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Societal aspects of genetically modified foods

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Abstract

This paper aims to examine some of the reasons behind public controversy associated with the introduction of genetically modified foods in Europe the 1990s. The historical background to the controversy is provided to give context. The issue of public acceptance of genetically modified foods, and indeed the emerging biosciences more generally, is considered in the context of risk perceptions and attitudes, public trust in regulatory institutions, scientists, and industry, and the need to develop communication strategies that explicitly include public concerns rather than exclude them. Increased public participation has been promoted as a way of increasing trust in institutional practices associated with the biosciences, although questions still arise as to how to best utilise the outputs of such exercises in policy development. This issue will become more of a priority as decision-making systems become more transparent and open to public scrutiny. The results are discussed in the context of risk assessment and risk management, and recommendations for future research are made. In particular, it is recommended that new methods are developed in order to integrate public values more efficaciously into risk analysis processes, specifically with respect to the biosciences and to technology implementation in general.

Keywords: Consumers; Risk perception; Technology acceptance; Regulation; Public engagement

1. Introduction

This paper attempts to address some of the issues relevant to society regarding the public acceptance or rejection of genetically modified foods and agricultural applications of gene technology. It is unlikely that a single social science discipline can effectively encompass all of the relevant issues. The current paper therefore encompasses expertise from social psychology, sociology, marketing and ethics. Input was also provided by the European Consumer Organisation, BEUC (Le Bureau Europeen des Unions de Consommateurs). Of interest is the agreement between the different disciplinary perspectives regarding key issues of interest, which are covered in the current paper. In particular, there is substantial evidence within different disciplines that it is public risk perceptions and attitudes that appear to drive beliefs about the acceptability or otherwise of emerging technologies such as genetically modified foods, although these have not to date been incorporated into regulatory processes and activities. It was concluded that institutional failure to address public concerns as part of their activities has had consequences for public trust in these same institutions, which has, in turn, had further negative impacts on the commercialisation of genetically modified foods. Taken

Abbreviations: ADIT, Agency for Diffusion of Technological Information; BEUC, Bureau Européen des Unions de Consommateurs; EC, European Community; EEC, European Economic Community; ENTRANSFOOD, European network safety assessment of genetically modified food crops; GM, genetically modified; GMO, genetically modified organism.

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together, it was thought that some changes should be made to the process of risk analysis associated not only with genetically modified foods, but also more generally. Suggestions for future research to address how public concerns and values might be fruitfully incorporated into risk analysis frameworks in the future are discussed in the context of a research agenda.

2. Genetically modified foods as a public issue: historical background

The first major controversy associated with gene technology in Europe took place in the late 1980s, when genetically modified foods were not at the commercialisation stage, but industrial applications of gene technology (for example, the production of pharmaceuticals and food ingredients) were developed to the production and marketing stages. The policy response was at first sporadic, and confined to national regulations. Later the European Commission harmonised the national regulations across Europe. Community legislation on genetically modified organisms concerning their authorisation has been in place since the early 1990s and throughout the decade this regulatory framework has been further extended and refined. The main legislation that authorises experimental releases and placing on the market of GMOs in the Community is currently Directive 90/220/EEC. A new, updated Directive 2001/18/EC on the deliberate release of genetically modified organisms entered into force on 17 October 2002. Further specific rules on GMOs for human consumption were introduced in 1997, in the Regulation on Novel Foods and Novel Food Ingredients (258/97/EC of 27 January 1997). The Regulation sets out rules for authorisation and labelling of novel foods including food products containing, consisting or produced from GMOs, recognising for the first time the consumers right to information and labelling as a tool for making an informed choice.

The labelling of GM maize varieties and GM soy varieties that did not fall under Regulation 258/97 are covered by Regulation (EC) 1139/98. Regulation 49/2000 sets our more specific labelling rules, by introducing a threshold for labelling purposes and Regulation 50/2000 requests the labelling of GMO derived additives and flavourings. Ongoing legislative initiatives concern the traceability and labelling of GMOs and the authorisation of GMOs in food and feed. European regulation is the result of a regulatory tradition, and reflects a specific policy process that frames the issue of gene technology solely as an issue of risks to the environment and human health.

An initial outcome of the implementation of the first European directive seemed to be a settlement of the conflicts over gene technology. This conclusion can be drawn from the observation that debates vanished and the level of conflict fell in most, if not all, European countries (for an overview see e.g. Durant et al., 1998; Torgersen et al., 2002). The silence was however, only temporary, and by 1996 the second international level controversy over gene technology was triggered by the arrival of genetically modified soybeans at European harbours late 1996 (Lassen et al., 2002b). The soybeans, coming from soy plants genetically modified by Monsanto to resist the herbicide *Round-Up*, represented the first large scale marketing of genetically modified foods in Europe. Other applications of biotechnology soon followed: events such as the attempted commercialisation of genetically modified maize and other genetically modified commodities focused public attention on the emerging biosciences, as did other biotechnology applications such as animal and human cloning.

