TRANSATLANTIC DIFFERENCES IN GMO PREFERENCES

Melody Bauer

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Approved by:

Gary Marks

Liesbet Hooghe

John Stephens

ABSTRACT

Melody Bauer: Transatlantic Differences in GMO Preferences
(Under the direction of Gary Marks)

The transatlantic divide between the United States and the European Union on genetically modified organisms is reflected in the distinct regulatory approaches, levels in crop cultivation, and consumer acceptance. The purpose of this paper is to outline the key characteristics of the different attitudes and regulatory approaches on genetically engineered crops and food as well as connect the dots of the preferences of the actors involved and how they have influenced consumers' preferences, the policymaking process, and regulatory outcomes. Public opinion, institutional structures, and cultural approaches to agriculture, and land usage are among the key features that help to explain the contrasting approaches and regulations seen in the United States and the European Union.

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LIST OF ABBREVIATIONS

BEUC	The European Consumer Organisation
DNA	Deoxyribonucleic acid
EPA	Environmental Protection Agency
EC	European Commission
EFSA	European Food Safety Authority
EU	European Union
FDA	US Department of Health and Human Services Food and Drug Administration
GE	Genetically engineered; genetic engineering
GM	Genetically modified
GMO	Genetically modified organism
NGO	Non-governmental organization
rDNA	Recombinant DNA
US	United States
USDA-APHIS	US Department of Agriculture Animal and Health Plant Inspection Service

SETTING THE STAGE

Introduction

There is a transatlantic divide between the United States (US) and the European Union (EU) when it comes to genetically modified organisms (GMOs), which is reflected in distinct regulatory approaches, levels in crop cultivation, and consumer acceptance. To varying degrees in the US and the EU, the preferences of various actors, such as government regulators, biotechnology companies, civil society, and consumers, have played a role in shaping the perceived benefit-risk narrative on genetic technology and the subsequent regulations. The relatively relaxed policies in the US, based on the substantial equivalence principle, stand in contrast to the EU's complex regulations, which contain precautionary clauses on traceability, mandatory labeling and thresholds for tolerable "contamination" of non-genetically modified products (Lau, 2015; Stephan, 2015).

The process of creating government regulation is not always straightforward, with various stakeholders vying to influence the policy process. Citizens and advocacy groups can participate through direct actions, demonstrations, media campaigns, or direct lobbying of industry or government, while mass media and the Internet provide fora for networking, collaboration, information dissemination, and public education by all actors involved. In addition, government institutional structures contribute to the decision-making process by predicting the level of participation of the stakeholders involved in the policy process (Einsiedel & Kamara, 2006). This is evident in the developments in the two regions: the process in the US has been remarkably stable and permissive since the 1980s, whereas public unease in Europe led to an increasingly negative environment toward agricultural biotechnology.

GMO acceptance can also be understood in the context of contrasting cultural identities, agricultural practices, and perceptions of land usage. American and European societies have historically moved along distinct cultural trajectories: American society, accelerated by industrialist and progressive forces, embraced a utilitarian approach to technology in agriculture, whereas many European societies continue to maintain traditional conceptions of cultural identity, "naturalness," and moral worldviews (Stephan, 2012). While cultural identities and values may not cause specific outcomes, they create the essential, enabling conditions for political mobilization, and remain highly influential in shaping the public's judgments on, and degree of support for, GMOs. Thus, understanding the regulatory divide between the two regions requires considering not only domestic politics but also the long-term historical evolution of these regions (Earle & Cvetkovich, 1995; Stephan, 2012, 2015).

Table 1 provides an overview of the key characteristics of the transatlantic attitudes and regulatory approaches on GMOs discussed throughout this paper. Public opinion, institutional structures, cultural approaches to agriculture, and land usage are among the key features influencing the contrasting approaches and regulatory outcomes seen in the US and the EU. Ultimately, I will seek to understand the influence of some of the actors involved on the different regulatory approaches, and to what extent the differences (for example, cultural and/or institutional) between these two regions also act as intervening variables.

Table 1: Contrasting attitudes and regulations on GMOs

Factors	United States	European Union
Regulation	Permissive environment; principle of substantial equivalence; GM foods and crops are prevalent in the marketplace	Negative regulatory environment; precautionary principle; variations of acceptance in member states, with the majority being hesitant or hostile toward GMOs
Public opinion	Public is generally optimistic, with a minority opposed to GMOs; less favorable opportunity structures for anti-GMO movement	Initial lack of public trust; influence of anti-GMO movement; public is generally pessimistic toward agrobiotechnology
Institutional structures	Strong biotechnology sector and strong pro-agrobiotechnology coalition in government and industry	Complexities of multilevel governance
Cultural approaches to agriculture and land usage	Modern, bifurcated approach to agriculture; values of efficiency, productivity, and utilitarianism	Interactive agricultural communities; traditional concepts of naturalness, cultural identities and livelihoods

Agricultural biotechnology 101

Biotechnology can be defined as "any technological application that uses biological systems, living organisms, or derivatives thereof to make or to modify products or processes for a specific use" (United Nations, 1992, p. 3). Biotechnology is in itself nothing new. Humans have bred crops selectively for environmental robustness or higher yields for several thousands of years, and the knowledge of crossbreeding can be traced back to the start of sedentary agriculture (Stephan, 2012). However, the advances of molecular genetics in the 1970s and 1980s enabled the selection of a specific part of a gene, or genes, responsible for producing an attribute in a plant or animal, such as the production of an enzyme or resistance to a particular disease. These genes could then be multiplied to increase a specific effect or added to an entirely different microorganism, animal, or plant. These technological developments in genetic engineering facilitated the targeted modification of an organism beyond traditional breeding methods (TNS Opinion & Social, 2010).

