ELSEVIER

Environmental Toxicology and Pharmacology 7 (1999) 85–93

ENVIRONMENTAL TOXICOLOGY AND PHARMACOLOGY
ETAP

Assessment

The social aspects of food biotechnology: a European view

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Received 13 January 1999; received in revised form 1 February 1999; accepted 1 February 1999

Abstract

The application of the modern biotechnology to food, notably through the use of GM, has raised concern amongst the European public. Values that underlie this public concern about food biotechnology, include perceptions of: trust, choice, need, and care for a sustainable society and natural balance. Recommendations are advocated for addressing these social aspects, in terms of improving consumer choice, promoting greater public involvement in decision making and achieving a sustainable society. A model of risk analysis for genetically modified organisms (GMOs) and genetically modified food that incorporates this social dimension, through the integration of risk analysis with a social impact analysis is proposed, in order to build greater popular trust into the decision making processes.

Keywords: Food; Food biotechnology; Genetic modification; Genetically modified organisms; Risk analysis; Social impact analysis; Trust; Public participation and decision making; Consumer choice in the food chain; European Union

1. Introduction and overview

1.1. The social impact of food biotechnology: aims and objectives

The aim of this paper is to identify a European position on the social impacts of food biotechnology. More specifically, it is seeking to address the certain key questions in relation to food biotechnology. What are the socially relevant aspects? How do we define them? Are they measurable? How should they fit into the decision making processes?

The objectives of the paper include: to review the concerns of European consumers regarding food biotechnology; and to identify possible strategies for implementation in policy/decision making processes which address these concerns.

Food biotechnology is not perceived by consumers as just another technology. It can trigger fundamental

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1382-6689/99/$ - see front matter
PII: S1382-6689(99)00009-5

unease in some consumers and fears about the longer term consequences. The paper seeks to identify the deeply rooted values of consumers that underlie their attitudes to food biotechnology. These values include concerns over: trust, consumer choice, need, sustainability and natural balance.

1.2. Definitions

This paper is concerned with the application of biotechnology, and in particular genetic modification (GM), to the production of food, including agriculture and food processing, that is the entire food chain. The paper covers plants and micro-organisms, but it does not cover transgenic animal and fish production. For the purpose of this paper the definition of Biotechnology used will be the broad one developed by the Organisation of Economic Co-operation and Development (OECD): 'Biotechnology is the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services' (cited in Bud, 1993).

Traditional industries such as baking and brewing, using yeast, and the discovery and the utilisation of micro-organisms and their products, such as penicillin, for therapeutic use, are examples of biotechnology. However, the major advances occurred with the so called new, or modern biotechnology from the 1970s. The modern biotechnology 'constitutes a growing range of techniques, procedures and processes, such as cell fusion, r-DNA technology and biocatalysis, that can substitute and complement classical biotechnologies of selective breeding and fermentation' (CEC, 1994). The key developments in the technology were those which allowed for the manipulation or engineering of genes. The term genetic engineering, has been superseded, in turn, within European governmental discourse by genetic manipulation and then modification. It is GM that lies at the heart of the modern biotechnology.

1.3. Summary

The attitudes of the European Union (EU) public, as surveyed by the Eurobarometer, towards food biotechnology are reviewed. The deeper values that make up such attitudes, are investigated by drawing upon surveys in The Netherlands and the UK which have utilised more qualitative techniques. The possibility of consumer choice through greater transparency and labelling is addressed, and the integration of the public into the decision making process is advocated. The contribution of modern biotechnology to the goal of a sustainable society is proposed.

The paper seeks to broadly identify uncertainties over the environmental and health impacts of agricultural biotechnology and food that are acknowledged within current scientific debate. The incorporation of these uncertainties are explained in relation to the risk analysis that is conducted on the release and use of genetically modified organisms (GMOs) into the environment and food chain in Europe, notably through the procedures under the deliberate release directive (90/220/EEC). A reappraisal of the precautionary principle is made in relation to risk management of GMOs and food safety, to acknowledge the range of factors beyond pure scientific based calculations which shape this principle and the risk analysis. The integration of a social impact analysis is proposed in a revised scheme of risk and social analysis, which offers a process for building trust, confidence and public identification with the regulatory decision making processes.