The result of these events has been to focus public attention on the emerging biosciences more generally, and on genetically modified foods in particular. The public debate has resulted in the formation of non-governmental organisations with explicit interest in debating the issues associated with the emerging biosciences. There are also increased demands for public participation in the debate about regulation and scientific strategy, and the rise of the "consumer citizen", who expresses acceptance or rejection of genetically modified products through purchase decisions or consumer boycotts (Frewer and Salter, 2002). Understanding societal responses to emerging technologies and their applications is key to developing commercialisation strategies associated with specific products, as well as optimising strategic development of science and technology in the future. The aim of the current paper is to discuss some of the societal issues relating to society, science, and genetically modified foods.

3. Public acceptance or rejection of genetically modified foods

3.1. Public attitudes and risk perceptions

In a democratic society where choice exists, people will not consume foods that they associate with some negative attribute. Various factors may contribute to concerns. These include beliefs that there is potential for negative environmental impact associated with production processes or agricultural practices and perceptions that there is uncertainty associated with unintended human or animal health effects. (The latter appears to be particularly true if people believe that these negative or risky effects are hidden by producers or regulators to serve a vested interest.) Ethical concerns are also important (for example, that a particular technology is in some way "tampering with nature", or that unin-

tended effects are unpredictable and thus unknown to science (Miles and Frewer, 2001). Some technologies may also be described as "transformative", as they have potential consequences for the way in which society is organised. Societal responses to the application of technology innovations may be driven by concerns about the impact that the technology will have on societal and social structures and relationships. For this reason, considerable effort has been directed towards understanding people's attitudes towards the emerging biosciences. Particular emphasis has been placed on understanding public attitudes towards genetically modified foods, as they were the focus of public negativity in the 1990s, particularly in Europe, events which appeared to surprise many stakeholders in the regulatory, scientific, and industrial communities.

3.2. What is an attitude?

Public acceptance of science and technology can be approached on different levels. Generally, the concept of *attitudes* provides the framework for social-scientific research in this area. Psychologists define an attitude as a tendency to evaluate a particular entity (the attitude object) with a certain degree of favour or disfavour (Eagly and Chaiken, 1993). Attitudes can be used to explain why some people support particular social policies, or ideologies, whilst others oppose them. A person who favours a particular policy is said to hold a *positive attitude* towards it, whereas someone who opposes it would hold a *negative attitude* (MacCorquodal and Meehl, 1948). Evaluative responses are those that express approval or disapproval, attraction or aversion, and so forth. Evaluative responses and the psychological tendencies that are assumed to underlie them differ not only in terms of *direction* (positive or negative) but also *intensity* (a very positive evaluation is likely to have a very different impact on behaviour compared to a slightly positive one). An attitude focusing on a relatively abstract concept is termed a value (for example, belief in the fundamental integrity of nature represents a value).

3.3. Risk perception and behaviour

Risk perception might be regarded as a specific form of an attitude towards a specific attitude object, a potential hazard. Research in this tradition has argued that people's responses to different risks are *socially constructed*. In other words, people's perceptions about a hazard influence people's responses to it. A particularly influential empirical approach was the psychometric paradigm developed by Paul Slovic and colleagues that has been used in both general risk research (Slovic, 1987, 1993) and specific hazard domains such as food research (Fife-Schaw and Rowe, 2000; Sparks and Shepherd, 1994). Empirical investigation within the framework of the psychometric paradigm has concluded that the technical risk estimates traditionally provided by experts do not influence people's behaviours and responses in the same way as their risk perceptions. For example, a risk that people perceive to be involuntary in terms of personal exposure is more threatening than one that that is perceived to be voluntary, even if the probability of harm is the same, or possibly even less.

For similar reasons, naturally occurring risks are less threatening than hazards which are technological in origin, and people fear potentially catastrophic hazards more than those which affect a similar number of individuals but at different times (see Katsuya (2001) for examples from the nuclear area; Slovic (1993) for examples contrasting technological and natural risk). Other concerns are very specific to particular hazard domains (for example, see Bauer, 1995; Fife-Schaw and Rowe, 2000). Public perceptions of risk have often been dismissed on the basis of "irrationality", and have tended to be excluded from policy processes by risk assessors and managers. However, it is these public concerns (and associated risk behaviours) that have direct consequences for human health, food safety and security, economic expansion, and international regulation. Otway (1987) has observed that effective risk management involves structuring decision-making processes in such a way that they can accommodate social concerns and provide institutional forms in which these social concerns can be discussed. In the case of genetically modified foods, public outrage was as much linked to perceptions that their exposure to potential risks, however small, was involuntary and uncontrollable.

In terms of understanding how people's attitudes and values influence their acceptance or rejection of genetically modified foods, it is important to understand their attitudes towards science and technology per se, where values such as beliefs about the integrity of nature may also be important. Other important beliefs include those held about the acceptability of specific consumer policies (for example, labelling of foods produced using genetically modification in production processes), their perceptions of risk and benefit associated with particular products, and linking these different factors to actual behaviours (for example, buying a particular genetically modified product).

Quite obviously, the different types of attitudes refer to conceptually distinct objects that are only loosely related to each other. Hence, it is by no means impossible for a person to have a negative opinion about genetic modification of foods as such (and to favour the labelling of products which were manufactured with the help of these technologies), but at the same time be convinced that a particular genetically modified food is a good product, whereas another one is not. An indivi-

dual consumer may still personally buy the critically evaluated genetically modified food because it has other attributes that make it attractive, such as its price, packaging, availability, or the convenience of its preparation. The complexity of these interrelating factors helps explain some of the individual differences in consumer behaviours associated with the actual purchase of genetically modified foods.

