to the British landscape. Moving outside the archive also reveals the role of the BSE and other scientific scandals, including thalidomide, in building a sense of public scepticism around new technology. The BSE scandal was described by some members of the public as a watershed moment, undermining trust in food production and regulation. In the next section of this paper, we examine how Monsanto and its allies in the British GM controversy chose to focus their public relations efforts on building a narrative of GM as a natural 'next step' in the long history of plant breeding. If early public mistrust of GM was focused solely around its 'alien' nature, this strategy makes sense. Yet if questions of 'naturalness' and the impact of the BSE crisis had become intertwined, a much larger problem had arisen for supporters

[5]On food scares shattering faith in British food safety systems, see Roslyng (2011, pp. 157–182).

of the technology. 'Education' of the public alone would be not enough if the corporations which supported genetic engineering—and the government which regulated them—were simply not trusted. The failure of Monsanto's campaign to win hearts and minds certainly supports this interpretation.

3 | BUILDING A HISTORICAL CONTINUUM OF BIOTECHNOLOGY

'How does this potato differ from a potato?', asked a 1998 leaflet from the chemical giant-turned-biotech firm Monsanto. 'It looks like any other potato', the leaflet continued. 'It does not taste any different'. The only difference between an ordinary potato and the Monsanto potato was that the latter had been altered using 'plant biotechnology' to require less chemical insecticide. There was no need for consumers to worry, as plant biotechnology was only 'a new stage in the development of traditional cross-breeding' (Monsanto, 1998a). Faced with consumer alarm at the spectre of GM food, Monsanto presented the history of plant breeding as a linear, natural progression from traditional breeding to genetic modification. In another promotional brochure, Monsanto acknowledged that fruit and vegetables do not taste 'as they used to', blaming 'Year round demand, forced ripening and early harvesting'. GM, again described as a 'new development of traditional cross breeding which has been employed for centuries', had the potential to restore the flavours of yesteryear (Monsanto, 1998b). These leaflets were part of Monsanto's 1998 advertising spree, which crumbled under a recommended de facto moratorium on GM crop trials, environmental activism and supermarket bans (Blair & Hitchcock, 2001, p. 47).

Despite its failure, materials from the GM Archive suggest that such rhetoric was necessary to win over the British public. In 1997, the Institute of Grocery Distribution (IGD), a research organisation representing the British food industry, formed several focus groups consisting of some 100 members of the public from across the UK. While attempting to gauge public attitudes to GM, IGD researchers found that consumers confused or conflated GM with earlier environmental controversies or food processing technologies. Some members of the focus groups were greatly concerned with food irradiation, introduced during the late 1980s. One participant was under the impression that cattle had already been genetically modified. When prompted to discuss how GM worked, many members of the focus groups were under the impression that chemicals were somehow involved:

> I know nothing about the process, but the assumption is it's going to be chemical.
> I want it [my food] fresh from the field, not saturated with chemicals.
> And that's it? … It makes it seem that the genes are not a chemical thing or anything, you are saying a gene is a natural thing?
> It's much nicer to know that it's [GM] been done just by removing from the plant the bit they do not actually want, or the bit they do want, rather than injecting chemicals and drugs and stuff. (Institute of Grocery Distribution, 1997)

It is likely that these members were muddling GM with earlier environmental concerns such as chemical pollution and excessive pesticide use. Materials released by Monsanto during the late 1990s routinely made the argument that GM was the natural 'next step' in the development of plant breeding. A 1997 booklet entitled 'Biotechnology: Solution for Tomorrow's World' described ancient farmers as practising selective breeding and creating new hybrids. 'They did not know it', explained the booklet, 'but they were practicing a rudimentary form of genetic engineering—a fundamental process used in biotechnology'. Rather than assert that GM was identical to the practices of early farmers, Monsanto introduced a series of intermediate steps from the origins of agriculture to recombinant DNA technology. Gregor Mendel and his experiments on peas constituted one. By understanding that 'unseen particles carry hereditary traits and that these traits are passed from generation to generation', Mendel's work 'serves as a foundation for biotechnology'. The 1953 description of the structure of DNA by Crick and Watson represented another step on the path to GM (Monsanto, 1997a). Monsanto were now pushing a particular narrative which emphasised the longevity of biotechnology and its gradual development over time.