Since the 1980s, biologists have used genetic engineering to alter a plant's characteristics, such as to increase resistance to diseases or longer shelf life for fruit. In 1994, Calgene's FLAVR SAVR tomato was the first genetically engineered food product to be commercialized in the US market. Only some 1.7 million hectares of insect resistant *Bacillus thuringiensis* (Bt) corn and cotton as well as transgenic herbicide-tolerant oilseed rape and soybeans were cultivated globally in 1996, the year GM crops were commercialized (Lucht, 2015). By 2016, 185.1 million hectares of genetically modified crops were planted by some 18 million farmers in 26 countries—an increase of 110%[1] (National Academy of Sciences [NAS], 2016). GM crops are cultivated predominately in the Americas, with the US (72.9 million hectares in 2016), Brazil (49.1) and Argentina (23.8) being the top producers; whereas only 136 hectares were cultivated in five EU

[1] Or about 12% of the world's cropland in 2016 (NAS, 2016).

member states (mostly in Spain) for 0.07% of the global total (International Service for the Acquisition of Agri-biotech Applications [ISAAA], 2016). Genetically modified crops continue to spread globally and are considered the fastest adopted crop technology in the history of modern agriculture (NAS, 2016).

OVERVIEW OF GMO REGULATORY DEVELOPMENTS IN THE US AND THE EU

US regulatory system for GMOs

From the onset, genetic technologies have been the subject of regulatory controversy. The development of recombinant deoxyribonucleic acid (rDNA) techniques in the US during the 1970s sparked intense debate within the wider scientific community as well as public concern that mutant organisms might be released into the environment (Marden, 2003). The 1974 Berg letter to *Science* and *Nature*, signed by a number of prominent researchers, invited scientists from around the world to defer voluntarily from conducting rDNA experiments until the potential risks of such molecules had been better evaluated or adequate methods had been developed for preventing their spread (Gaskell & Bauer, 2006). In February 1975, 140 scientists and lawyers convened at the Asilomar conference to discuss the ramifications of the scientific breakthrough. They decided to introduce responsible self-regulation in order to mitigate future state and federal government regulation of genetic engineering and adopted interim guidelines, which were then endorsed by the National Institutes of Health, a US federal medical research agency. These guidelines and their apparent effectiveness at biological containment were a soothing gesture to American lawmakers and the US public at large and set the stage for declining public interest in novel genetic techniques. Additionally, the lack of safety crises in the US in the ensuing years allowed rDNA research to gain respectability (Marden, 2003; Stephan, 2015).

By the 1980s, the introduction of GM crops and foods to commercial markets was imminent, raising environmental and safety concerns. There were congressional hearings on GM technology and a movement to draft new legislation specific to its application. As a result of American scientists being the first movers in both the scientific and regulatory aspects of biotechnology, the US had developed its position as a global leader in the field, and scientists and governments supporters were reluctant to cede this (Marden, 2003; Stephan, 2015).

In 1986, the finalized Coordinated Framework for the Regulation of Biotechnology[2] outlined the coordinated, risk-based system of the federal agencies involved with the review of biotechnology research and products. The US policy was built on three tenets: (1) the substantial equivalence principle: a focus on the substantial equivalence of a GM crop or food product to a traditional counterpart in terms of composition, nutrition, and safety, rather than on the fact that genetic engineering was used in the process; (2) only regulation grounded in verifiable scientific risk would be tolerated; and (3) as the technology used in GM products is on a continuum with other agricultural innovations, any risks are seen as similar to those of traditionally produced foods (Marden, 2003; Lau, 2015; USDA-APHIS, 2017). Ultimately, the approach was that effective scientific and industry self-regulation could preclude inhibitory legislation, ensuring the development of the GMO industry (Marden, 2003).

In the US, three federal agencies are responsible for regulating GM products under the same laws governing the health, safety, efficacy, and environmental impacts of conventional products. The Department of Agriculture Animal and Health Plant Inspection Service (USDA-APHIS) controls the importation, handling, interstate movement, and environmental release of transgenic plants, with the aim of protecting existing crops from risk. The Department of Health and Human Services Food and Drug Administration (FDA) regulates GMOs in food, drugs, and biological products, while GMO microorganisms and pesticides are managed by the

[2] This was proposed by the Reagan administration and further developed by both the George H. W. Bush and Clinton administrations (Marden, 2003).

Environmental Protection Agency (EPA). Officials of the three regulatory agencies collaborate to ensure that any arising safety or regulatory issues are appropriately resolved (USDA-APHIS, 2017; the Library of Congress, 2015).

Depending on the characteristics of a given GM product, it may be subject to the jurisdiction of one or more of these agencies. The USDA requires businesses to submit a wide range of information before GM plants can be introduced in the US under regulated or nonregulated status. New GM foods require premarket approval if they contain high levels of allergens or toxic substances or reduced levels of essential nutrients[3]; the FDA recommends a voluntary consultation process to determine whether new products would require this approval. However, as GM foods fall under the FDA classification of "generally recognized as safe," they typically do not require special labeling or premarket approval (Lau, 2015; FDA, 2018). The more lenient approach seen in the US is complemented by the threat of litigation against both individual companies and federal regulators (Stephan, 2015).

Some argue that, "The core scientific principles of US regulations, such as 'substantial equivalence,' cannot be understood outside their political, legal, and cultural context" (Stephan, 2015, p. 17) and that regulatory outcomes are partial to what benefits food producers and retailers. In addition, the revolving door migration among agrobiotechnology industry lobbyists and regulators is seen not only as a political foible but also as an expression of a wider belief system that produces a far-reaching consensus between the two groups: to lobbyists and regulators, GM products are generally progressive and benign and offer impressive economic opportunities. The data on American public opinion[4] indicate that the general population holds a

[3] Insecticides are a special subclass under the jurisdiction of the EPA (Lau, 2015).

