Ethical Matrix
Manual

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February 2006

LEI, The Hague

Contents

1. Overview

1.1 What is the ethical matrix?

The ethical matrix is a conceptual tool designed to help decision-makers (as individuals or working in groups) reach sound judgements or decisions about the ethical acceptability and/or optimal regulatory controls for existing or prospective technologies in the field of food and agriculture.

The ethical matrix applies a number of prima facie principles to a set of selected interest groups. The standard principles are: respect for wellbeing, autonomy and fairness, and together they form the columns of the ethical matrix. The rows consist of the 'interest groups' (i.e. affected parties) that are relevant to the issue in question. These might include different groups of people, such as consumers and food producers, but also non-humans, such as farm animals. The arrangement of principles and interest groups in a table, forming the ethical matrix, facilitates easy cross-referencing in deliberation and subsequent reflection on an issue.

The ethical matrix was initially designed to facilitate ethical deliberation by those with particular knowledge and/or interest in novel biotechnologies, but who may have little or no formal training in academic ethical theory or have only limited experience in applying such theory to concrete issues. The aim of the ethical matrix is to help users identify ethical issues raised by the use of novel technologies and to arrive at intellectually defensible decisions. However, the ethical matrix does not prescribe any particular decisions.

1.2 By whom and when can the ethical matrix be used?

The ethical matrix may be used by a number of groups or individuals in order to structure ethical deliberation, for example on the use of new biotechnologies. A number of organisations can apply the tool, including:

- governmental advisory committees and/or ad hoc working parties;
- ethics committees at various levels;
- non-governmental organisations;
- participants in exercises in public deliberation;
- commercial companies.

The ethical matrix has also been used by individuals to examine bioethical issues in academic publications, in courses at secondary schools and universities, and in a web-based educational program. The ethical matrix can be used:

- at a strategic level to review ethical dimensions;
- to review the specific ethical impacts of individual technologies (e.g. for a patent or licence application).

1.3 What are the expected outcomes of exercises using the ethical matrix?

Use of the ethical matrix may be expected to result in one or more of the following outcomes:

- raise awareness of a wide range of ethical issues;
- encourage ethical reflection;
- provide a common basis for ethical decision-making;
- identify areas of agreement between individuals who might nevertheless differ in their overall judgements;
- clarify the basis of disagreements;
- make explicit the reasoning that underpins any ethical decisions.

1.4 What the ethical matrix cannot do

Although the ethical matrix aims to provide a structure for ethical deliberation, it would be wrong to assume that its use could ever enable a committee to arrive at a definitive judgement without applying sound independent ethical reflection and judgement. For the process to be effective, decision-makers must reach a measure of agreement on the interpretation of the principles. Different interpretations of the weights assigned to each of the principles by different people preclude a definitive ethical judgement. Thus, it is not possible to automatically arrive at a unique or prescribed course of action from the use of the ethical matrix.

2. Background theory

The ethical matrix was introduced by Mepham (Centre for Applied Bioethics, University of Nottingham) in 1994 and has been further developed since then. It has been used to review a number of emerging biotechnologies, including: bovine somatotrophin, GM salmon, the use of transgenic animals in experimentation, Xenotransplantation, functional foods and GM crops. Over the last ten years the method has also been used by various European Groups (for example in The Netherlands, Germany, UK and Norway) and by a range of committees, from government advisory groups to NGOs. In addition it has been used in teaching and training contexts.

Methodologically, the ethical matrix is a development of the principles encompassed by the common morality, i.e. the ethical code shared by most members of a society in the form of unreflective common sense and tradition. However, because the common morality may only amount to the 'lowest common denominator,' it is likely that real progress in addressing ethical issues will only be made by conscientious, informed dialogue which goes well beyond 'unreflective common sense.'

The aim of the ethical matrix is to select principles that collectively are representative of the two major traditions of ethical theory and thinking of western societies. This means that these traditions, namely, consequentialism and deontology, should be represented by adequate principles.

This section sets out the core elements of the theoretical background of the ethical matrix method. Further information on the development of the method and more extensive information on the ethical theories discussed can be found in Section 2.6.

2.1 What are the essential features of the ethical matrix?

There are several ways in which the ethical matrix can be applied to assist decision-making, but all uses share some important common features. In all cases, the ethical matrix offers:

- a good starting point for ethical deliberation (i.e., a process which entails the careful consideration and discussion of the ethical implications of an issue) which encompasses both:
  a. different perspectives (e.g. stakeholders or affected parties), from which the impact of a proposed novel technology can be assessed;

b. different concerns, (i.e. ethical principles) according to which the impact of a proposed technology may be differentiated and analysed.

- however, the possibility of conflicting outcomes in applying the principles to specific cases suggests that it is best to consider the principles as *prima facie* in nature. This implies that, typically, some principles will need to be assigned more importance, or weight, than others. That is to say, when examining the specifics of a case, a particular principle, although given due consideration in the analysis, may be overridden by another principle that is deemed more important;
- the weight assigned to particular principles in specific cases usually differs between people using the ethical matrix, and to some extent this is because ethical deliberation entails an appeal to several forms of evidence. 'Evidence' is defined here as 'anything that provides material or information on which a conclusion or proof is based'. Such forms of evidence include, for example:
  a. scientific and economic data;
  b. assessments of the consequences of risk and uncertainty (e.g. reflected in the different ways people apply the Precautionary Principle);
  c. assessments of the intrinsic value of different forms of life (which may reflect peoples' differing world views);
  d. tacit, folk or practical knowledge.
- qualitative or quantitative assessments of impacts recorded in the different cells of the ethical matrix (ethical analysis) provide a road map of salient ethical concerns, the different weightings of which underpin the various ethical judgements made.

2.2 How is ethical theory represented in the ethical matrix?

The ethical matrix is based on the concept of prima facie principles (i.e. rules of action that are 'valid at first appearance'), as described by the American medical bioethicists Beauchamp and Childress. Prima facie principles differ from other principles by allowing a stronger case to overrule a weaker one in particular circumstances. This facilitates ethical decision-making - because following the principles rigidly might easily end up in a deadlock, or appear to endorse conflicting courses of action. The standard version of the ethical matrix operates with the three prima facie principles of 'respect for wellbeing, autonomy and fairness', which together form the columns of the ethical matrix (for definitions see Box 1).