From this overall analysis a more socially responsible, responsive and accountable model for the application of food biotechnology is posited.

1.4. Developments in food biotechnology—an overview

The initial developments in food biotechnology, focused on the GM of micro-organisms to enhance production of enzymes for use in food manufacture. The application of GM in these areas, remains the most extensive use in food production to date. A further major area of application has been the development of a wide range of crops modified for agronomic traits. The main traits developed for commercial use to date have been: herbicide resistance and insect resistance (e.g. in maize, Soya bean, cotton, oil seed rape), and virus resistance (e.g. potato). In addition, composition has been modified to increase shelf life or the content e.g. Flavr Savr tomato and AVEBE's modified amylopectin potato).

Experiments are increasing rapidly on crops modified for nutritional and health advantages in the final food product, so called 'functional foods' and 'nutriceuticals', both for human consumption and animal feed. In addition, crops and animals are being modified for production of pharmaceutical benefit, so called 'pharming'. The metaphor is used of crops becoming factories, producing: vaccines (e.g. the polio vaccine in a banana), plastics, industrial starches, and feed supplements and enzymes.

The initial developments are directed to the food production in the developed world. Promised modification of crops for growth in the difficult conditions in the developing countries (e.g. saline resistant and drought resistant crop plants) are not at the marketing stage whereas, herbicide and insect resistant plants are being extensively planted in North America, Australia, China, and increasingly Latin America.

The increased commercial planting of GM crops has in turn brought increased public awareness of the entry of GM into the food chain.

2. Social aspects

2.1. Introduction

The identification of the important social and ethical aspects of food biotechnology for EU consumers can be derived from an analysis of both quantitative surveys, conducted by Eurobarometer, and qualitative surveys carried out in The Netherlands and the UK

2.2. European citizen opinion: attitudes and values

The Eurobarometer Survey 46.1 'The Europeans and modern biotechnology' (CEC, 1997b), supplemented two earlier surveys from 1991 and 1993 on European citizen opinion on biotechnology (see Marlier, 1992, 1993). Annex 1 contains a summary of the results of the 1997 survey. The findings of this survey include the following salient observations (CEC, 1997b):

2.2.1. Knowledge and anticipated effects of the technology

There is a correlation amongst respondents between a greater objective knowledge and both optimistic and pessimistic views of its anticipated effects. Greater knowledge does not bring either increased support for biotechnology nor greater opposition.

2.2.2. Perceptions of benefit and risk of applications

Perception of risk is higher amongst those with greater objective knowledge and those who have discussed biotechnology over recent months, but such perception is low amongst those with little knowledge. Overall Europeans show awareness of both benefits and risks of Biotechnology—a mixed stance that has been mirrored in surveys in countries such as Canada and Australia. (see also Zechendorf, 1994).

2.2.3. Labelling

The majority of the respondents (74%) favour labelling of genetically modified foods.

2.2.4. Regulation

Overall, the findings suggests a lack of confidence in self regulation, but also a relative lack of trust and confidence in the effectiveness of EU and national regulation and institutions, suggesting worrying implications for the legitimacy of the governance of modern biotechnology.

2.2.5. Confidence and trust

The lack of confidence in government, is echoed in the response to the question as to the most reliable source of information on biotechnology. The responses were as follows:

- Consumer organisations (58%).
- Environmental protection organisations (56%).
- Schools/universities (35%).
- Public authorities (18%).
- Industry (7%).

A problem for surveys of attitudes to biotechnology, has been the lack of prior knowledge and understanding of the technology amongst the public. However respondents can, and do, draw on their existing cognitive frameworks to formulate their attitudes on the technology and its applications (Martin and Tait, 1992). Hence, in addition to these quantitative surveys, more qualitative attempts have been made to assess consumer attitudes to GM food, by seeking to relate consumer's attitudes to their more deeply held concerns and values. These surveys were conducted in The Netherlands (Hamstra, 1995) and the UK (Frewer et al., 1996, 1997a,b; Grove-White et al., 1997). The key values which emerged were based around perceptions of trust, choice, need and care for a sustainable society, which included conceptions of natural balance.