[4] More on this in the following section.

largely positive reading of technological progress, albeit with weaker confidence in its safety and latent concerns about physical and moral ramifications (Stephan, 2015).

GMO regulations in Europe

The American approach to regulation stands in contrast to developments in Europe. In the early 1990s, the topic of GM foods in the EU remained limited to parliamentary debates about the transposition of European directives concerning the dissemination of GMOs and to various media articles on biotechnology. The use and commercialization of GMOs started to gain traction with the public at the end of 1996 when animated debate surrounded the authorization of Bt corn and the very first imports of transgenic seeds arrived in Europe from the US. Public opinion was marked strongly at this stage by various completely legitimate scares, such as bovine spongiform encephalopathy (BSE), HIV-contaminated blood, asbestos, and other perceived regulatory failures. While these issues had nothing to do with GM foods, they led to strong public distrust toward the food and agricultural industry and government regulatory agencies, which were perceived as potentially disregarding health risks in order to protect certain political or economic interests (Bonny, 2003; Paarlberg, 2014).

Trust is an important factor for the perception of many types of risk, including those related to GM foods (Land & Hallman, 2005). As Dan Glickman, former US Secretary of Agriculture, observes:

> With all that biotechnology has to offer, it is nothing if it's not accepted. This boils down to a matter of trust. Trust in the science behind the process, but particularly trust in the regulatory process that ensures thorough review—including complete and open public involvement. (Glickman, 1999)

Thus, because confidence in European government institutions, industry, and certain technological advances had decreased at the time when genetic engineering issues were being widely publicized, coordinated anti-GMO campaigns were successful in influencing the national debates on GM crops and foods in many European countries. European NGOs, such as Friends of the Earth, Greenpeace, and the European Consumer Organisation (BEUC), saw no consumer benefit from GM foods that might justify even a hypothetical risk and began warning consumers against such products, simply on precautionary grounds (Paarlberg, 2014).

As a wave of public opposition to GMOs swept through Europe, the EU's initial Novel Foods Regulation in 1997, which included relatively moderate provisions on GMOs, became meaningless (Stephan, 2015). The anxieties of European consumers led several EU member states to resort to national bans on GM crops and the European Commission to establish its general policy for GM food regulation in 2002. The Commission also founded the European Food Safety Authority (EFSA), a scientific committee and the legislative body responsible for conducting environmental and health risk assessments of any GMO to be cultivated or marketed within the EU (*Regulation (EC) 178/2002)*.

In addition to the public outrage caused by various food-industry related crises in the 1990s, the EU's tradition of risk-averse regulation in other areas meant that the precautionary principle became the central tenet for GMO regulation. Detailed in Article 191 of the Treaty of the Functioning of the European Union, the precautionary principle is a risk management strategy whereby if a given policy or action may cause harm to the public or environment, and if there is no scientific consensus on the issue, the policy or action in question should not be pursued (EUR-Lex, 2016; European Commission, 2015).[5] The European legislation on GMOs (for example, *Regulation (EC) 1829/2003* on GM food and feed, *Regulation (EC) 1830/2003* concerning the labeling and traceability of GMOs and GM products, and *Directive 2009/41/EC*

[5] The situation should be reviewed, however, once more scientific information is available. The precautionary principle should also "only be invoked in the event of a potential risk and can never justify arbitrary decisions" (EUR-Lex, 2016).

on the contained use of GM microorganisms) seeks to protect the environment and human and animal health, defend consumer interests, and ensure that the EU's single market works effectively *(Regulation (EC) 178/2002)*.

The EU's GMO authorization process includes extensive and case-by-case assessment by the EFSA. The labeling and traceability regulations of GM foods are both process- and product-oriented and aim to label goods that involve genetic engineering at any stage of production. Labeling is required for food products that contain over 0.9% of biotechnological events (*Regulation (EC) 1829/2003*) and for GMOs for food use, food items containing or consisting of GMOs, and GMO derivatives, regardless of whether or not the GMOs are detectable in the end product (for example, sugar from GM sugar beets) (*Regulation (EC) 1830/2003*; Henard et al., 2012; European Commission, 2015).[6]

Approval of GM crops at the EU level can conflict with the regulatory policies of individual member states, and the ultimate deciding power rests with member states. The *de facto* moratorium initially set by various EU countries on the cultivation and importation of GM seeds and foods continues today, with *Directive (EU) 2015/412* allowing EU member states to challenge EFSA risk assessments and to restrict or prohibit the cultivation and use of a particular EU-approved GMO within their borders, if the member state provides additional data demonstrating that the GMO poses a risk to environmental or human health (EC MEMO/15/4779). However, such challenges are brought primarily for political or economic

[6] In the context of the EU's strict regulations, it is interesting to note that numerous products are exempt from GMO labeling obligations. Enzymes produced by GM microorganisms used as processing aids (Twardowski & Malyska, 2015) as well as animal products, such as dairy, meat, and egg products, derived from animals fed GM ingredients also do not require GM labels, despite the fact that imported GM soybean meal is a major feed ingredient for most poultry and livestock in Europe. The EU imports annually some 32 million metric tons of soybeans and soybean meal to be used in feed protein; nearly all of it is from genetically engineered varieties. Non-GM feeds account for less than 15% of total compound feed production in the EU (Henard et al., 2012).

reasons. An example of this is France's ban in 2008 of EU-approved MON810 corn, which contains an engineered insecticidal protein. France alleged that MON810 was an environmental risk because of the potential for insects to develop resistance to insecticide (the hypothetical impacts had been rejected by the EFSA). Because the scientific basis of the ban was unclear, the French government's position was seen as being largely (bio)political, with ministers deciding against scientific opinion to give the appearance of being "green" for the sake of political expediency. The French ban of MON810 was declared unlawful by the European Court of Justice in 2011, yet the French government continues to ban MON810. France's moratorium on MON810 and other similar restrictions by individual EU member states indicate "government interference with science to justify political handling of risk management and bypass European and national agencies in charge of biotech risk assessment under European directives" (Kuntz et al., 2013, p. 499).