Respect for:

- Wellbeing is considered to be the best way of representing utilitarian concerns ('maximising the good')
- Autonomy represents deontological concerns (treating others as 'ends in themselves')
- Fairness represents respect for justice, an interpretation advocated by the philosopher Rawls

Box 1 Principles used in the ethical matrix

The rows consist of the 'interest groups' that are relevant to the issue in question. These might include different groups of people, such as consumers and food producers, but also non-humans, such as farm animals or wildlife (also designated 'the biota') This is because the purpose of the ethical matrix is to help consider each interest group in relation to each of the three principles.

Which interest groups are included in the ethical matrix depends partly on the issue at hand. A critical factor is that 'ethical standing' is claimed for all interest groups specified. In other words, they are subjects of ethical consideration in their own right, and not just means to others' ends. Furthermore, the way they are affected by a novel technology should differ systematically from each other. Thus, even though all producers are also consumers, in respect to a given technology, they will usually be affected differently.

Given these practical constraints, it has usually been found possible to limit the ethical matrix to four interest groups. A generic version of the ethical matrix (see Figure 1) can be adapted to address a range of different issues in food and agriculture. Each cell then specifies the main criterion that would be met if a particular principle (e.g. fairness) were respected for a particular interest group (e.g. consumers).

However in order to be of value in specific cases the rather abstract principles used in the generic ethical matrix (Figure 1) often need to be specified in ways that more accurately reflect the particular issue under consideration. For example, Figure 2 illustrates a form of ethical matrix used in analysing the ethical impacts of using the commercially produced hormonal preparation (bovine somatotrophin, bST) to increase the milk yields of dairy cattle. This example is explored more fully in Section 5.1.

Respect for:	**Wellbeing**	**Autonomy**	**Fairness**
Producers	Satisfactory income and working conditions	Managerial freedom	Fair trade laws
Consumers	Safety and acceptability	Choice	Affordability
Treated organisms	Welfare	Behavioural freedom	Intrinsic value
Biota	Conservation	Biodiversity	Sustainability

Figure 1 A generic ethical matrix

Respect for:	**Wellbeing**	**Autonomy**	**Fairness**
Dairy Farmers	Satisfactory income and working conditions	Managerial freedom of action	Fair trade laws and practices
Consumers	Food safety and acceptability; Quality of life	Democratic, informed choice e.g. of food	Availability of affordable food
Dairy cows	Animal welfare	Behavioural freedom	Intrinsic value
Biota	Conservation	Biodiversity	Sustainability

Figure 2 An ethical matrix used in the ethical analysis of bST use in dairy cattle (Mepham, 2005)

As noted above, different groups, to address different issues have used the ethical matrix approach in different ways and its versatility might be considered one of its particular merits. For example, Figure 3 shows an ethical matrix that was used to examine issues faced by the Norwegian fishing industry, in which the principles of respect for 'dignity' and 'justice' replace those for 'autonomy' and 'fairness' in Figures 1 and 2. The number of interest groups in this case is increased from four to seven (to include, e.g. 'the fishing industry' and 'future generations') and the principles are specified much more fully than in Figure 1. Such amendments to the generic ethical matrix were introduced as a result of discussions with representatives of the various stakeholder groups involved, e.g.

fishermen and consumers. The use of the ethical matrix in public participatory exercises is considered in more detail below (see Section 3.4).

Respect for:	**Wellbeing**	**Dignity**	**Justice**
Fishermen	Safe and secure workplace and income, as well as stable social situation	Right to control of their work situation and respect for their occupation	Equal right to professional practice for different categories of fishermen
Fishing industry	Stable deliveries from the fisheries; a part of the welfare goods obtained in the value chain	Acknowledgement of their place in the value chain: being heard in negotiations.	Equal terms for this industry as for other marine occupations
Other users of the sea and coast	Access to welfare goods directed at marine activities as other users	Respect for their needs and their use of the coast and sea	Equal access to the resources
The society as a whole	Income from marine activities	Freedom to manage resources for the best of society as a whole	Equal living conditions for urban and rural societies
Consumers	Guarantees for healthy food in adequate amounts	Opportunities for the consumer to chose and influence the production of food products	Fish products of good quality available for different consumer groups
Future generations	No activities that threaten their health or living conditions	Knowing that earlier generations acted with respect for their welfare	The conservation of marine environment and resources so that future generations will have the same opportunities we have
The biosphere	That fish and other animals are not exposed to unnecessary pain	Harm and abuse of nature as limited as possible	The diffusion to a viable level of environmental burdens over a variety of ecosystems

Figure 3 A customised version of the ethical matrix designed to assess the future of the Norwegian fishing industry (Kaiser and Forsberg, 2001)

2.3 Ethical analysis and evaluation

Ethical analysis using the ethical matrix usually entails comparing two situations. Often these are, firstly, the current situation (the status quo) and,

secondly, the situation that is expected to result from the introduction of a new biotechnology. For example, growing a herbicide-tolerant GM food crop might be expected to increase yields, reduce susceptibility to biotic stresses, increase producers' profits and reduce prices of food products in the shops. But these impacts (commonly perceived as positive) might, to a degree, be offset by negative effects, such as reduced biodiversity in the farmland environment, loss of farm jobs, reduced consumer choice and threats to the certified status of organic farmers. The ethical matrix serves, in the first instance, to provide a template for detailed discussion of these and other concerns.

A common way of using the ethical matrix is to 'score' the perceived impacts for each cell using a semi-quantitative scale, e.g. ranging from -2 to +2. For example, in the case of the prospective use of GM herbicide-tolerant crops, respect for farmers' profits might be modestly increased (i.e. the score = +1), whereas because of wider impacts on wildlife, biotic autonomy (specified as 'biodiversity') might be decreased (score = -1). Insignificant impacts are recorded as '0.' It is important to stress that use of scoring does not imply that one can 'calculate' a judgement by aggregating the scores entered for each cell. Not only are the scores very imprecise, being simply short-hand for 'very' (+2 and -2) and 'quite' (+1 and -1), but scores in different cells are not of equal weight. Therefore, to aggregate the scores of the different cells in an ethical matrix would be a serious misuse of the ethical matrix.