Lack of trust in the regulatory process and the credibility of regulations emerged from research in the UK and was linked to a weak sense of agency in the regulatory process (Grove-White et al., 1997). Conversely, in The Netherlands where the respondents felt trust in the regulatory process and authorities, then they also felt that they had control (Hamstra, 1995). However, this trust can be undermined by fear, which can be induced by lack of knowledge of food production and how to interpret information on the packaging (Hamstra, 1995).

Freedom of choice is linked to: variation in products and variation in prices, as well as, consumer knowledge about the interpretation of information on packages of foodstuffs and the production methods. Because of a lack of knowledge and uncertainty over the effects on health and natural balance, biotechnology undermines this freedom of choice somewhat and engenders some fear and insecurity (Hamstra, 1995). The notion of choice was a complex issue. On consumer choice, the low price of a food was a key determinant, but was also seen as an economic constraint against real personal choice. Labelling was seen to be of limited utility because of the desire to have information about the social context of the decision to produce a food through GM. Choice as a citizen was also an important factor, but here there was resignation and, once again, a lack of a sense of personal agency (Grove-White et al., 1997).

Applications of food biotechnology that are seen as important, or needed, are supported, as opposed to those that are seen as trivial. Perceived need was associated with agricultural applications in which modification appeared to improve production (such as drought resistant crops) as opposed to the end product (frost resistant strawberries) (Frewer et al., 1997a).

Consumers are at pains to discriminate between classes of product and the different issues, negative and positive, that these raised (Hamstra, 1995; Grove-White et al., 1997; Frewer et al., 1997a). For example, whether the use of herbicide was increased or reduced was seen as an important criterion for assessing GM crops (Grove-White et al., 1997).

The value of care for a sustainable society covers concerns over: the natural balance, the usefulness or necessity of the application of modern biotechnology, trust, health, social dissipation and third world problems. Natural balance covered recognition of potentially positive implications of biotechnology such as: possible cleaner, less chemical dependent, and more efficient food production protecting the environment and using fewer raw materials, and the preservation of rare species through cloning. Negative effects were also identified such as: decline in crop diversity, as super crops may come to predominate food production, overproduction, with threats to the environment and ecosystems, and irreversibility of harm, for example upon different trophic levels in the natural food chain (Hamstra, 1995).

2.3. The possibility of choice

Individual choice can also be seen from the perspective of the consumer, as well as the citizen. The notion of informed choice in the market place is the basis of the concept of consumer behaviour. This requires the availability of different types of products, adequate labelling and knowledge to allow informed choice. The nature of the citizen, in contrast, refers to the individual in relation to governance (Gabiel and Lang, 1995).

A situation in which a majority of the Europeans reject or accept biotechnology/GM on ill-defined grounds is undesirable. Therefore, an extensive information campaign is needed to allow Europeans to make an informed choice. The information to be provided should consist of several elements, including:

- A basic understanding of GM and food production processes through the food chain.
- Advantages and disadvantages of GM as portrayed from different perspectives.
- A system of labelling, including the labelling of products.
- And finally, it must clarify the decision making process and involve a wide range of information providers.

However, the role of information is limited if there is no basic education in this field. Therefore, a good longer term strategy is to build (some of) the above elements in the European education system. This is currently the responsibility of member states, but the European Commission has a role to play.