The variations in acceptance of agricultural biotechnology and GM foods between EU member states are greater than the variances in socio-demographic characteristics typically observed in surveys (for example, age, gender, profession, level of education, etc.) (Gaskell et al., 2010). These differences are reflected in the diverging policies, private attitudes, and agricultural and industrial approaches, with some European countries being more favorable or less hostile to genetic technology, and others being more hostile. The member states that are open to genetic engineering include GM crop producers: Spain, Portugal, the Czech Republic, Slovakia, and Romania. States ready to adopt locally cultivated crops, if EU approval is granted include: the United Kingdom (UK), Ireland, Denmark, Estonia, Finland, Lithuania, and Sweden. Then there are those countries that are hesitant to adopt biotechnology and where there are contradictory forces: the Netherlands, the Flanders region of Belgium, Bulgaria, France, and

Germany. Finally, there are several member states that are opposed to biotechnology: Austria, Hungary, Slovenia, the Wallonia region of Belgium, Luxembourg, Greece, Italy, and Latvia (Henard et al., 2012).

Despite the Commission's stated priority for a science-based policy geared toward a knowledge-based bio-economy, country-specific pressures have influenced the legal framework. John Dalli, a former EU Health and Consumer Policy Commissioner, maintains that, "The problems of implementation of the GMO legislation [at the EU level] do not stem from its design or its objectives, which remain relevant, but rather from the way these sensitive issues are handled at a political level" (European Commission, 2011). The multilevel governance of the EU grants member states the role of principal agents of enforcement (with many veto points), assuming formal political roles in European regulatory committees, the Council of Ministers and the European Parliament, while US states have little say in the decision-making processes of federal regulatory authorities (Toke, 2004; Stephan, 2015).

PUBLIC ATTITUDES AND CULTURAL CONTEXT

Public attitudes toward GM crops and foods

In addition to regulation, public perception may be a significant hurdle to the acceptance of new technology. Consumers are generally keen to know about the foods they eat, sources of food, and, if the food is processed, what ingredients may have been added (Wunderlich & Gatto, 2015). Because the average consumer does not have the scientific knowledge or resources to decide for her/himself whether GM foods constitute a risk, they have to rely on the competence, transparency, and honesty of the various actors participating in the food supply chain to assess the risk of eating GM foods. Thus, trust is an essential component of public perception and acceptance of genetic technology, with a broad range of actors—from civil society, scientists, regulatory agencies, industry, and the media—contributing to the formation of this trust (Lang & Hallman, 2004). The degree of trust that the public places in actors and institutions is influenced by the wider cultural context (Stephan, 2012).

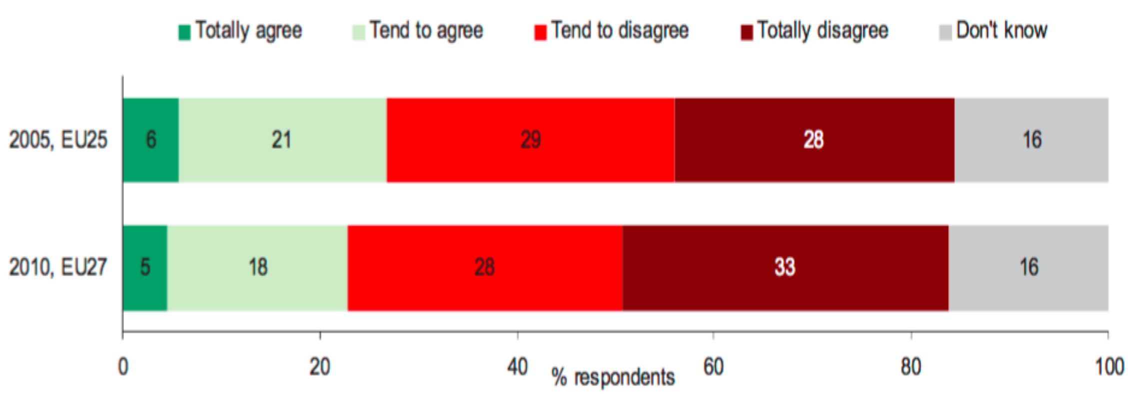
Consumer concerns about the safety of GMOs can have a direct impact on GMO management, and various forums of public involvement provide opportunities for the public to affect the policies, and therefore trajectories, of technology. Whether the public displays trust toward the institutions that appear to control GMOs is a crucial issue for academics and policymakers interested in understanding consumers' reactions to GM foods (Lang & Hallman, 2005; Gaskell & Bauer, 2006). Surveys provide quantitative data that offer a glimpse of public opinion and have been used widely in both the US and the EU. However, it is worth noting that different surveys often come to contradictory conclusions despite questioning the same public; as

Stephan notes, “Too much evidently depends on how questions are framed, on what terminology is used or on what information is supplied” (2015, p. 17).