Some users have employed a wider scale (+5 to -5) to provide added discrimination, but others rely on noting 'positive' and 'negative' impacts only, without using scores. In some uses of the ethical matrix, it merely serves to identify ethical issues, and no attempt is made to quantify assessments of the impacts on different principles. Even so, judgements made in such cases may benefit from the deliberative process and the recorded comments made during discussions and/or debates.

2.3.1 Content of the cells

The factors in each cell of the ethical matrix, which are relevant to performing an ethical analysis, can be considered as forms of evidence (see Section 2.1). But evidence seems to come in two major types that conform to the categories of 'facts' and values'.

Facts

To perform an analysis of the GM crop, you would need to know, for example:

- what increases in yield are obtained when the GM crop is grown, and the likely secondary effects on financial profits;

- whether any effects on the chemical nature of the crop have implications for consumer health;
- whether biodiversity is affected, positively or negatively.

Some people consider that because we often are dealing here with quantifiable 'facts,' the answers to such questions should be straightforward. But the nature of the 'facts', i.e. whether they were obtained reliably, and whether they are relevant to the question at hand, are all matters over which there is sometimes considerable disagreement. Even the scientific theory considered to justify particular data examined may be questioned, and if the supplier of the data is thought to be biased (e.g. if a commercial company produced the key data supporting their own product, or if the data were produced by a pressure group known to be ideologically opposed to the product) neutral observers might suspect that the evidence was unreliable. Assessing evidence may thus entail examining different versions of the facts where there is controversy; and assessment of the trustworthiness of the evidence may be important. Any such qualifications need to be reflected in assessments of the evidence recorded in the cells.

Values

In other cases, values are more important than facts, and in contrast to factual data, consideration of these cells of the ethical matrix requires an individual judgement that is not only dependent on quantifiable consequences, but on the value attributed to them. For example, in the pursuit of national economic objectives by allowing the growing of GM crops, a value judgement is required on the extent to which it is acceptable to e.g. threaten the livelihoods of organic farmers, or to take unknown risks with human health if appropriate scientific evidence on food safety is unavailable. Someone, on the one hand, advocating radical free market economics and someone else, on the other hand, believing in a social market economy might well agree on some of these factual outcomes, but they would presumably differ in the weight they assign to them. The cells of the ethical matrix can record these outcomes as well as include the evaluative qualifications that follow.

Possible asymmetries between positive and negative scores

In theory, for any proposed action, any of the principles specified in the individual cells of the ethical matrix might either be respected (earning a positive score) or infringed (deserving a negative score). But positive and negative scores do not necessarily balance each other, even for a single specification. Thus, sometimes the duty 'not to harm' might be thought to be more compelling than

the duty to 'do good.' An illustrative example is use of a GM hormone (bST) to increase milk yields in cattle (see Section 5.1), when the duty not to harm the animals is often considered much more important than the duty to improve their lot. Just as different principles often carry different weights, so can positive and negative effects for a given principle. The underlying rationale for this is that in ethics actions and omissions are not automatically on a par.

2.3.2 Ethical evaluation

It would not be possible on the basis of the above form of analysis to directly deduce the ethical acceptability of any proposed technology, for two reasons. Firstly, as noted, different individuals may assign different weights to different principles and to the evidence. Consequently, the principal objective of the ethical matrix - to integrate and respect a variety of ethical concerns - cannot be reached by summing up scores. The next step in the process, ethical evaluation, involves subjectively weighing the different impacts, which allows you to reach an ethical judgement on the acceptability of the technology in question.

Secondly, the ethical matrix does not assess overall ethical acceptability because such a judgement would be dependent on available alternatives. When comparing the overall ethical acceptability of two situations, neither might be ethically acceptable by comparison with some third option. In other words, a system adjudged marginally more ethically acceptable than another according to the analysis might still fall far short of a system that has not been investigated. But performing an ethical evaluation may be considerably improved by going through this process. What you get out of the ethical matrix is totally dependent on what you put in.

3. Users of the ethical matrix: user groups and objectives

When considering whether to apply the ethical matrix, a user should consider a number of contextual and logistical issues. This section includes information on who should, when, and how, to apply the ethical matrix. General methods and user information are set out in the following sections, but further details on the use of the ethical matrix for specific case studies are given in the section on case studies (see Section 5).

3.1 Different ways the ethical matrix can be used

The ethical matrix may be used in several ways and by different groups of people, or even by individuals. So it is not surprising that the organizational requirements are likely to be quite different in different circumstances; and to be critically influenced by factors that are not directly related to the nature of the ethical matrix as an ethical tool. Such factors not only include financial and time limitations but also the degree to which participants in a group exercise are encouraged to set the agenda themselves rather than follow a prescribed procedure. With reference to the latter point, the different ways in which the ethical matrix may be used will be greatly influenced by whether its use conforms more to a 'top-down' approach than to a 'bottom-up' approach.

3.1.1 Top-down approach

In a top-down approach the specifications of the ethical matrix principles are largely set by the organizers, who have acknowledged expertise in facilitating bioethical deliberation, and play a prominent role in structuring the exercise.

3.1.2 Bottom-up approach

In a bottom-up approach the organizers provide less explicit guidance, and defer to the majority views of the (usually) inexpert participants in specifying the principles and conducting ethical deliberation.

3.1.3 Which one to choose

Advantages of the top-down approach are that it provides a firm structure for debate, ensures that discussion is focused on the relevant issues and facilitates closure of the debate. However, to the extent that the organizers direct the proceedings the top-down approach may (appear to) be undemocratic, and it is vulnerable to intentional or unintentional abuse. The bottom-up approach has the advantage that it is more explicitly democratic (although it also depends critically on the organizers' advice) and can, in theory, respond more readily to grass-roots issues. However, the main risk of the bottom-up approach is that participants' misconceptions as to the purpose and methodology of the ethical matrix may distort the exercise and undermine its true objectives. At worst, if the participants fail to appreciate the importance of the method, the bottom-up approach might be (mis)used to justify a partisan viewpoint. Thus, both the top-down approach and bottom-up approach carry some risks.