The issue of consumer acceptance thus includes understanding of very broad, socio-political factors, such as public trust in regulatory institutions and the information about risk management that is provided by these same institutions. Political actors in a narrow sense (i.e., governments, political parties, environmental policy groups) as well as scientists working in basic research in the field of the biosciences are often interested in public attitudes towards technologies on a global level. Regulatory institutions and consumer organisations, on the other hand, may be more concerned with public beliefs about the acceptability of consumer policies, such as the labelling of genetically modified ingredients and commodities, and communication about traceability mechanisms through the food chain. Food manufacturers may be more narrowly interested in consumer's attitudes towards the buying of particular products for a particular occasion in a particular shop. In general, however, all aspects of the science and society debate are of interest to those with an interest in the strategic development of the biosciences and commercialisation of specific products.

3.4. Methodologies adopted

Different branches of social research have evolved in the last decade that contribute to the information needs of the various actors (for reviews, see Bredahl et al., 1998; Hamstra, 1998; Levidow and Marris, 2002; Zechendorf, 1994). Many different methodologies have been adopted to answer this question. These have included opinion polls that aim to gauge the absolute level of favour or disfavour in the general public across different cultural and demographic groups (for example, the Eurobarometer 52.1, published by the European Commission in 2000), to qualitative investigations involving in-depth interviews with consumers (for example, Miles and Frewer, 2001). These data have been used to develop causal models to explain the interrelationships between general socio-political attitudes, the extent to which people trust institutions responsible for regulation and technology development, and perceptions of risk and benefits associated with the emerging biosciences and their application in the manufacturing of particular products (for example, Bredahl, 2001; Siegrist, 1999).

The optimal approach to understanding the complex relationship between society and the emerging biosciences is to consider the results of differential approaches together, and to consider how best to harmonise the results to facilitate understanding of the science and society relationship more generally, as well as specifically focusing on particular applications such as genetically modified foods. For example, Hansen et al. (2003) have observed that different disciplines (such as sociology and social psychology) may use diverse (and in some instances similar) methodologies to addressing key questions associated with risk perception, attitudes, and food choice—that different theoretical approaches frequently produce the same conclusions in terms of implications for understanding the science and society relationship adds to the robustness of these conclusions. One factor that has emerged as being of great importance in understanding public acceptance of genetically modified foods has been that of trust, whether in regulatory institutions and the motives of scientists, or in information about the risks and benefits of particular technological applications of science and technology. The issue of trust appears to have wider application to the acceptability of risk management activities as well as social policy more generally. Trust will be considered in the context of the emerging biosciences applied to food production in the next section.

3.5. Trust in risk regulation and risk management

There is much debate about the need to increase public confidence in regulation and risk management, particularly in the context of established and emerging technologies. Regulatory institutions often attribute low levels of public confidence to distrust in both risk management practices and the motives of scientists and regulators. However, early efforts at science communication have demonstrated that simply conveying factual information about the risks and benefits of genetic modification (or indeed other technologies and technological practices) is unlikely to result in consumer acceptance of the products of these technologies. More recent attempts to include public perspectives in a direct way within risk policy frameworks begin to assume equality from the public and scientific experts in terms of inputs into risk management. Approaches to improving public confidence in risk management processes have included reassessing the way in which risks are managed by regulatory institutions and bodies. Such attempts may focus on increased transparency in regulatory practice (increased tendencies to hold meetings of scientific advisory committee meetings in public, for example) and increased public participation and consultation in regulatory decision-making (Mathias and Frewer, 2000). The extent to which increased public participation has an effect on public trust in scientific processes and regulatory processes is, however, largely unevaluated.

3.6. Trust in institutions and information sources

A key issue is the extent to which the public believes certain risks are managed effectively by regulatory institutions with the aim of protecting the public. Frewer et al. (in press) note that it is important to distinguish between the concepts of "social trust", which has origins in socio-political analysis, and "source credibility" which is derived from empirical work in applied social psychology (for reviews, see Johnson, 1999; Renn and Levine, 1991). "Social trust" refers to people's willingness to rely on experts and institutions in the management of risks and technologies and here is most usefully described as a socio-political attitude that is generalized over particular issues and institutions. Societal trust in regulators, science and industry is likely to be particularly important if the public perceive that they have no control over a particular event or activity, but must confer responsibility for ensuring consumer protection or public welfare onto others—as arguably is the case with genetically modified foods. An example of this type of analysis is provided by Siegrist (2000), who used the concept to explain perceived risk and benefit associated with gene technology. In this research, social trust was positively related to perceived benefit but negatively related to perceived risk. Siegrist (1999, 2000) has demonstrated that trust in companies and scientists conducting research in the area of gene technologies has a strong effect on the overall levels of risk and benefit perceived to be associated with those technologies.

One consequence of empirical analyses into the role of trust has been the substantial effort made by some governments, regulatory bodies, and other key stakeholders to direct resource towards increasing public trust and confidence in their activities. At one level, this has involved increasing transparency in decision-making processes. One effect of this has been to open weaknesses in technical practices to public scrutiny (for example, in the case of the different uncertainties associated with risk assessment), increasing the need to develop more effective approaches to risk communication. At another level, there are increased demands for institutional reform, to facilitate more socially inclusive decision-making processes per se. At both levels, the issue of increasing and maintaining public trust and confidence in institutional, scientific, and industrial practices is likely to be a topic of future research, and highly relevant to the future commercialisation of genetically modified foods as well as other technological innovations.