Well before the safety crises that triggered the anti-GMO events in Europe, a groundswell of opposition was detected, with a sizeable majority of Europeans considering agrobiotechnology applications as harmful to health and the environment and 85% of respondents calling for stricter regulations (Zechendorf, 1994). Surveys since the early 1990s showed that members of the European public had generally not yet made up their minds about biotechnology, but that if they did want more information, they were more likely to trust anti-GMO groups espousing negative, value-based attitudes toward the technology than to trust industry and government sources (Tait, 2001). Anti-GMO groups made a strong impact on public perception, and they received extensive publicity due to the dynamism of their actions: countless mass dissemination of warnings, petitions, alerts, and leaflets; standard letters to elected officials and agricultural firms; lawsuits; demonstrations; and sabotaging GM crop trials and imports. The endless circulation and use of anti-GMO information on the Internet gave it credibility; compound repetitions made it seem more reliable (Bonny, 2003). However, much of the anti-GMO information in circulation at the time was partial and biased; examples of comments from anti-GMO activists include the following: “GMOs are unsafe and must never be released into the environment.” “We don’t know enough about GMOs to risk releasing them—what is being done about this?” “Why doesn’t someone do something to understand the risks of what GMOs are?” (EUR 24473, 2010, p. 209). The 1999 Eurobarometer showed that, in regards to GMOs, actors judged by respondents to be “doing a good job for society” were primarily consumers’ unions, doctors, the media, and environmentalist groups, while industry was judged as the only actor most often “not doing a good job” for society regarding GMOs (Eurobarometer 52.1., 2000).

There is a greater focus nowadays on new technologies as a result of increased concern about sustainability, with Europeans favoring the impetus toward innovation so long as the public is involved in decisions about new technologies when social values are at stake and there are appropriate regulations to balance the market. The latest Eurobarometer in 2010 indicates that while the crisis of confidence in regulation and technology that characterized the 1990s is no longer the dominant perspective in Europe, GM foods remain the Achilles' heel of biotechnology. Although attitudes toward genetic engineering improved slightly after the peak of public opposition from 1996 to 2000, the overall picture throughout 1996 to 2010 as presented in Figure 1 and Table 2 is one of declining support across many European countries; opponents outnumber supporters three to one, and in no country is there a majority of supporters[7] (Gaskell et al., 2006, 2010).

Figure 1: Support for GM foods in the (then) 27 EU member states



Source: Gaskell et al., 2010, p. 37

[7] In the 2005 Eurobarometer, only 27% of respondents regarded GM food positively; this number dropped to 23% by 2010 (Gaskell et al., 2010).

In general, respondents believe that the governance of science should be based on moral and ethical considerations rather than scientific evidence (Gaskell et al., 2010). Member states with a ban on GM crop plantings generally show low values of public support and vice versa. For example, amongst European countries, Spain has registered the highest index level of public optimism for biotechnology/genetic engineering concurrently between 1991 to 2010. Spain is also the EU's leading producer of Bt corn with over 90% of total acreage in the EU (or 30% of the annual Spanish corn crop) (Gaskell et al., 2010). Since Bt corn was first planted in Spain in 1998, farmers have had good experiences with the crop's efficacy against the corn border infestation, which, together with reduced pesticides costs and yield gains, translates directly into increased revenues (Gómez-Barbero et al., 2008).

Table 2: Trends in support for GM foods in Europe

% of respondents who agree or totally agree that GM food should be encouraged

	1996	1999	2002	2005	2010
United Kingdom	52	37	46	35	44
Ireland	57	45	57	43	37
Portugal	63	47	56	56	37
Spain	66	58	61	53	35
Denmark	33	33	35	31	32
Netherlands	59	53	52	27	30
Norway	37	30			30
Finland	65	57	56	38	30
Belgium	57	40	39	28	28
Sweden	35	33	41	24	28
Italy	51	42	35	42	24
Austria	22	26	33	24	23
Germany	47	42	40	22	22
Switzerland	34				20
Luxembourg	44	29	26	16	19
France	43	28	28	23	16
Greece	49	21	26	14	10
Czech Republic				57	41
Slovakia				38	38
Malta				51	32
Hungary				29	32
Poland				28	30
Estonia				25	28
Slovenia				23	21
Latvia				19	14
Lithuania				42	11
Cyprus				19	10
Iceland					39
Romania					16
Bulgaria					13
Croatia					13
Turkey					7

Source: Gaskell et al., 2010, p. 40

The issues associated with food safety that Europeans are most concerned about include GMOs, pesticide residue, pollutants in food products, and the presence of antibiotics or hormones in meat (TNS Opinion & Social, 2010). Public concerns about risks and safety together with the perceived absence of benefits remain paramount issues; GM foods are seen as "unnatural," and many Europeans report feeling uneasy about the notion of GM foods. However, while only a small number of GM-labeled products are on sale in various European countries, and a majority of the European public is somewhat averse to GMOs, studies have also found that most people are actually neither really interested in nor very alert to the presence of GM ingredients in products, even when present in the foods purchased. The quality in proportion to the price turned out to be a paramount concern, regardless of whether a food item was labelled GM. A 2010 study concluded:

> The observations underline the fact that what people say differs from what they do. Though the data obtained are not sufficiently extensive, it may reasonably conclude that (i) most people do not actively avoid GM foods while shopping, suggesting a divergence between their opinions and actual shopping patterns; (ii) linking purchasing data with answers to questionnaires is a more reliable way to establish attitudes than relying on opinion polls only. (EUR 24473, 2010, p. 209)

The US was the initial driver and promoter of agricultural biotechnology, and legal actions rather than wide popular pressure gave rise to the country's current regulatory framework (Stephan, 2015). The American government's approach to GM products has helped the industry to grow: the country leads in biogenetic agricultural productions, contributing 72.9 million hectares of land and accounting for 40% of global GM crops (ISAAA, 2016). Over 100 GM crops with a single engineered trait have been introduced in the US market to date; by contrast, fewer than 40 have been introduced in the EU (Lau, 2015). Corn, cotton and soybeans—the three most widely grown GM crops in the US—initially accounted for only small percentages of farmland in 1996 but now supersede conventional crop varieties, and the adoption rate of genetically engineered crop varieties is over 90% (Wunderlich & Gatto, 2015; Lucht, 2015). The majority of processed foods in the US contain at least one GM ingredient, and American consumers have been ingesting GMOs for the last two decades without ill effects (Funk & Kennedy, 2016).