Despite these caveats, and provided that users are aware of them, adequately resourced exercises using the ethical matrix should facilitate attainment of all of the objectives listed in Section 1.3. However, in all uses of the ethical matrix it is necessary to appreciate that it is not just a procedural tool but also a substantive tool. That is to say, the ethical matrix can only be expected to prove of real value if users are prepared to engage conscientiously with the issues at a theoretical level, and not to assume that it merely involves 'ticking boxes.' Of its nature, the ethical matrix inevitably makes more demands on users than would, say, completing an opinion survey.

The next three sections (3.2 – 3.4) identify the principal features of the three main ways the ethical matrix can be used. More detailed guidance on organizational matters is provided in subsequent sections.

3.2 Use of the ethical matrix by a small group (and by individuals)

The major limiting factor here is the lack of diversity of viewpoints, but to a degree, especially with small groups, this deficiency might be offset by the concentrated effort and high level of interaction between the participants that can be brought to the deliberative process. For convenience, it is assumed here that a working party of six people is using the ethical matrix to formulate an ethical position on a new biotechnology. In such circumstances it is important to adhere to the guidelines outlined in Box 2.

a)Access to professional advice on ethical theory in deciding on the relevant interest groups to include in the ethical matrix and on the specifications of the principles to be used. The generic ethical matrix in Figure 1 provides a basis for most formulations, but particular cases may require different or additional interest groups and/or reformulation of the principles (e.g. as in Figure 2).
b) Authoritative technical advice (e.g. scientific, economic and sociological) must be available, preferably from experts who can be interrogated e.g. to explore issues of uncertainty which may not be evident from printed publications.
c) A willingness by members of the working party to 'put themselves in the shoes' of each interest group in turn in assessing the ethical impacts of the biotechnology.

Box 2 Guidelines for effective use of the ethical matrix

If the working party is drawn from a cross section of society, the output of such deliberations is most likely to be a discussion document which identifies areas of agreement and disagreement and may serve as a stimulus for wider consultation. On the other hand, an NGO working party, with a particular ideological stance on biotechnology in general, might find in the ethical matrix a tool that effectively systematizes its position on the specific biotechnology in question.

3.3 Use of the ethical matrix by a government commission/advisory body

Typically, advisory committees experience fewer constraints than those identified in section 3.2, efforts having usually been made to select a membership representing a wide range of expertise and viewpoints. Moreover, such bodies are usually able to call on the highest level of technical advice available, and have easy access to legal and economic advice provided by government departments. They are usually supported by an efficient secretariat.

The guidelines summarized in Box 2 are clearly also of use here, although depending on the composition of the commission/advisory body, the requirement for point c) may be less important if all the relevant interest groups are represented (if only, as in the case of non-human species, by proxy).

3.4 Use of the ethical matrix in exercises in public participation

EU States are now officially committed to consulting the public on the ethical implications of prospective novel biotechnologies, so there is an obvious need for effective generic tools by which these issues might be addressed. In that the ethical matrix was originally designed to facilitate ethical decision-making by people with little prior acquaintance with either biotechnology or ethical theory, its use in such public participatory exercises (PPE) represents both the main rationale for its introduction and its most formidable practical challenge.

In contrast with the uses described above, public participatory exercises are likely to be subject to a number of potentially serious limitations and constraints. Financial, space and time restrictions will inevitably limit the numbers of people who can, or wish to, participate, and there will always be questions about the representative nature of the groups involved, and whether, in view of time and motivational factors, their level of understanding of the issues is likely to result in meaningful conclusions. For these reasons, the following sections concentrate on the organizational arrangements for a typical public participatory exercise. Other users might also find these guidelines useful, but they will not always be fully applicable to their own circumstances.

It is assumed, for current purposes, that a workshop is to be run, under the auspices of a government department, to consider the ethical implications of a novel agri-food biotechnology; and that relevant stakeholder representatives will be invited to participate. Box 3 lists some basic requirements.

a) An appropriately balanced group of people (e.g. stakeholders) willing to devote time and attention to an issue
b) Adequate time for organizers and participants to engage in conscientious preparation, deliberation and reflection
c) Access to people with expertise in the relevant fields of enquiry (generally including technical, sociological and economic experts)
d) An environment conducive to relaxed dialogue and reflection
e) A team of organizers who can provide constructive, unbiased advice

Box 3 Basic requirements for a public participatory exercise

4. Applying the ethical matrix in workshop exercises

The ethical matrix can be applied in a number of different forms for different purposes. The context in which the method is applied has a bearing on the timeline of the process and the resources required. There are also significant differences in the way a workshop is organized depending on whether a top-down approach or bottom-up approach is used (see Section 3.1).

It is important to clearly define the scope of the study and the workshop objectives. This not only impacts on the selection of participants, but also influences the briefing that is sent to participants and the breadth of discussion at the workshop. In order to ensure that a step-by-step approach is used in the application of the ethical matrix methodology a generic flow diagram of the relevant stages is set out (see Figure 4).

4.1 Planning phase

4.1.1 Defining the scope of the study

It is important to define clearly the scope of the study or stakeholder discussion. This includes identifying and justifying the importance or relevance of the issue, the aims of the study, the outcomes and the justification for using the ethical matrix as the methodology.

4.1.2 Defining the ethical matrix

The ethical matrix has evolved over a period of more than ten years and several different versions have been applied to different topics. It is therefore important to clearly define the ethical matrix that will be applied during the workshop, in particular stating the interest groups to be included and the specifications of the principles for the interest groups.

Which interest groups are included in the ethical matrix depends partly on the issue at hand. A critical factor is that 'ethical standing' is claimed for all interest groups specified. In other words, they are subjects of ethical consideration in their own right, and not just means to others' ends. For some interest groups, individuals are generally considered to have ethical standing (e.g. in the cases of people and farm animals), but in other cases only collectives (such as species, herds or forests) are assigned ethical standing.