A major instrument for making informed choice has always been considered the labelling of food products. The basis of the European regulation of GM food is that only food that is no longer equivalent to non GM food should be labelled, as laid down in EC Regulations: 258/97 and 1139/98. The method of determining equivalence, as laid down for the food products of GM Soya and maize in 1139/98, is through the detection of modified DNA or protein in the final food. The entry of GMOs into the food chain and the massive commingling of GM crops with non GM crops has clouded the efficacy of labelling the final product. This is especially the case for compound foodstuffs that contain ingredients, such as oils and lecithin, derived from raw materials that have undergone modification at an earlier stage of the food chain. Such ingredients may not be detectable. Consequently, many retailed foods are likely to contain ingredients that originate from GM crops but are not labelled. Also, in large scale food industrial processes and commodity trading systems, contamination can not be avoided. This can only be accommodated by the application of threshold levels. In addition, the labelling system must be verifiable.

For consumers, wishing to make their choice of food product based on the relatively sophisticated and differentiated bases, as outlined previously, such as the impact upon the environment and upon sustainability of the form of agricultural production, labelling will prove to be neither informative nor transparent. Although the labelling system is not entirely consistent, it is in itself a useful element of consumer information. A comprehensive review of the system to get more uniformity is desirable.

Complementary to labelling, transparency right through the food chain must be created, by the use of a comprehensive system of segregation and certification of GM crops and their products from non GM crops at each stage of the food chain, and for this to be reflected in the final labelling information. There is ample precedence for such a comprehensive system of transparency as in the case of halal meat production and organic food certification. (Consumers International, 1998a). This degree of transparency would allow consumers to make a more fully informed choice of foodstuffs, in line with their more deeply felt values on such issues, and would provide for a more democratic and participatory basis for transparency. With the increased use of GM crops, segregation will become even more important.

The public's need, and expressed desire, for information on food production and content need to be acknowledged and incorporated into regulatory decisions, so that consumers can express their preferences in the market place (Consumers International, 1998b). In the case of food biotechnology such risk may become more acceptable where there is transparency and openness throughout the processes of production in the food

chain and at the point of consumption. This is reflected by public support for the labelling of the products of modern biotechnology and full information about their food. Such transparency may need to include traceability throughout the food chain.

In order to provide a full choice of products, a principle has to be accepted that there should be a choice of foods produced without the use of gene technology available to consumers. This principle would require that there should be a channel of supply which could guarantee the exclusion of the use of ingredients from GM crops in food and feed as well as exclusion from the use of processing aids and food additives.

2.4. Involvement in decision making

Greater public knowledge and access to information alone will not guarantee public acceptance of the products of food biotechnology. There is a need to reconnect the public to the decision making, governing the regulatory processes for food biotechnology, in order to build public trust and confidence in this decision making. This will involve decision making, which is seen to take the differing views of the public, both as consumers and as citizens with different social interests into account.

In order to incorporate these views, greater understanding is needed about the basic values of the different publics throughout Europe and how these values inform their attitudes towards food biotechnology. These qualitative surveys need to embrace all of the member states in Europe. These surveys should be sponsored by the European Commission and member state governments. The findings of such surveys must be incorporated into the decision-making processes, starting at the level of R&D policies through to the risk analysis of GMO and food biotechnology products. Further techniques will be utilised to incorporate the public's views, which may include the use of citizens' juries and consensus conferences.

This wider inclusion into the decision making process should engender greater social acceptability and trust in the regulatory processes through greater public involvement and understanding. This involvement will lead to a more informed and effective regulatory process. Public acceptance may also be enhanced through extending this more open process of regulation into more informed consumer choice in the marketplace through greater transparency.

2.5. Sustainable society

The development of modern biotechnology may contribute to the move towards a sustainable society if it meets with the following conditions, which take into account the concerns and values of consumers: (adapted from de Vriend, 1997):

- The applications fit in to more ecologically balanced agro-systems, such as rapid detection methods for infections with pests, diseases or other types of stress in plants.
- The applications lead to less waste in crop production and diminish the need for chemical pesticides.
- The benefits can be justified to consumers, in terms of values that they perceive as important in food production, for example ensuring the application can be linked to a 'more natural' form of production.
- Awareness is shown in the development of the technology of the possible negative impacts that its deployment might have on the interests of small-scale farmers in the developing countries, for example the development should focus on low-tech, easily adaptable and cheap applications for developing countries (e.g. breeding programs).
- The risks to the ecosystem are limited.
- It contributes to the preservation of bio-diversity.
- Greater trust is created: by ensuring transparency over the deployment of biotechnology throughout the food chain, from laboratory and field research, through commercial growing, commodity handling, and food processing, to retail and consumption of the products of food biotechnology.