3.7. Public concerns about genetically modified foods

One potential reason for the lack of trust in institutions and institutional activities is that the public perceive that institutions have failed to take account of the actual concerns of the public as part of their risk management activities. Most research effort has been devoted to assessing peoples attitudes towards genetically modified foods as a technology. Numerous "opinion poll"—type surveys have been conducted on national and cross-national levels (for a review, see Hamstra, 1998). The most inclusive of these is the Eurobarometer, the official public opinion instrument run by the European Commission.

3.8. The Eurobarometer results

Five special Eurobarometers have been conducted in the last decade to gauge the overall level of consumer attitudes towards biotechnology in the European Union (Eurobarometers 35.1 in 1991, 39.1 in 1993, 46.1 in 1996 (European Commission, 1997), and 52.1 in 1999 (European Commission, 2000); Eurobarometer 55.2 in March 2002,—Europeans, science and technology (European Commission, 2002). The survey Eurobarometer 52.1 (European Commission, 2000) asked approximately 16,000 European citizens to indicate their attitudes towards genetically modified foods of the first generation ("Taking genes from plant species and transferring them into crop plants to make them more resistant to insect pests") as well as the second generation ("Using modern biotechnology in the production of foods, for example to give them a higher protein content, to be able to keep them longer or to change the taste"). Participants were asked to indicate their attitudes on four dimensions, including usefulness, risks, moral acceptability, and whether the application should be encouraged.

In this study, the first-generation example scored slightly above and the second-generation example slightly below the scale midpoint when evaluated for usefulness, moral acceptability, and whether they should be encouraged. Both scored slightly above the midpoint when evaluated for risks (see Fig. 1). These results indicate that Europeans seem to have relatively neutral attitudes towards genetically modified foods as a technology. Interestingly, these attitudes tend to be more positive where the "first generation" of genetically modified foods is concerned, and more negative where the "second generation" is concerned, which is in clear contrast to the hopes of many decision-makers in science and industry. Moreover, there appears to be a downward trend over time. When compared to the results of the previous Eurobarometer survey (46.1 in 1996), consumers' attitudes to both generations of genetically modified foods have become more negative in terms of usefulness, moral acceptability, and whether the technologies should be encouraged—only attitudes concerning risk remained more or less constant.

It is perhaps of limited utility, however, to discuss the Eurobarometer results in this aggregate way. For example, the "neutral" attitude covers differences between

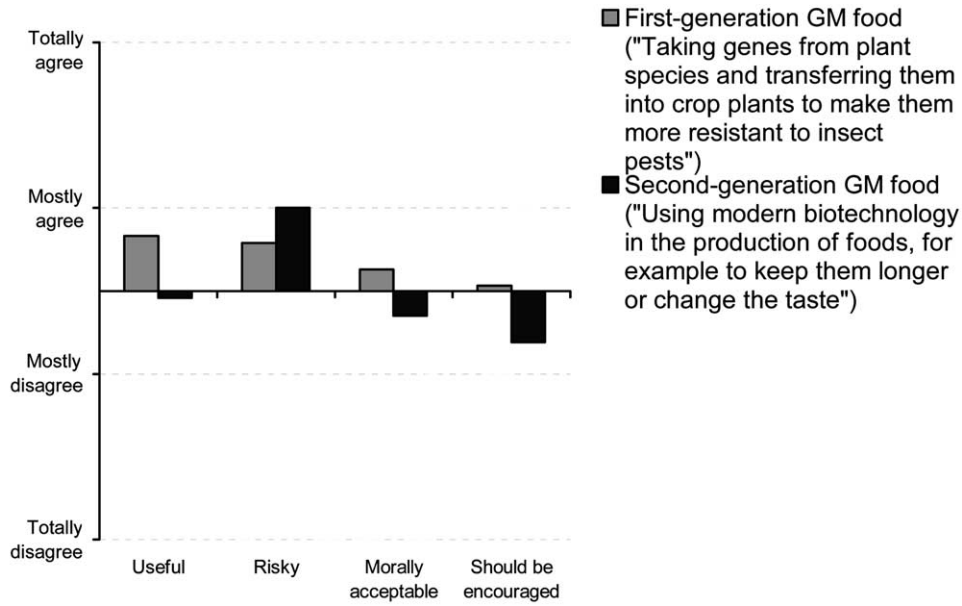

Fig. 1. Attitudes of Europeans to genetically modified foods. Data source: Eurobarometer 52.1 (European Commission, 2000).

nations as well as within nations, where some are highly critical, others not. We should be careful when interpreting the results of the two questions: first and second generation is not the only difference: the first one is formulated in terms of a food commodity, the other in terms of a crop. Thus the differences may reflect different underlying attitudes, firstly to food per se, secondly to the environment.