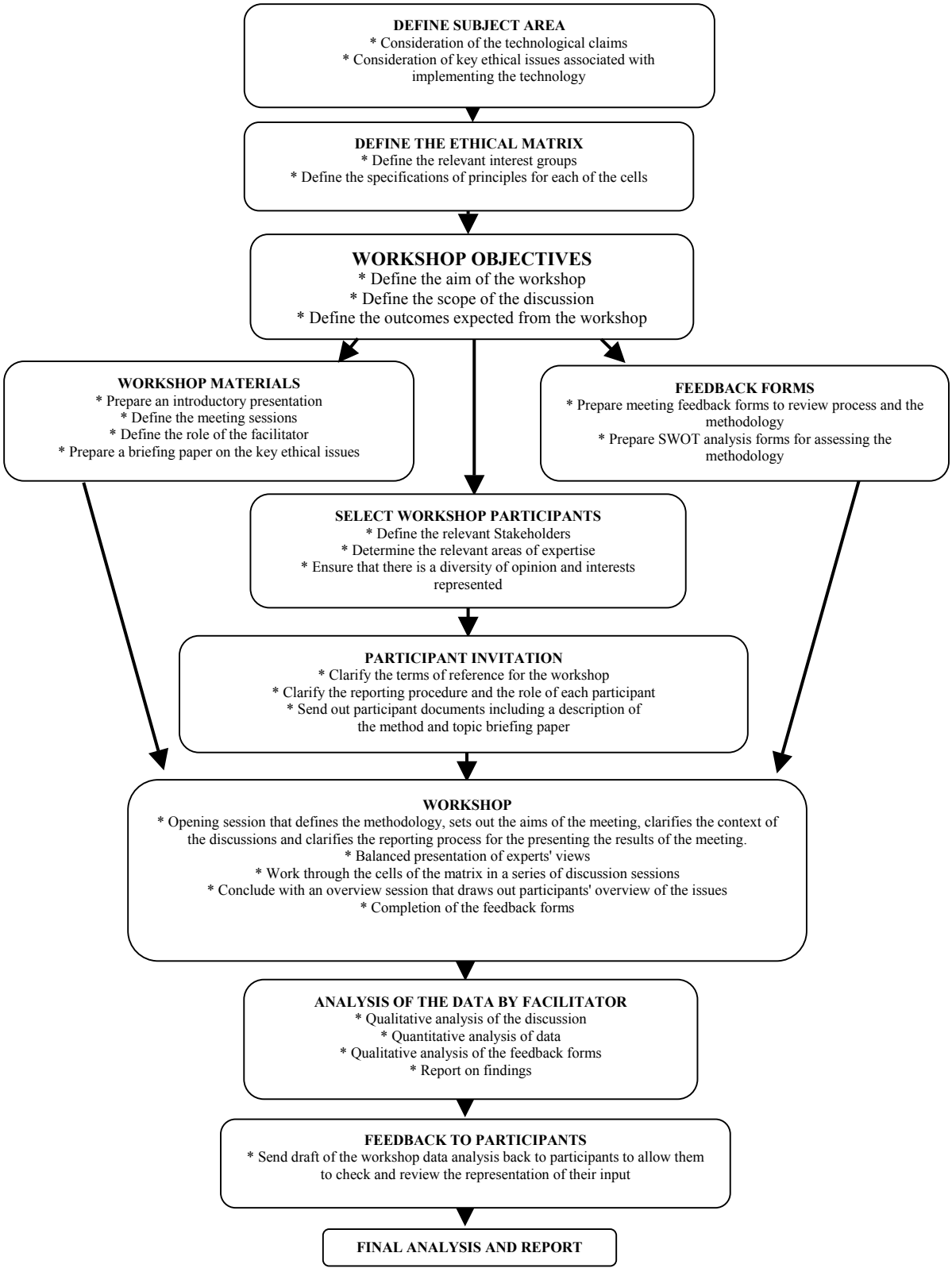

Figure 4 *Summary of a generic protocol of the ethical matrix*

4.1.3 Workshop objectives

t is important to clearly define the workshop objectives. This not only impacts on the selection of participants, but also influences the briefing that is sent to participants and the breadth of discussion at the workshop. Objectives should include:

- consideration of the technological claims;
- consideration of key ethical issues associated with implementing the technology;
- definition of the aim of the workshop;
- definition of the scope of the discussion;
- definition of outcomes expected from the workshop.

4.1.4 Selecting the approach: top-down approach or bottom-up approach

Early on in the planning process, a decision needs to be made on whether a primarily top-down approach or a primarily bottom-up approach will be adopted. The top-down approach is less flexible in terms of the structure of the ethical matrix, but it allows participants to interpret principles in individualistic ways, and to record these as additional information or as qualifications. A bottom-up approach is more responsive to participants' opinions, but requires a much more extensive initial discussion to define the structure and content of the ethical matrix. Consequently, by comparison with a top-down approach, time and resource constraints may restrict the extent to which this is a feasible approach. Application of the ethical matrix by a top-down approach, Diagram 1 summarizes the separate stages of the procedure.

4.1.5 Selecting the participants

Defining the selection criteria is arguably one of the most significant issues when constructing a participant list. The list is likely to be substantially different if: a) an assessment of ground-roots opinion is sought (from volunteers with no or low public profile), rather than b) an assessment from well-known proponents or opponents of the technology, whose position has been previously well advertised. The latter may feel less free to act in an open-minded way, but their opinions may attract more public interest.