3. Risk analysis and regulation

3.1. Scientific uncertainties

Attempting to predict the effects of the use of GM in agriculture and food production has raised several scientific uncertainties. These are the focus of scientific research projects within Europe (BBSRC, 1998). Scientific opinion is divided about the importance of these uncertainties. These uncertainties include:

- Incomplete scientific knowledge about how genes work in a specific environmental context to be able to predict with certainty what will happen when genes are transferred from one organism to another, and about the stability of the transferred genes (or transgenes).
- The possibility of 'escape' of transgenes from their host organism into others.
- That the GMOs themselves will become invasive or persistent.
- Other unintentional and unpredicted interactions between GMOs and their environment.
- GMOs and food safety (e.g. antibiotic resistance and potential for allergenicity).
- Effects upon agricultural practice.
- Secondary impacts upon bio-diversity.

These scientific uncertainties are reflected in consumers' perception of the risks of the release of GMOs into the environment and the consumption of GM food. Such perceptions are presented in Section 2.2 of this report. The relevance of these scientific and lay public uncertainties are considered in Section 3.3 and Section 3.4.

3.2. Conventional risk analysis

An example of a template commonly used for the process of risk analysis for food and environmental safety is the scheme defined by the FAO/WHO Consultation on Risk Analysis held in Geneva in 1995 (FAO/WHO, 1995). This scheme defines risk analysis as including:

- Risk assessment.
- Risk management.
- Risk communication.

Risk assessment consists of: (i) hazard identification, (ii) hazard characterisation, (iii) exposure assessment and (iv) risk characterisation. Risk management is the process of managing the output of the risk assessment step (the risk characterisation). Risk communication is a two-way exchange of views covering the whole process.

The European Commission proposed that the process of risk assessment of food safety should be seen as a scientific process, to be conducted by scientific advisors (under the appointment of DG XXIV. The processes of risk management and communication were identified as the political processes (CEC, 1997a).

The basis for risk assessment is scientific, however the experience with GMOs and GM Food is limited. These uncertainties have led to deployment of the precautionary principle to the process of risk analysis of GMOs.

3.3. Risk management and the precautionary principle

The precautionary principle is an approach to risk management that is applied in circumstances of scientific uncertainty reflecting the need to take action in the face of potentially serious harm in the absence of scientific proof. The precautionary principle is not a matter for science alone, since it is a political and value laden statement expressing a fundamental shift in attitude of the general public to the environment (O'Riordan and Cameron, 1994; Kasanmoentalib, 1996).

Taking a precautionary approach to the application of modern biotechnology to food and agriculture includes monitoring when necessary to indicate possible adverse effects, and the assessment of risk be modified in line with developing knowledge of the impacts of the technology and its applications.

The application of the precautionary principle to risk management of food biotechnology in practice, is found in the EC directive regulating the deliberate release of GMOs to the Environment (90/220). All releases of GMOs to the environment have to be given approval under the Deliberate Release Directive. The precautionary principle operates through a case-by-case, step-by-step assessment of the risks. Each GMO is considered individually and authorisation for placing on the market is only given once data has been collected from experimental trials which demonstrate that unrestricted use will have no adverse effects. However what is an 'adverse effect' has not always been agreed upon between Member States (von Schomberg, 1998).

The boundaries to conducting risk assessment under this directive are unclear and have varied across member states (Levidow and Carr, 1996). In addition, the processes for conducting these assessments have differed somewhat in different member states, to fit into the dominant socio-political administrative culture of the individual state. For example, Denmark (Toft, 1996) and the Netherlands (von Schomberg, 1996) have constructed the assessment processes through the involvement of wider social consultation.