3.9. What are the public worried about?

A first "wave" of qualitative research tried to clarify about what risks people were concerned. The concerns identified in these studies ranged from more or less concrete unintended effects, such as allergies, outcrossing, and development of super-weeds, to worries prompted by uncertainty per se, for example, unintended effects on human health and the environment, and the potential irreversibility of any negative impact. Subsequent qualitative and quantitative research has elucidated the details of moral concerns related to genetically modified foods, highlighting issues like unnaturalness, "tampering with nature", animal welfare, the power balance between producers and consumers, democracy, and disparity between the industrialised world and the third world (Bredahl, 1999; Bredahl et al., 1998; Grunert et al., 2001; Miles and Frewer, 2001; Lassen et al., 2002a; Gaskell et al., 2001).

The range of concerns voiced by consumers is remarkably constant over fields of applications. Some of these concerns are intrinsic to the technology itself. Others appear, in part, to be expressions of worries about risks. Perceived unnaturalness is one such example. On one hand, it appears as an expression of a fundamental concern over human interference with "the Order of Nature". On the other hand, unnaturalness can also be an expression of concern about risk—people defending this view believe that there are inherent safety mechanisms present in nature and natural processes. These naturally occurring safety mechanisms are currently beyond our modern scientific understanding, and constitute a security against disastrous and unchecked developments. Gene technology, it is argued, bypasses these mechanisms, with potentially dangerous results (Madsen et al., 2002).

Another finding of recent research is that, although the public is concerned with the outcomes of technical risk assessments, they are also concerned about the uncertainty related to these outcomes, suspecting that risk assessments are based on an insufficient level of scientific knowledge (Lassen et al., 2002a; Wagner et al., 2001). Consequently, the risk assessments currently conducted may especially not be able to address long-term effects of genetically modified foods (see for a discussion of the technical issues of risk assessment and uncertainties König et al., 2004, and Cellini et al., 2004). In addition, the public's understanding of usefulness is not necessarily in accordance with the view of researchers, industry and public authorities. The public tend to reject economic arguments as being inadequate to legitimise such a controversial technology as gene technology applied to food production. Interviews in Denmark have, for example, shown that some members of the public stress the role of "societal usefulness" in the sense that genetically modified foods must help relieve suffering of human beings—or alternatively benefit the environment—if they are to be acceptable (Lassen et al., 2002a).

3.10. The internal structure of attitudes to genetically modified foods

Qualitative investigations provide a much richer understanding of people's concerns and perceptions than surveys. A potential problem with qualitative, in-depth investigations as the ones reviewed above is that they are usually based on small samples, potentially limiting their generalisability. However, some large-scale studies have tried to quantify the relative importance of perceived risk, perceived usefulness/benefit, and moral acceptability of genetically modified foods for people's overall support the technology.

Hampel (1999) re-analysed the Eurobarometer 46.1 data (collected in 1996) and estimated the relative importance of these factors for six different fields of applications, including genetically modified foods of the first generation ("Taking genes from plant species and transferring them into crop plants to make them more resistant to insect pests") and the second generation ("Using modern biotechnology in the production of foods, for example to give them a higher protein content, to be able to keep them longer or to change the taste"). For both generations of genetically modified foods, he found that only the perceived usefulness and moral acceptability of the application determined people's overall support for it, with moral acceptability being the slightly stronger determinant, whereas the influence of perceived risk was negligible when the other factors were statistically controlled in the model.

In a survey involving representative samples of Danish, German, Italian, and UK consumers, Bredahl (2001) investigated the degree of interrelatedness among consumers' perceptions of 15 specific risks and benefits associated with genetically modified foods. If consumers judged these risks and benefits independently and only then formed an overall evaluation, the co-variation among these perceptions should be negligible. If, on the other hand, people judged the risks and benefits on the basis of their prior attitudes towards gene technology, their co-variation should be substantial. And indeed, the 15 risks and benefits could statistically be reliably represented by a common underlying perceived-risk dimension and a common underlying perceived-benefit dimension. Bredahl's analysis of the internal structure of consumer attitudes to genetically modified foods suggests that people first form attitudes towards the overall risk and usefulness of the technology, and only then infer from these attitudes how risky or beneficial they find a particular consequence related to a particular application of the technology.

3.11. Relation to general socio-political attitudes and values

It has often been found that consumer attitudes towards genetically modified foods can reasonably well be predicted by general socio-political attitudes or values. Among these are, for example, attitudes towards technological progress (Bredahl, 2001; Frewer et al., 1994; Hamstra, 1991; Sparks et al., 1995) and attitudes towards environment and nature (Bredahl, 2001; Frewer et al., 1997; Hamstra, 1995; Siegrist, 1998). In the Bredahl (2001) study mentioned above, for example, no less than 61% of the variance in perceived risk and 53% of the variance in perceived benefit could be explained by such general attitudes and values.

Research in this tradition has mainly been carried out by academic researchers who use multivariate statistical techniques to model the internal and external structure of whole attitude systems. Results suggest that attitudes to genetically modified foods may have "value-expressive" functions to consumers (Katz, 1960) rather than being the result of a risk-benefit trade-off as assumed by models of technical rationality. Interestingly, this conclusion is in sharp contrast with common interpretations of opinion poll data. Discussions following the publication of the Eurobarometer 46.1 (European Commission, 1997), for example, stressed that consumer acceptance or rejection of gene technology was the result of a "balancing" of perceptions of usefulness, risks, and moral concerns (Durant et al., 1998; Biotechnology and the European Public Concerted Action Group, 1998).