Monsanto's case for the continuum between GM and other forms of plant breeding was aided by the company's publications playing fast and loose with terms such as 'biotechnology' and 'genetic engineering'. Another booklet of the same period claimed that 'Farmers discovered biotechnology 10,000 years ago', citing crossbreeding and fermentation as examples of ancient biotechnology. Other forms of biotechnology were more recent. 'As early as the 1700s', commented the booklet, 'naturalists identified many kinds of hybrid plants'. These discoveries were then linked to the rise of hybrid corn in the United States during the 1930s which, the company noted, had 'contributed to tripling corn yields in this century' (Monsanto, 1997b). Monsanto's promotional leaflets were a crude and belated effort to change the mind of a British public opposed to the introduction of GM crops. The GM Archive implies that these campaigns were developed in response to public concerns over the 'naturalness' of GM crops and their place in the countryside.

Yet Monsanto had been engaged in the creation of the 'ancient biotechnology' story prior to meeting public resistance in Britain. In a 1984 booklet entitled 'Genetic Engineering: A Natural Science', Monsanto equated the natural exchange of genes between plants with the exchange of genes through recombinant DNA technology. Unlike traditional breeding and hybridisation, 'genetic engineering enables scientists to transfer specific genes', meaning that 'they are able to improve crops in a less haphazard, less time-consuming way' (Monsanto, 1984). The booklet also described ancient farmers as early biotechnologists. 'Farmers and plant breeders', announced Monsanto (1984), have long 'mixed and combined genetic information in new ways to create better

hybrids. Though they did not know it, they were applying genetic engineering'. Around 100,000 copies of this booklet were printed in the United States from 1984 to 1985, with an associated film entitled 'Genetic Engineering: The Nature of Change' reaching an audience of five million. These materials were geared towards the 'cultural commonsense' of the American public, with an emphasis upon such cherished ideas as 'technological determinism' and the 'hegemony of the free market' (Kleinman & Kloppenburg, 1991, p. 430).

It was common practice for biotech companies and their supporters to create promotional timelines of the technology, which use ancient practices of domestication and fermentation to argue that GM is 'nothing new under the sun'. (van den Belt, 2009, p. 1305). British supporters of GM adopted this strategy. At a 1998 conference, Cooper & MacLeod (1998, p. 131), Director of the National Institute for Agricultural Botany (NIAB), repeated the argument that early farmers had been unconscious participants in genetic engineering. 'For hundreds of years', he posited, 'plant breeding has been carried out with little or no understanding of the scientific basis for the improvements that resulted'. MacLeod described a three-tier history of agricultural biotechnology, progressing from the domestication of crop plants to hybridization and finally onto genetic engineering. Similar arguments were evoked in reports for non-scientific audiences. A short book produced by the UK Agricultural Biotechnology Industry began with a potted history of British agriculture by J. Malcolm Stansfield, Director of the Farm Management Unit at the University of Reading. Before arriving at modern biotechnology, Stansfield took readers through an account of plant breeding since the early nineteenth century, including hybridisation and Mendelian genetics. Adopting new innovations such as GM was therefore simultaneously in harmony with the history of British farming and vital for its future (Stansfield, 2001).

These cases show that narrative of GM as a recent development in a linear history of agricultural improvement did not arise in response to British misgivings. The narrative was widely used by supporters of GM and had been employed by Monsanto for over a decade. There were issues within this narrative from continuity too. For one, it was initially adopted by Monsanto for an American audience, with a heavy emphasis upon 'faith in science and scientists' (Kleinman and Kloppenburg, 1991, p. 433). In a 1998 leaflet entitled 'Food Biotechnology. Look Who's Behind It', Monsanto attempted to draw upon the power of scientific expertise. A series of quotes from leading scientists and other authority figures attempted to reassure the British public that GM crops were safe. 'After twenty years of research and scientific scrutiny', stated Professor Mike Wilson, Deputy Director of the Scottish Crop Research Institute, 'this versatile and safe technology [GM] is finally delivering the economic and environmental promise'. Other experts were cited stating that GM crops could feed the world, provide consumers with more nutritious food or even replace fossil fuels (Monsanto, 1998c). Yet in the wake of the BSE crisis and other late twentieth-century food scares, an appeal to expertise was probably not the best strategy to deploy in Britain.

Despite a flood of publications and advertisements, the claim that plant breeding was a gradual and ever-advancing process did not turn the tide of public opinion in favour of GM. One major problem with the narrative was that GM was a commercial technology owned and distributed by biotech firms. It therefore had to be marketed as a novel and profitable innovation: hardly an approach in keeping with a newfound emphasis on gradual change and similarity with historical techniques. Monsanto, for example, had a habit of comparing developments in the biological sciences to the exponential growth in computer power described by Moore's Law. 'At Monsanto', its 1997 Annual Report explained, 'we believe that a similar, nonlinear trend in biotechnology capabilities is creating comparable growth potential in the life sciences' (Monsanto, 1997c). Pickard (2001), Director-General of the British Nutrition Foundation, declared that 'Genetic engineering is the single most important development in biology since Charles Darwin's exposition on the origin of species by means of natural selection in 1859'. This declaration was laid out in the preface of the same report where Stansfield had carefully laid out the evolving technology leading to GM.[6] Another, more mundane, reason for the failure of the continuity narrative was that it just had too much to do in too little time. In 1997, Dr. Geoff Spriegel, Research Director for the Sainsbury's supermarket chain, addressed members of the NIAB. Spriegel (1997, p. 62) explained what he saw as the implications of consumer ignorance for the introduction of new agricultural technology:

> In this scenario, technical development has continued apace, almost without reference, or even a means of reference to the consumer. This leads to difficulties when we [in the industry] try to explain new technology to consumers as enhancements to previous production techniques, when knowledge of the techniques which are being replaced is very limited.

A simplified form of Spriegel's argument is that the problem faced by food and biotech companies was that the British public had not been kept up with the latest technological developments in plant breeding and food processing. Any new development, including the creation of GM crops, was therefore seen as a radical and potentially dangerous change to the status quo. It was certainly true that the public-facing narratives of biotechnology embraced by Monsanto and other supporters of GM were simplistic. Even if the British public were prepared to label the domestication of agriculture or Mendelian genetics as 'biotechnology', huge spans of time existed between these events. Biotechnology, therefore, seemed not to advance by small increments but by vast (and potentially risky) leaps. The failure of this narrative also suggests that it was not well adapted to the British context or that it was focused upon the wrong issues. The focus groups convened by the Institute of Grocery Distribution in 1997 indicated that some members of the public associated GM with the use of chemicals in agriculture and irradiation in food preparation. This association, and participant's subsequent belief that GM did somehow involve the novel use of chemicals, is indicative of wider anxieties surrounding food and agriculture in Britain. In this scenario,

[6]Another problem with the continuity narrative was that it could just as easily be harnessed against GM, portraying it as part of a line of exploitative technologies. See Kloppenburg (2004).

asserting that GM was no different to earlier forms of agricultural technology would have made little impact. Modern agriculture and its reliance upon novel science and technology were the source of anxiety to begin with.

4 | CONCLUSION AND DISCUSSION

The GM Archive offers us two insights into the controversies of the 1990s. The first is that surveys, government commissions and the reaction of environmentalist groups all indicate that there was pressing public concern over whether GM crops were 'natural' and could fit into the British landscape.[7] As the decade wore on, these concerns became tied up with other anxieties, such as food safety. A 1999 report from the Nuffield Council on Bioethics (1999, pp. 13–15) found that many respondents to their public consultation on GM were concerned by breaches of the 'species barrier', such as the placement of 'fish genes' into strawberries. The Council also noted that a sense of GM being 'unnatural' was closely tied to concerns over the safety of GM foods. They speculated that the latter was a legacy of the BSE crisis, which had undermined the reputation of government standards and industrialised agriculture. Faced with growing public hostility, the British government announced a series of 'Farm Scale Evaluations' of GM crops in 1998 to justify a de facto moratorium on their commercialisation (Grove-White, 2006, p. 171).[8] Bioscience regulation was reviewed the following year and the Agriculture and Environment Biotechnology Commission (AEBC) was subsequently founded in 2000. The Commission later reported that there was no practical experience in Britain for 'agricultural separation', making it near-impossible for commercialised GM crops to co-exist with non-GM agriculture and the wider environment. This, combined with negative public feedback and poor results for biodiversity from the Farm Scale Evaluations, caused the Labour government to reverse course on GM commercialisation (Grove-White, 2006, pp. 175–176).

The second insight from the GM Archive is that Monsanto and its supporters constructed a narrative of GM being part of the long history of plant breeding. There were undoubtedly shortcomings in the execution of this strategy in Britain. The industry publications discussed in this paper did not go into any detail on the array of biotechnologies available to plant breeders, including industrial-scale hybridisation, mutation breeding and cell fusion. These absences lent the historical continuum argument a somewhat superficial air, as it jumped from the origins of agriculture to Mendel and then onwards to GM. We can also speculate that regulatory and safety regimes, talked up to reassure the public that GM was safe, instead gave the impression that GM was something different and dangerous. Jasanoff (2005, p. 112) has argued that the political portrayal of the release of GMOs as a process 'deserving special concern' had several consequences, highlighting the unpredictability of field experiments, the lack of accountability for their consequences and scientists' growing hostility to the regulatory process. This emphasis on safety highlighted the novelty of GM and undermined the argument from historical continuity.