Although the US is sometimes portrayed as a non-contentious market, the picture of GM foods there is not always clear. Between two-thirds and three-quarters of American consumers initially expressed little to no concern about genetic techniques in food production and were likely to buy GM products (O'Connor et al., 2004). Marked US public concern about the technology did not emerge until 1997, driven in part by the controversy in Europe. While there have been repeated complaints from consumer groups, NGOs, and trade partners that the safety, allergenicity, and environmental concerns of GMOs have not been adequately considered, the opposition has not had the same pivotal influence as in the EU (Marden, 2003). There appears to have been a peak in both awareness and concern around 2000 to 2001; general public awareness reached 53%, and only half the population still believed in the substantial benefits of agrobiotechnology over the next 20 years. Opposition had again declined somewhat by 2006 and was estimated at 34% (Stephan, 2015). In a 2016 Pew Research Center survey (see Table 3), 48% of respondents said the health effects of GM foods are no different from other foods, 39% said GM foods are worse for one's health, and 10% said such foods are better for one's health. Most Americans surveyed say they know little about GM foods, and many people hold "soft" views about their health effects. Sixteen percent (16%) of respondents, however, care a great deal about GM foods and believe they pose health and environmental risks (Funk & Kennedy, 2016).

Table 3: Public opinion in the US on GM foods

% of US adults who say foods with genetically modified ingredients are generally ____ than foods with no genetically modified ingredients	
If given an option of saying "not sure"	
Worse for health	33
Neither better nor worse	32
Better for health	7
Not sure	26
No answer (vol.)	1
Among those saying "not sure"	
Worse for health	22
Neither better nor worse for health	58
Better for health	11
No answer (vol.)	10
Views about GM foods when both questions are combined	
Worse for health	39
Neither better nor worse for health	48
Better for health	10
No answer or refused to lean (vol.)	3

Note: Respondents were first given the option of answering "not sure" when asked about the health impacts of genetically modified foods. Those respondents (and any who gave no answer) were then asked which option they were "leaning" toward if they had to choose.
Source: Survey conducted May10-June 6, 2016.
"The New Food Fights: US Public Divides Over Food Science"
Pew Research Center

Source: Funk & Kennedy, 2016

A recent report from the National Academies of Sciences, Engineering, and Medicine suggests that while there is scientific consensus that GM foods are safe, many Americans perceive disagreement in the scientific community over whether or not GM foods are indeed safe to eat. This skepticism perhaps arises from concerns regarding the motives of research scientists, with some 30% of Americans believing that research findings on GM foods are often influenced by the researchers' desire to help their industries. The same number of Americans also say that research findings on GM foods are influenced by the best available evidence. Generally, Americans with greater knowledge of science topics are more likely to trust information from scientists and to see scientific research findings about GM foods in a more favorable light (Funk & Kennedy, 2016). The Eurobarometer showed comparable results regarding individuals who are more science savvy (Gaskell et al., 2010).

In addition to the concerns raised over health and environmental risks, anti-GMO activism in the US in the early 2000s highlighted socio-economic arguments about the corporate monopoly control of the food chain and damage posed to small and organic farmers (Reisner, 2001). Demands were made for the mandatory labeling of GMOs and more stringent evaluations of their potential negative impacts on the environment and human health. While these campaigns ultimately failed to reform the US regulatory framework, they did achieve some limited victories: In 2002, organic food labels were established, and the FDA announced more rigorous guidelines on premarket food safety evaluations in 2004. Numerous state bills and court cases yielded a patchwork of rudimentary segregation and labeling laws (Stephan, 2012). Several New England states with strong positions on organic farming have led the resistance against genetic engineering, requiring GE seed labels and allowing the voluntary labeling of GM-free products (Tokar, 2009). In 2014, Vermont was the first state in the US to pass legislation requiring the labeling of GM foods, effective July 1, 2016, while Maine and Connecticut passed similar labeling laws, albeit with a trigger clause requiring other states to pass labeling requirements before their own legislation goes into effect (Chokshi, 2014).

While anti-GMO activism in Europe has been integral in mobilizing public pressure for stringent regulations, the success of these campaigns has been related to both political opportunity structures and the ability of anti-GMO narratives to activate widespread and preexisting, culture-based anxieties. American NGOs have attempted to replicate European success but have faced a powerful pro-agrobiotechnology coalition and less favorable political opportunity structures. The differences in NGO narratives and the broader cultural context is reflected in the strategies of biotechnology industry and responses of farmers' organizations: cautious incrementalism or indifference in Europe compared to American optimism (with some exceptions) (Stephan, 2012).

Overall, the data from direct consumer surveys show that consumer knowledge of GMOs in both the US and Europe is generally low and remains superficial (Lucht, 2015; Wunderlich & Gatto, 2015). Survey respondents showing low GM knowledge also reported a disproportionately strong reliance on popular media as a source of information. This can be problematic, however, as the media can propel incomplete and simplified knowledge en masse, leading to partial or inaccurate knowledge and information (Wunderlich & Gatto, 2015). For example, the fact that intense research work is being done on the biosafety of GMOs is often ignored in the public debate. J. E. Bering maintains that anti-GMO activists:

> Have encouraged the exploited public unease very effectively because most people are unaware that biosafety research is being done and, with the exception of GM vaccines and other medical uses, there has been very little direct public benefit to counteract perceived risks. (cited in EUR 24473, 2010, p. 209)

Although GMO-related information in the popular public sphere may not always originate from scientific sources, consumers are apt to trust these sources over mainstream scientific sources (Wunderlich & Gatto, 2015).