3.12. Public acceptance of particular applications of genetically modified foods

The supposition that risk perceptions may be offset by perceptions of benefit has lead many scientists and industrialists to assume that if only a particularly desirable benefit can be developed in the context of genetically modified foods, then public acceptance will result. Problematically, how the public defines risk and benefit, and how the experts define the same issues, may be very different. Furthermore, the public are not homogenous with respect to their opinions and attitudes. Differences in perceptions of risk and benefit associated with various hazards exist between different countries and cultures, between different individuals within countries, and within different individuals at different times and within different contexts (Burger et al., 2001). The food industry will need to predict what kind of genetically modified products will be acceptable as well as beneficial to consumers, particularly in the area of 'preventative nutrition therapy', where novel foods with specific health benefits will be developed and commercialised. Failure to so do is likely to compromise commercialisation of specific products, particularly as judgements about what constitutes a benefit is likely to be left to consumers own judgements in the market (Jensen and Sandoe, 2002). For instance people do not necessarily eat healthy foods at present, despite considerable efforts

at developing health information campaigns (Havas et al., 1998). There is therefore no reason why people will automatically accept novel foods that have health benefits, independent of additional concern about the technological approach used to produce them. To some extent, barriers to healthy food choices are linked to demographic factors (Subar et al., 1995; Johansson and Andersen, 1998; Billson et al., 1999). For example, more affluent, better educated women are generally more health conscious and thus may be more motivated to process complex diet and health messages. Sensory properties of foods are likely to be as important as functional—or health-related factors in determining whether consumers accept novel foods produced with the aid of genetic modification, liking of particular sensory properties again being prone to inter-individual variation. Thus introducing consumer benefits associated with particular foods is unlikely to result in a general acceptance of genetically modified foods—rather some consumers will be very positive towards some products, others will prefer alternative food choices. Of course, food choice assumes the introduction and implementation of effective labelling strategies in this instance. Again, this topic is worthy of future research.

3.13. Public demand for information about genetically modified foods

In the latest Eurobarometer on science and technology, 55.2, (European Commission, 2002), the European Commission included a module on consumer attitudes towards policy issues related to genetically modified foods. In one of the questions, consumers were asked to indicate (on a three-point scale with response categories ranging from "inclined to disagree" over "don't know" to "inclined to agree"), whether they agreed that genetically modified foods "should only be introduced if it is scientifically proven that they are harmless". Of the approximately 16,000 European consumers participating in the survey, 86% indicated agreement. When asked whether they wanted "to know more about this kind of food before eating it", 86% agreed. When asked if they wanted "the right to choose", no less than 95% of the participants agreed. For many consumers, labelling is a primary source of information about a food product. From this, one might deduct that the large majority of European consumers would prefer to have information about genetically modified foods available, and an overwhelming majority wants to be able to make an informed choice, necessitating the labelling of genetically modified foods. Moreover, consumers expect an assessment of known or potential risks and a precautionary management of these risks before a genetically modified food is granted approval for marketing in the European Community.

3.14. Providing information about genetically modified foods: previous research

Previous research has attempted to understand the influence of providing information about the risks and benefits of genetically modified foods on attitudes towards these foods. In general, the results have been somewhat equivocal, although there is some evidence indicating that communication per se is unlikely to result in greater acceptance of genetically modified products. The results should, however, be considered in the wider context of science and society, and the need for increased transparency associated with production processes.

Frewer et al. (1998) presented British consumers with persuasive messages about genetically modified foods and observed a polarising effect: consumers with initially negative attitudes became even more negative, and consumers with initially positive attitudes became even more positive. The information had been attributed to different information sources, and it was found that the extent to which participants trusted or distrusted these information sources had little effect on how they interpreted the information. A similar study (Frewer et al., 1999), where the persuasive content of information provided was varied, produced no effects on attitudes. Similar results were observed by Peters (1998), using different kinds of media reporting as stimuli in an attitude change experiment with a sample of German consumers. Analysis of think-aloud protocols gathered in that study showed that consumers' spontaneous cognitive responses were more negative when the tendency of the message was more positive. This suggests that benefit communication may even provoke reactance in some consumers, possibly because consumers doubt the motives of communicators in attempting to convince them of the merits of genetically modified foods.

In a large experimental study involving consumer samples from Denmark, Germany, Italy, and the UK, Scholderer and Frewer (2003) tested the effects of different information strategies on consumers' attitudes to genetically modified foods as well as on actual product choice. None of the information strategies resulted in attitude change. This was true of "balanced" information about food biotechnology in general, information about the risks and benefits of specific products, and different advertising formats promoting a "hard sell" approach. In all cases, consumer attitudes proved remarkably resistant to change. Unlike attitudes, consumers' product choices were sensitive to provision of information. However, the effect was negative, and it was uniform: all information materials significantly decreased the probability of consumers' choosing the genetically modified products. Labelling alone, as used in the control groups, did not have such an effect, possibly because participants were not explicitly made aware that the label existed (see also Frewer et al., 2003).

Eiser et al. (2002) note that technology acceptance is unlikely to be dependent on perceived risk. Furthermore, perceived risk is unlikely to be dependent on trust. Instead, expressions of trust and perceived risk may often be reflections of prior or more general attitudes towards the technology. This implies that risk communicators and regulators should consider factors influencing the broader acceptability or unacceptability of new technologies, such as genetic modification. Critical factors that determine the successful implementation of traceability strategies have also been discussed by Miraglia et al. (2004). In the experiments described, the results should not be used to imply that communication with the public about emerging technologies should not occur. One consequence of so doing would be to increase perceptions that technological processes are being kept hidden from the public to protect the vested interests of producers, which is likely to have a further negative impact on trust in the food industry and science.