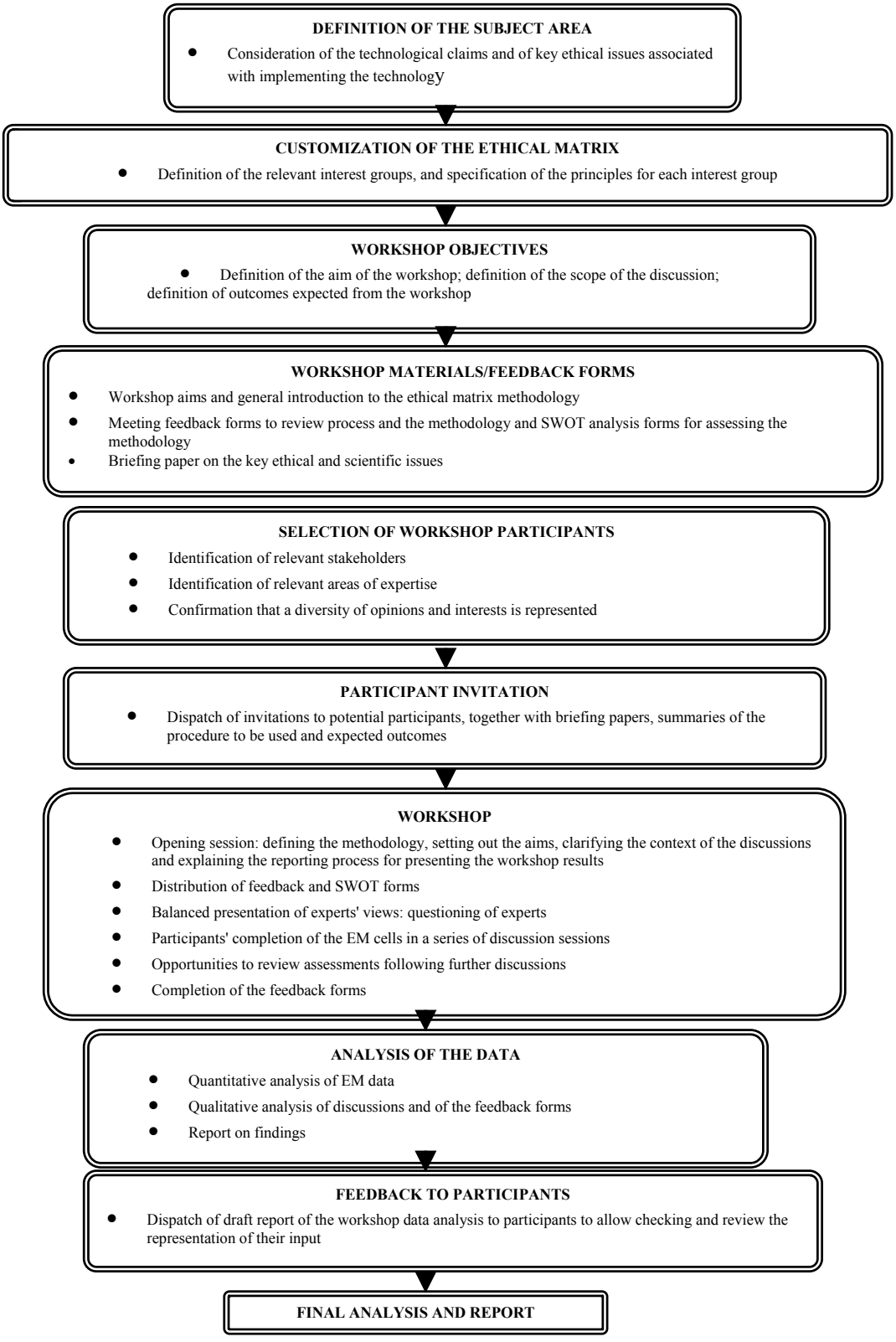

Diagram 1 The ethical matrix by a top-down approach

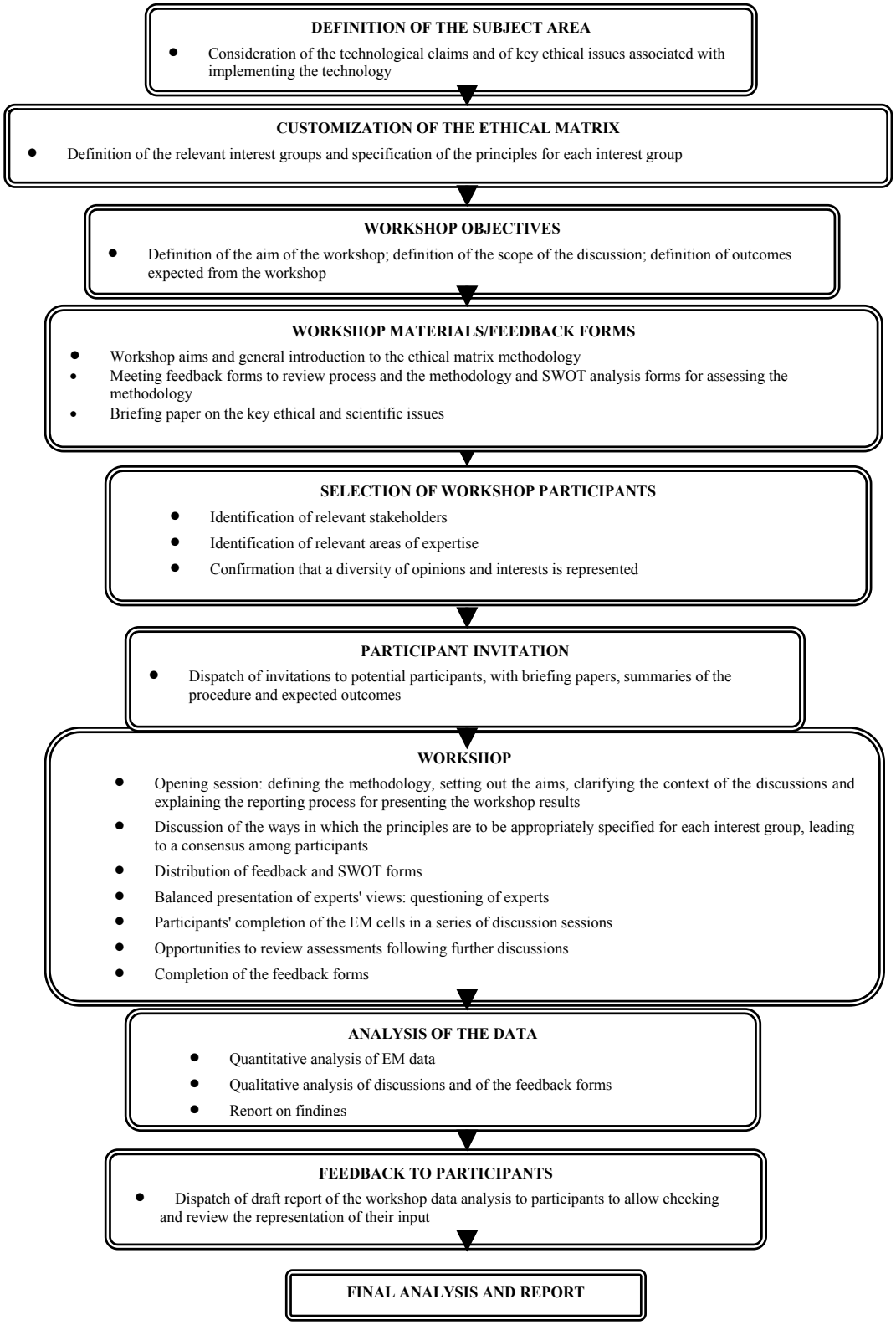

Diagram 2 The ethical matrix by a bottom-up approach

The range of participants selected ought ideally to reflect the breadth of issues e.g. appropriate expertise and viewpoints. As the methodology can be used with lay participants (e.g. members of the public) or with expert groups, the selection of participants should be determined by the aim of the workshop and what issues the research team wishes to explore or define. If appropriate (i.e. with an expert workshop), it may be advantageous if the known positions/starting points of the participants range from strongly favourable to strongly opposed to the issue.

Subject matter will have a strong influence over the selection of participants in that representatives of all stakeholder groups should be present (including those who represent, by proxy, interest groups such as farm animals and wildlife). However, the inclusion of non-experts ('men and women in the street') may also be considered important, even though it may slow down the process if 'learning curves' are steep.

Under certain circumstances, participants' anonymity should be preserved. Their particular institutional affiliations should not be identified unless previously explicitly agreed and an informative description should be agreed in advance to establish credibility.

4.1.6 Workshop materials

All participants should be sent appropriate briefing documents at least 2 weeks in advance of the meeting. These documents are produced and distributed to ensure that all participants can familiarise themselves with the methodology before the meeting. The participant invitation and briefing documents should include the following:

- workshop aims;
- general introduction, e.g. impacts of the biotechnological innovation;
- need for participatory tools;
- ethical matrix methodology (see Diagrams 1 and 2 for top-down or bottom-up approach);
- role of bioethical analysis in relation to the aim of the workshop.

4.2 Running the workshop

4.2.1 Introductory presentation

In order to the set the scene for the discussion and further clarify the use of the ethical matrix, an introductory presentation should be given by the principal facilitator(s). Speaker(s) or facilitator(s) should present the following elements:

- opening session:
  - definition of the methodology;
  - introduction to the ethical matrix;
  - setting out of the aims;
  - clarification of the context of the discussions;
  - balanced presentation of experts' views, and questioning of experts (where appropriate).
- application of ethical matrix to a specific biotechnology:
  - introduction to the technology or subject area;
  - evidence used in the bioethical analysis;
  - overall assessment and general comments;
  - summary discussion.

The facilitator should finally clarify the reporting process for the workshop and assure participants that their identities will remain anonymous (if that is the agreed condition of the workshop).

4.2.2 Ethical analysis

Following the opening introduction from the facilitator the participants then discuss the impact of the use or application of the method or technology on the interest groups. This is conducted in a series of discussion sessions.

> An important decision concerns the point at which weights are assigned to the separate cells of the ethical matrix. Some people who have used the ethical matrix consider that it is helpful to assign weights in advance of the consideration of any impacts, e.g. animal welfare might be considered 'quite important' or 'very important.' Other users consider that all decisions about weighing are best left until the ethical evaluation stage. Indeed, there seems to be no intrinsic reason why this choice should not be left open.