Cultural approaches to agriculture and land usage

Explaining the divergent approaches between the US and the EU, however, goes beyond the typical debate about whether the US takes excessive risks for the sake of efficiency, or whether European countries are irrational in their insistent precaution and concern over the safety of GMOs. In addition to scientific information, the public's perception of genetic technology is influenced by cultural resources from one's symbolic past (Gaskell & Bauer, 2006).

Numerous accounts of GMO regulation implicitly acknowledge that culture plays some role in regulatory outcomes, politics, and public opinion. Stephan (2015) notes that, "When rendered more explicit, cultural factors manifest themselves in terms of social trust, regulatory styles or traditions and public 'outrage'" (p. 7). Culture embodies the context of political agency and "is the basis for social and political identity that affects how people line up and how they act on a wide range of matters" (Ross, 1997, p. 39). Cultural factors should be included as an integral part of an analysis that also considers other elements derived from regulatory politics, public mobilization, and interest group behavior (Stephan, 2015). Consequently, one manner through which GMO acceptance can be understood is in the context of different historical perceptions of land usage and agricultural practices.

While European relations to the natural environment were marked with spiritual precepts and material interdependence, American settlers swiftly shook off their hereditary attitudes and undertook the challenge of mastering a "wild" continent. These dynamics produced divergent civilizations dispositions, or the tendency to perceive relations between nature and humanity as either interactive or bifurcated. American bifurcated approaches shifted from the interactive European tradition of pastoral beauty toward the magnificence of wilderness, albeit alongside a continued exploitation of the same. Nature has taken a meaning of grandeur and truth in the US, while in Europe it remains mired in compromises (Stephan, 2012).

Agriculture in Europe is typically regarded as an integral part of the environment—the "middle landscape" wherein natural processes and human activity coexist. Farming, with its associated landscapes, livelihoods, and practices of food production, is a principal illustration of the variety and overlap in land usage patterns (Stephan, 2012) and the accompanying "strong ideological and physical linkages between rural and urban" (Herrick, 2005, p. 291). Methods of heavy plowing are deeply rooted in the European farming tradition, and no-tillage[8] farming is rarely practiced (Eurostat, 2018). The pioneer aspect of American history created the notion of the need to "conquer" and win a livelihood from the wilderness, while in Europe, Romanticism in the nineteenth century saw the beginning of a shift away from technological mastery over nature. Additionally, the destruction of Europe during the two world wars of the twentieth century made it necessary to rebuild and restore European agriculture, while the mainland US remained untouched and continued to develop its agricultural production without the interference of conflict (Ujj, 2016).

In Europe, only a relatively small area is currently under no-tillage in contrast to the US, Australia, Canada, Argentina, and Brazil (Mäder & Berner, 2012). American farmers are more reliant on herbicides in order to preserve soil quality. While tillage is a useful weed management option and makes the use of herbicides less necessary, it also dries and compacts soil, leading to extensive erosion, an undesirable trait particularly in the drier central and southwest US states (Ujj, 2016). The no-tillage method was adopted in the US after the Dust Bowl in the 1930s (Mäder & Berner, 2012). Prior to the tragic dust storms, the plow dominated American agriculture and represented the larger efforts of European settlers to transform and cultivate their newly homesteaded land. Heavy steel plows were applauded for their efficiency in creating a finely titled, smooth surface without residue. Throughout World War I, the US government encouraged the use of the steel plow in order to maximize production as part of the home front war effort. The push for maximum production, in addition to the use of the moldboard plow

[8] No-tillage is a minimum tillage farming practice in which the crop is sown directly into soil that has not been tilled since the harvest of the previous crop. Weeds are controlled through the use of herbicides and/or appropriate mulching (Eurostat, 2018).

during a devastating drought, led to the 1930s Dust Bowl, in which an estimated 282 million acres of land—including 50 million acres of cropland—were destroyed by erosion and another 100 million acres were severely damaged (Strand et al., 2014).

In 1935, the Senate Public Land Committee created the USDA Soil Conservation and advocates for soil conservation vilified the moldboard plow, equating soil erosion with poison that endangered an important resource and farmers' livelihoods. These events, along with research in conservation tillage[9], inspired the federal government to pass a series of policies that supported conservation tillage and to provide financial support to those farmers willing to adopt innovative conservation methods such as stubble mulching, contour plowing, ridge planting and terracing. Technology also evolved, making conservation tillage more accessible and efficient through the use of new equipment and practices such as herbicides and the Allis-Chalmers no-till planter. Overall, such developments and policies encouraged American farmers to adopt new practices in their soil management and engagement with agricultural landscapes (Strand et al., 2014).

In contrast to many farms in the US, European farmers in large spaces are faced with cold and humid conditions during crop cultivation, limiting the suitability of no-tillage practices (Mäder & Berner, 2012). Uptake of no-tillage ranges from 4.5% to 10% of total arable land in Greece and Finland, and from 2.5% to 4.5 percent in the UK, Spain, Slovakia and the Czech Republic. Reduced tillage is practiced on 20% to 25% of arable land in Portugal, Germany, and

[9] Conservation agriculture comprises a combination of practices that minimize alteration of the structure and composition of soil, safeguarding it from erosion and preserving soil biodiversity. No-tillage and reduced tillage, combined with permanent soil cover and crop rotation, are essential practices in conservation agriculture. Such practices mitigate the risk of soil degradation by increasing the organic carbon stock, thus improving biological activity, the water-retention capacity of soils, and soil fertility and structure, which in turn reduce soil erosion and nutrient run-off, and improve soil resistance to compaction (EUR 23767, 2009).