3.15. The issue of traceability of genetically modified foods and ingredients

As part of the ENTRANSFOOD network, an empirical investigation into the needs of consumers regarding the labelling of genetically modified foods and food ingredients was conducted in three European countries, Italy, Norway, and England (Miles and Frewer, 2002). Participants did not believe that a labelling strategy for foods containing genetically modified ingredients could be effective unless accurate traceability mechanisms are developed. Otherwise there would be no way of identifying where such ingredients are actually located within the food chain. Overall, about 40% of people claimed that they would not buy, and 40% claimed that they would possibly buy genetically modified food. There were few differences between the three countries, implying that some of the cross-cultural differences observed in previous research were disappearing. People in all three countries wanted "clearer labelling of genetically modified foods on food packaging". The English, in particular, wanted an effective and transparent system of traceability throughout the food chain. People approved of enforcing ingredient traceability once they were made aware of its potential. The results indicated that public distrust in genetically modified foods is, in part, driven by lack of personal control over exposure to products, together with reduced opportunities for consumer choice over consumption. Scientific and regulatory inability to trace genetically modified foods from field to table will act to reduce public confidence in food safety.

It was concluded that consumer response to the development of an effective system of traceability for genetically modified food and ingredients throughout the food chain was generally very positive, although specifically did not influence people's attitudes towards consumption of genetically modified foods. Failure to implement an effective traceability strategy for genetically modified foods and ingredients may have a negative long-term impact on consumer confidence in safety, particularly in the current climate of consumer distrust in food safety, science, and risk regulation. It was therefore recommended that, as traceability mechanisms are developed, this information should be placed in the public domain. Similarly, incidents of cross-contamination between genetically modified and non-genetically modified ingredients should be reported to the public as soon as they occur.

An alternative view is that, as cross-contamination may also occur between genetically-modified and non-genetically modified plants, cross-contamination will occur in the fields and so all foods must be labelled as genetically modified—in this case, of course, improved traceability is unlikely to make any difference to consumer confidence and acceptance.

4. Public participation as a way forward

It is often argued that decisions over gene technology should be left to the free market, in-so-much that consumers can choose to buy, or not buy, genetically modified products. This argument, however, ignores some structural barriers that prevent "the market" serving as a conveyer of democratic decisions. These barriers include factors related to gene technology per se, as well as assumptions concerning relations between the market and the consumer.

4.1. The public and policy development

The controversy over genetically modified foods can be interpreted as an expression of the inability of the policy measures set up in the 1980s to deal with and allay the concerns of the public. Public concerns reached far beyond the risks to environment and health addressed by the existing regulation. As has been discussed, one interpretation is that public authorities and companies, when constructing a regulatory framework in which the developing technology was contained failed to take due account of what was driving public concern. Thus the motives of those developing the framework appeared suspect and unconcerned with public and environmental welfare. Failure to take account of societal concerns associated with emerging technologies may jeopardise the legitimacy of the regulatory framework and regulatory agencies with responsibility for developing that framework. Similarly, the public may also cease to trust industry, which may be perceived to be protecting a vested interest in developing self-regulation

regarding technology implementation. However, private companies need to commercialise novel products in the context of appropriate regulation; particularly in controversial areas like gene technology, this is a prerequisite for successful business. Public authorities, on the other hand, also need accountability to secure that the regulation at least to some extent reflects the public views—the alternative being a ''technocracy'' unacceptable in most countries.

In response to the perceived decline in trust, regulatory bodies have increasingly stressed the importance of transparency in decision making processes, as well as developing mechanisms in order to understand the concerns and values of the general public. One outcome has been an increased interest in participatory procedures to involve the public in the decision making process in some way. This development in turn has led to a growing interest in funding social scientific research into understanding public attitudes to technology (as is the case for genetically modified foods).

4.2. The need for early involvement of the public

Many have argued that, in a free market economy, products will succeed or fail on their merits or inadequacies. Whereas the market may function well as a guide for product development for simple products, more complex products, such as those including genetically modified ingredients, are associated with some inherent problems. In the first place, there is often a time span of 10 or 15 years from the initial investments in the genetic construct to the final product is on the shelf, significantly delaying consumer feedback as a guideline for product development. A response to this problem is to involve consumers early in the product development process, rather than seeking a market response only at commercialisation. Empirical research on the success of technological innovations has repeatedly shown that the early involvement of end-users contributes significantly to the likelihood of market success (for example, see Cooper and Kleinschmidt, 1987; Dwyer and Mellor, 1991; Wheelwright and Clark, 1992). In the second place, the lack of opportunity to make use of the market as a guide for product development is combined with the huge investments genetically modified foods represent, and a need in the involved industries to recover development costs.