3.4. Integrating public concerns in risk analysis

Risk assessment needs to be based upon scientific calculations, but as these calculations are subject to

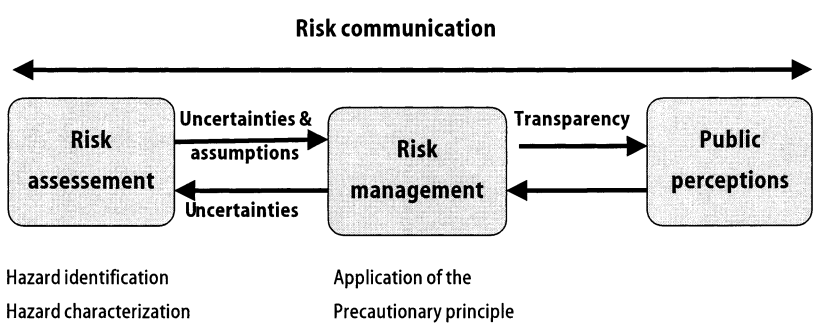

Fig. 1. Risk analysis according to FAO/WHO.

uncertainties, the wider influences and social contexts affecting such calculations need to be acknowledged and incorporated into the process of risk analysis. The public's perceptions of risk are socially constructed, leading to a gap between the risk perceptions of the public and those of experts on a wide variety of hazards (Frewer et al., 1997a). While scientific estimates of risk fail to take account of social constructions of risk, the public's estimates are likewise based on factors other than scientific assessment (Bauer, 1995). The confidence in risk regulators, is also a factor in the public acceptance of risk, as are factors such as: dread, long term effects, and the concern that exposure to risk is involuntary. Where risk exposure is perceived as more voluntary, that is where the public perceive that they have the opportunity to make an informed choice, then such risk may become more acceptable. The public's assessment of these other factors, apart from scientific calculations, means that risk perceptions are socially embedded.

At present, a number of these factors are not being addressed in the regulatory process. Research indicates that there is considerable lack of trust by consumers in both government and industry, yet it is these institutions which are responsible for introducing the techniques. Thus even if regulatory controls and risk analysis are properly conducted they might not be believed. The need is to link both the concepts of risk and trust. The incorporation of wider social concerns as articulated by different social actors should be included in risk analysis to produce a more socially embedded and acceptable process of risk analysis of the applications of modern biotechnology to food.

Building upon the previous scheme for risk analysis, presented in Fig. 1, a possible approach which incorporates a parallel social impact analysis, is presented in Fig. 2. The key point of this modified scheme is that decisions are made incorporating both risk analysis and social impact analysis, building greater trust in and acceptance of the regulatory process. This will improve the quality of decision making and facilitate its expedition, which should at the minimum meet the same time frame as the previous scheme for risk analysis.

In the revised scheme the regulatory and social streams will overlap and interact to produce a more widely negotiated set of criteria, which will frame the risk analysis. The decision is made by the risk manager, taking into account the social impact analysis and the lay perspectives. These perspectives will be continuously monitored and evaluated and will inform the decision making. The scheme will provide a more socially responsive, plural and accountable form of decision making.

4. Conclusions and recommendations

4.1. Conclusions

An assessment of the social impact of food biotechnology has to consider the attitudes and more deeply held values that European consumers hold towards food and the nature of its production, from agriculture through food processing through to food consumption.

The impact of the technology upon the processes of production and consumption engender consumer concerns over the naturalness of food, the control and choice that consumers are able to exercise and their desire to achieve a care for a sustainable society.

Surveys conducted in Europe indicate that consumers are capable of a sophisticated and differentiated evaluation of the wider impacts of specific applications, in both social and environmental terms. Such evaluations shape the attitudes of consumers to the suitability of the applications of modern biotechnology to food.

The processes for the regulation of this new technology and its application to food production do not always enjoy the confidence of the European public. The levels of trust are low, however confidence and trust are higher in countries that practice a more open and inclusive process of regulatory decision making, notably in the process of risk analysis.