France, and on 40% to 50% in the UK and Finland (EUR 23767, 2009). Mixed farms with fodder, animals and cash crops are instead considered ideal in view of environmental protection, nutrient recycling and a farm's impact on the soil and climate (Mäder & Berner, 2012).

The European pastoral idea of nature and landscape, which includes aesthetic and socio-economic elements, continues and has fueled important movements of resistance against modern industrial or technological change (Stephan, 2015). Cultural identities have frequently drawn on images of agricultural and artisanal livelihoods and their associated humanized environments. While the arrival of technological changes are not automatically imbued with a value judgment, whether such changes are implemented depends on the cultural meanings attached to them (Stephan, 2015). The pressures of domestic and global economic competition have further increased the appeal of traditional agriculture landscapes. Many European countries continue to emulate the agricultural civilizations they once embodied, in contrast to the American utilitarian context (Stephan, 2012).

The Jeffersonian idea of the fiercely independent, small-holding yeoman farmer flourished with the expansion of the American frontier and was subsequently folded into a coalition of progressive, industrialist forces, united in the utilitarian rationale of productivity and technology (Thompson, 2001). The majority of farmland in the US (with some exceptions, particularly in the East Coast) is detached from urban sprawl, industrial estates, and wilderness. In contrast to Europe where land is perceived to attain its highest environmental value when used for agriculture, neither regulators nor the public in the US perceive strong positive externalities from farming, with some scholars maintaining that if a widely shared public good is at stake, it is the production of low-cost food products. There is less commitment to cultivated landscapes, as land is seen to reap a higher environmental value when removed from farming and returned to its natural state (Baylis et al., 2008).

In contrast to European interactive agricultural communities that recognize associations with nature in food products and mixed cultural landscapes, American society embodies a modernist, bifurcationist culture in which the values of abundance, efficiency and simplicity tend to supplant neo-traditionalist concerns about culinary heritage, stable cultural identities, and the middle landscape. European and American societies have historically moved along distinct cultural trajectories, and while these trajectories do not directly cause regulatory outcomes, they still have an effect on the politics of GMOs in the EU and the US (Stephan, 2015).

Nature can have plural connotations, and many Europeans (and a minority of Americans) perceive GMOs as a threat to one or several of these meanings, such as traditional livelihoods or cultural identities related to agriculture and food, or the concept of a metaphysical "natural order" (Stephan, 2015). European concerns about the "unnaturalness" of GMOs relates to other agricultural innovations, such as antibiotics in animal feed and the use of pesticides. Agriculture biotechnology has come to represent a sounding board for contemporary European anxieties about modernity, globalization, and the decline of national identity. Some feel that such developments have been driven by industrialization and the desire for increased productivity, regardless of environmental or health considerations, leading to uniform and bland food (Marris, 2001). Support for local products, food cultures, and traditional methods are frequently seen as an essential element of protest against, or a reversal of, the industrialization of food (Stephan, 2012). Such concerns also contribute to the ethical critique of the "unnaturalness" of GM crops and foods, crowding out utilitarian benefit-risk evaluations. These dynamics are significantly weaker in the US, despite the fact that other anti-GMO narratives have recently gained prominence (Stephan, 2015).

The nationalization of American cuisine in the twentieth century did not glorify authentic ingredients as cultural heritage but rather heralded the "mass market of industrial cuisine" whose utilitarian motives were complemented by images of gratification and symbolic associations (Pilcher, 2006, p. 53). Food advertising campaigns carried a host of implicit signals about beauty, health, and vitality, which became embedded in the framework of basic American cultural themes: democracy, capitalism, industrialism, individualism, leisure, and youthfulness (Stephan, 2012).

Nevertheless, a local food movement is beginning to make inroads into the largely homogenized US food system, with a coalition of consumer and civil society organizations attempting to build a broader national consensus around local and regional food systems. Numerous farm-to-school/college programs have been established and helped to increase the number of official farmers' markets from 1,755 in 1994[10] to 8,144 in 2013 (Stephan, 2012; Ag Marketing Resource Center [AGMRC], 2018). "Culinary capital," demonstrated through detailed knowledge of quality food products and dishes, is also becoming increasingly trendy (Smith, 2009). However, the increased attention to food provenance in the US may not be as intensely associated with images of nature and/or traditions as in Europe, and the appeal of local food may sometimes be combined successfully with the potential utilitarian benefits of GM crops (Mazzocco & Novotorova, 2008; Stephan, 2012).

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[10] When the USDA's Agricultural Marketing Service began tracking farmers' markets (AGMRC, 2018).

CONCLUSION

In the EU and the US, the benefit-risk analysis narrative on GMOs has been influenced throughout the years by numerous actors and resulted in distinct attitudes toward, and regulations on, genetically engineered crops and food. Circumstances in the US, such as favorable institutional structures, a strong agrobiotechnology industry, and government support, allowed for the adoption of a permissive environment of GMOs; while in Europe, public unease led to a negative environment and resulted in complex regulations and a *de facto* moratorium on GM crops and food in many EU member states.

The adoption of GMOs in the US and the EU, however, it is not only a matter of the science, politics, or lobbying involved but also about the public preferences, which are influenced by cultural factors. As seen with GMO regulations in Europe, the public's perception of the safety of new technology can directly impact the trajectory of technology implementation via the opportunities structures provided to the public to engage with and affect change in regulatory outcomes. The degree of trust the public places in actors and institutions is influenced by the wider cultural context (Stephan, 2012). The varied cultural approaches to agriculture and land usage seen in the US and the EU, combined with the unique histories, identities, and ideologies can be attributed to the different levels of trust in the food chain, to the levels of optimism about new technology, and the extent to which negative or positive images of GMOs persist.

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