In regions where traditional advertising strategies were adopted, the approach helped fuel high levels of consumer negativity about genetically modified foods, as well as reinforcing public cynicism regarding the motives of regulators and producers in engaging in communication at all. The traditional strategy was based on the 'deficit model' explaining the public resistance with lacking knowledge, thus assuming that information in itself would create acceptance. As this strategy was proven partly erroneous (Biotechnology and the European Public Concerted Action Group, 1998), in the mid 1990s a shift towards participatory strategies can be observed. At the core of these strategies is the perception that in order to ensure societally accountable development of genetically modified foods, the public must be involved in debates and decisions to a larger extent. Consequently, governmental agencies and independent institutions have played a major role in the development of the participatory tools that may facilitate this development. Examples include like The Danish Board of Technology, The Rathenau Instituut in Holland, the Agency for Diffusion of Technological Information (ADIT) in France and the Institute for Technology Assessment and Systems Analysis in Germany.

4.3. What is a participatory process?

The ideal of the participatory processes is to be proactive and engage in a debate with the citizens prior to the development of the technologies and products (as opposed to forcing consumers to be reactive in the context of the marketplace). Different tools such as technology foresight, citizen panels, focus groups, and future search conferences have been developed in order to make possible the active involvement of the public (Klüver et al., 2000). The most well known of the methods is probably the consensus conference, originally developed in the United States by National Institute of Health (Einsiedel and Eastlick, 2000), but developed into their existing form as a participatory tool by the Danish Board of Technology (Einsiedel et al., 2001).

4.4. What is the right participation method?

To date, consensus conferences have been applied in relation to a number of different applications of gene technology countries across the world. In their ideal representation as democratic instruments, consensus conferences serve two purposes (Klüver, 1995). The first of these is to provide popular input to the parliamentary political system, the second to initiate a broader debate and reflection on technological change. These goals are achieved by the creation of a forum at the interface between experts, non-experts and decision-makers. The structuring element is a dialogue among lay participants, who, thanks to an educational effort, are transformed into 'well-informed' lay participants regarding the particular technological issue at stake. During the conference, the lay panel frames the issue, interrogate selected experts and finalise their judgement of the technology at question in a final statement—most often expressing the consensus reached by the panel during their deliberations.

Although consensus conferences have been subject to some criticism stressing their possible democratic

drawbacks and dangers of "disguised power exercises" (e.g. Purdue, 1995), there is no doubt that they, like other participatory tools, do improve the decision making process. Short term effects are scarce (Klüver, 1995; Einsiedel et al., 2001), but in the long run a desirable effect is qualification of the debate, also allowing contested knowledge, normally suppressed by powerful actors, into the process of deliberation. Other deliberative mechanisms are available, and these are reviewed elsewhere (Rowe and Frewer, 2000). The key element in all of this, however, is the opportunity for the development of dialogue between stakeholders including the public, as is accomplished in the consensus workshops funded by the European Commission (QLK1-2001-30067) project for instance.[1]

5. Conclusions

Much of the controversy associated with the commercialisation of genetically modified foods has been the result of regulatory bodies failing to take account of the actual concerns of the public, which has fuelled public distrust in the motives of regulators, science, and industry. Jensen and Sandoe (2002) have observed that the decline in public confidence in food safety matters continues, despite the creation of new food safety institutions such as the European Food Safety Authority. In part, they argue, this is because communications about food safety issues (including genetic modification) that are based on scientific risk assessments do not reassure the public. This may be because

> risk assessments are determined by the exact choice of putative hazard....to be assessed for possible unwanted consequences, and by the exact demarcation in time and space of the possible consequences to be addressed..... These choices clearly affect the outcome of the risk assessment, but they are not themselves the results of a scientific process. Jensen and Sandoe (2002, p. 247)

In the case of genetically modified foods, communication efforts have focused on adverse health effects, whereas public concern has been much broader, focusing on risk (and risk perception), benefit, and need. Risk assessment per se does not therefore deal with public concerns. One result has been increased distrust in the motives of institutional actors and other stakeholders perceived to be interested in promoting the technology. If public confidence is to be regained, it is important to explicitly incorporate public concerns into the risk analysis process, perhaps through developing new and influential methods of public engagement and consultation. Once public concerns (and the values on which they are based) are understood they can be more effectively introduced into risk assessment and risk management practices.

In terms of policy recommendations, it is becoming very apparent that institutional transparency, coupled with the integration of public concerns into policy development and implementation, will facilitate the introduction of emerging technologies and their applications (for example, genetically modified foods) into society. In order that this strategy might be successful, it is important to understand what is driving public concern, and to integrate this into policy development rather than dismiss it as irrational as has sometimes happened in the past.

Finally, it is possible to identify some research questions that directly result from the conclusions presented here. Although they are directly relevant to the issue of societal aspects of genetically modified foods, most have generic implications for understanding better the often-troubled relationship between science and society. These are listed below.

- How best should different information about what risks are assessed within risk analysis be communicated to the public? How can public concerns be incorporated into this process? How does this relate to strategic decisions about the development and commercialisation of bioscience innovations applied to food production and more generally? Who should communicate to whom?
- How can effective and inclusive public participation in risk management and science and technology policy be developed?
- Should new methods of consultation (for example, e-democracy) be developed to provide a more societally inclusive basis for risk management?
- How can policy impact of public participation be assessed, and the results of this analysis be communicated back to both participants and the wider community?
- What changes to institutional structures need to be made in order to accommodate these processes (for example, should new information channels be developed to create internal links between public consultation, risk assessment, and risk managers in institutionalised fora?)

[1] http://www.consensusworkshops.org

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