Yet there are limitations to what the GM Archive alone can reveal. The organisation of the archive, for instance, can give the misleading impression that Monsanto embarked on a campaign to promote the historical continuity of biotechnology to assure the British public. In fact, the argument that biotechnology has been with us since the dawn of civilisation was already a standard talking point among biotech firms and their supporters by the time GM arrived in Britain. The history of Monsanto in the United States demonstrates that appeals to history were a standard part of its public-relations toolkit, not an 'organic' reaction to public feeling. The history of British food scares, most notably BSE, also indicates that the ground for widespread mistrust of GM and authority figures had already been laid by the 1990s. Neither does the published material in the archive offer insights into Monsanto's inner workings during the GM controversy.[9] Despite the efforts of archivists to conserve material, archives are fundamentally selected 'snapshots' onto the past. Their interpretation, arrangement and description 'lead the historian, or not, to the 1 or 2 percent of surviving records in that box, and all other relevant boxes' (Cook, 2011, p. 613).[10] The task of the historian is to apply 'contextual information' to interpret archival records and avoid seeing them as 'separate disembodied items' (Duff & Johnson, 2002, pp. 487–488).[11] In the case of GM in Britain, this contextual information can come from several accessible reports and archives. One example is Sciencewise, a public engagement programme which publishes the dialogue from its discussion groups and interviews.[12] Another is the 2003 GM Nation report, an initiative launched by the labour government which consisted of some 600 public meetings (P.D.S.B., 2003). As the GM controversy becomes part of history, archival sources will doubtlessly play an ever more important role in understanding it.

Understanding the presence of 'naturalness' and narratives of historical continuity around biotechnology is also important for contemporary debates. Following the departure of Britain from the European Union, the British government had raised the possibility of rethinking the commercialisation of GM or turning its attention to plants and animals produced by gene editing. Although gene editing is more targeted than other forms of genetic biotechnology, its use in plant breeding was regulated in the same way as recombinant DNA technology by the European Court of Justice in 2018. With the possibility that gene edited crop plants may now appear in British fields, its advocates have attempted to portray gene editing as 'natural'. In

[7]At this point, we might consider why the natural versus unnatural debate has not been subjected to greater scholarly analysis. Turney (1998, pp. 3–4) has argued that public objections to research avenues in genetics have often been dismissed as an irrational or instinctive reaction against science as a whole.

[8]The U.K. embraced 'participatory democracy' with programmes such as the GM Nation project. However, such democratic inclusion was not necessary in countries such as Canada, where there was less public opposition to GM. See Hartley and Skogstad (2005).

[9]Accessing the archives of existing corporations, particularly those with chequered pasts, remains challenging for historians. For a recent example, see Mitman (2021).

[10]For a quantitative study of the impact of cataloguing on historical research, see Dunley and Pugh (2021).

[11]Historians of early modern science, for instance, recognise that archives served two important functions during that era. First, they 'aspired to function as undistorted lenses onto politics, to capture empirical signs of all aspects of power and decision making'. Second, they 'were important as repositories of precedent, preserving evidence of a prescriptive past to be translated into the present' (Popper, 2016, pp. 88–89).

[12]Available at https://sciencewise.org.uk/

2021, George Eustice, Secretary of State for Environment, Food and Rural Affairs, declared that 'Gene editing has the ability to harness the genetic resources that mother nature has provided'. Huw Jones, now Professor of Translational Genomics for Plant Breeding at Aberystwyth University, put it slightly less mystically. 'In its simplest form', he argued, 'gene editing is merely a speedier way to find the genetic variation made by natural processes' (Harvey, 2021).

This position shows little evidence that British scientists and politicians have moved on from the 'narrow humanly blind "scientific" approach to GM crops and their regulation' (Grove-White, 2006, p. 171). In fact, attempts to equate gene editing with naturalness may replay the same controversies over GM crops examined in this paper. A report on naturalness by the Nuffield Council on Bioethics (2015, pp. 59–60) reveals that some members of the public still imbue nature with intentionality or balance, which biotechnology can upset. Rather than appealing to crude stories or analogies, advocates of new plant breeding technologies would be better advised to embark 'on a deep and continuous engagement with societal actors at all stages of the research process', to better recognise and address pre-existing perspectives (Macnaghten & Habets, 2020, p. 361). As the history of GM in Britain demonstrates, attempting to 'overpower' ingrained public scepticism or fear by manufacturing simplified histories of agriculture will not guarantee the embrace of a new technology.

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CONFLICT OF INTEREST

There is no conflict of interest to declare.

AUTHOR CONTRIBUTIONS

M.H. conducted archival research and wrote the manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the GM Archives of the Science Museum in London.

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