For effective risk analysis, the risk management must consider the concerns and needs of the public, and extend the science based evaluation to include consideration of these social and cultural concerns. The broader approach to risk management will enable a clearer application of the precautionary principle.

This approach will in turn make for an effective process of risk communication and a more harmonious system of risk management. Effective risk communication needs to be underpinned by a process of decision making that is as open as possible over the deployment of the technology from the research and design process onwards.

Transparency in the market place should offer informed choice to the consumer in the purchase and consumption of their food, taking into account the consumers' desire to make personal choices based on individual perceptions of the external costs and ethical implications of the origins, process of production and final composition of the food.

Labelling of the final food product is an important instrument of openness. Additional information systems are necessary to provide background information.

Modern biotechnology may engender positive consumer reaction in its application to food and may be of a positive and important benefit to society as a whole, both in Europe and other areas of the world.

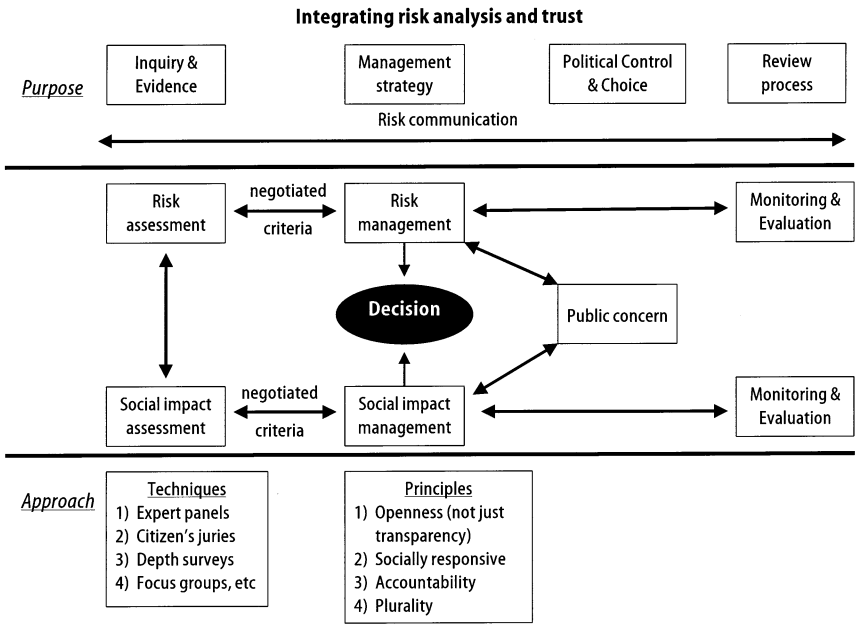

Fig. 2. Integrated risk analysis and trust.

To ensure a positive response from society, the technology needs to be deployed in ways that the public perceive as beneficial and good.

4.2. Recommendations

1. EU policy on GM foods should give emphasis to the building of trust as well as to the assessment and management of risk.
2. Social impact analysis should be incorporated in the risk analysis process to fulfil the precautionary principle.
3. Steps should be taken to ensure greater public participation in the decision making process.
4. Transparency and openness should be developed in the regulatory process.
5. In-depth and ongoing surveys and research are needed to understand consumers' attitudes and values.
6. The systems for labelling needs extensive examination and revision to answer better the needs of consumers.
7. Basic understanding of food production processes including the role of GM should be included in a long-term education strategy.
8. To ensure informed consumer choice, segregated and/or identity preserved food chains should be maintained.
9. Systems to verify the segregation and/or identity preservation of food chains should be established.
10. Developments in biotechnology should not compromise strategies for sustainability and the preservation of bio-diversity.

Acknowledgements

This paper is the outcome of the meeting with the same name, held from December 16–18, 1998, in Ede, The Netherlands, under the auspices of the European Training and Assessment Foundation (ETAF), Wageningen, The Netherlands. The authors would like to acknowledge the valuable contributions made by Dr Dirk A. Toet (Nestec Ltd, Vevey, Switzerland) and by Dr Huib Vigeveno (Unilever, Rotterdam, The Netherlands).

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