Box 4 Weighing the principles

In terms of the method, the ethical matrix facilitates the assessment of the impacts of a defined biotechnology in terms of respect (or lack of respect) for the ethical principles - e.g. wellbeing, autonomy and fairness as applied to the defined interest groups. Application of the principles aims to ensure a coherent approach to analysing ethical issues, which is designed to facilitate and promote informed decision-making. Participants' analyses of the ethical impact of the chosen biotechnology are facilitated by:

Asking them to either:

a. discuss each of the cells of the matrix;
b. if a more qualitative approach is needed participants are asked to complete a questionnaire in the form of a workbook in which are listed questions relevant to the principles and interest groups in the ethical matrix. Ideally, an audiorecording of discussions will be made, but alternatively notes may be taken by an experienced notetaker who is assigned solely to this task.

For both of the approaches above (a and b), questions may be proposed by facilitators to expedite the process, particularly if time is limited. If workbooks are used participants may then modify these questions. If only discussion sessions are used, participants can then reflect on and review their early responses.

When a computational approach is used, participants are asked to attribute a weight to each of the impacts for each interest group in each cell of the ethical matrix, by determining whether the ethical principle is respected or infringed, using a Likert scale of: strongly infringe/infringe/neutral/respect/strongly respect/don't know. (This scale can been translated into numerals, where strongly infringe = -2 and strongly respect = +2, etc for data analysis).

When the scoring is completed the participants are asked to judge the ethical acceptability of the biotechnology by taking all their scores into consideration. This gives an overall ethical judgement, but it should be noted that this judgement is not an aggregate of the scores.

4.3 Post workshop feedback

4.3.1 Feedback forms

In order to ensure the collection of views at several levels during the meeting, a series of feedback forms should be prepared and distributed at the end of the discussions. These forms:

- record the participants' overall judgement on the technology considered;
- allow participants to feedback their views anonymously on the topic being discussed;
- comment on the methodology and engagement process, and the overall aim of the workshop.

Overall final judgement on the biotechnology or topic being discussed. This form allows participants to set out a considered opinion on the technology or

topic. For example if the group is discussing the possible licensing of a technology, categories specified on the feedback form might be:

- qualified approval (stating the nature of the qualifications);
- qualified rejection (stating the nature of the qualifications);
- firm rejection;
- don't know.

An evaluation form of the methodology to include:

- overall view of the method;
- opinion on whether the ethical matrix aided or hindered the process;
- suggested improvements;
- additional comments.

4.3.2 SWOT analysis

An analysis of the strengths and weaknesses of, opportunities for, and threats to the methodology (a SWOT analysis) may be conducted. Forms of a standard design for such purposes should be used. This is a useful tool for further development of the methodology.

4.3.3 Anonymity

The workshop convenors should decide which of the above forms should be anonymous. However, the status of the form should be clearly stated on the feedback form. It is useful to assign each participant a code.

4.3.4 Evaluating the outcomes of the process

This process is performed by the organisers/facilitators. During the post-workshop analysis, the discussion sessions are transcribed and the feedback forms processed. A detailed analysis is then conducted on the transcript to draw out the key discussion points and issues. The dialogue is analysed to examine a number of key points, such as areas of consensus and divergence in the group's and individual views.

4.3.5 Reporting

In order to ensure that participants are confident in the way the discussion has been represented and with the quality of the analysis and reporting, transcripts of the discussion should be sent to the participants by post. Each participant should

also be sent a copy of the draft report so that they can identify how their input or comments have been used. This process of verification allows participants to ensure that their comments have not been taken out of context. It can also be valuable to obtain expert verification of the draft report in the form of peer-review.

The final report should be sent to the commissioning authority, all participants and relevant interest groups.

4.3.6 Timeline

Time	Task	Comments/Content
3 months before	Selection of workshop participants/speakers	Can be time consuming process identifying suitable participants/experts
2 months before	Dispatch of invitations to potential participants and expert speakers where appropriate	This allows time after the initial invitations are sent out to follow up on non-respondents and to find alternative participants for those who are unable to attend due to previous commitments.
6 weeks before	Preparation of participant documents	Description of the ethical matrix methodology; topic briefing paper; agenda for meeting
5 weeks before	Send out participant documents	
4 weeks before	Hire venue and book hotel accommodation where necessary	
3 weeks before	Prepare meeting feedback forms to review process and the methodology	Prepare SWOT analysis forms for assessing the methodology Prepare workbooks where used
1 week before	Confirm hotel accommodation and refreshments	
1 week before	Prepare introductory presentation	
1- 2 days	Running of workshop itself	
2 weeks after	Analysis of data and report on findings	Circulate to participants for comments
1 month after	Final analysis and report after feedback from participants	

The timeline for applying the ethical matrix is highly dependent on the objective of the exercise and the desired outcomes. This can be very specific to the use of the ethical matrix and therefore should be considered on a case-by-case basis.

But as a guide, when running a participatory workshop a lead-time of 3 months is advised.

4.3.7 Sample budget

As with the issue of a timeline for the application of the ethical matrix, the resource requirements for applying the ethical matrix are very context dependent. The required resources very much depend on the objective of the exercise, the number of participants, the reporting requirements and the outcomes of the event. Budgetary costs may vary considerably depending e.g. on whether:

- the meeting is held in-house, or whether an external venue has to be hired;
- it is a one-day or longer meeting: (in the latter case accommodation and meal costs will have to be covered as well as travel expenses);
- external speakers are used.

As a simple example of the potential resources usage (sample budget), the following can be used a guideline for conducting an expert ethical matrix exercise, viz. a one-day event with 15 participants. It is assumed that the report will be submitted to a relevant commissioning body (e.g. government department, funding organisation):

- personnel:
  - project manager (planning the exercise, writing briefing papers, facilitating the meeting, writing the feedback report);
  - project secretary (managing the participant invitations, meeting arrangements, meeting feedback forms, transcribing the meeting discussion sections);
  - expert speakers (when invited).
- communications:
  - distribution of material to participants;
  - printing of draft and final reports;
  - press release.
- participation:
  - travel and subsistence payments for participants (substantial component of the budget).
- facilities:
  - hire of meeting room;
  - AV and recording equipment.
- other Resources:
  - web-based or email-based questionnaire and report forms.

4.4 Strengths and limitations of the method

A number of strengths and limitations of the ethical matrix have been raised and discussed in previous sections. The following list of strengths and weaknesses anonymously recorded from workshop participants may aid users to think through a number of logistical and methodological issues:

- strengths:
  - identifies issue and focuses debate;
  - very good vehicle for education/discussion;
  - teases out issues and peoples' feelings;
  - enables a wide range of issues to be discussed;
  - aids the decision-making process;
  - a fruitful way of organising an ethical debate;
  - allows diverse groups to come together;
  - considers factors that might otherwise have been ignored;
  - provides structure for discussion;
  - allows most key issues to be considered;
  - (allows one) to learn and consider ideas and perspectives of others;
  - (provides a) positive/constructive environment for developing discussions;
  - allows a broad range of expertise to have a formative discussion;
  - forces the formation of an argument;
  - encourages examination of issues from a wide variety of stakeholder perspectives;
  - gives opportunity for everyone to express views and share ideas;
  - (encourages) open-mindedness - and so a better appreciation of some issues.
- limitations:
  - devotes equal time to subjects which vary in importance;
  - some pertinent issues could be missed;
  - very vocal participants may override others;
  - how do we get to a decision point?;
  - composition of the group may influence the main points of emphasis;
  - may restrict analysis from different philosophical basis;
  - isolates topic from wider more general issues and trends;
  - difficulty in getting into depth on each topic;
  - lack of time/participants' expertise will lead to incorrect ill-considered conclusions.

5. Case studies

The ethical matrix has been used in a number of academic and educational projects. The Biotechnology and Biological Sciences Research Council (BBSRC) in the UK funded a project 'Bioethical analysis in technology assessment: Application to the use of bovine somatotrophin and automated milking systems' (1997 - 2000) in which the ethical matrix was used to assess the potential impacts of two dairy biotechnologies. The BBSRC (2001) also financed a one-year study into public and stakeholders' views of issues arising from the potential use of biological systems such as microorganisms and plants to decontaminate polluted land, water and air in the UK. This was part of a wider study examining how interested parties may be enabled to identify and discuss issues arising from new biotechnologies such as bioremediation, using the ethical matrix.

A Norwegian group used the ethical matrix during a two-day workshop with stakeholders on the future of the Norwegian fishing industry (1999), funded by the Research Council of Norway. In 2004, the same group used another variant of the ethical matrix to assess the ethical aspects of genetically modified salmon to support a pending decision of the Ethical Council on Patent Issues, funded by the EU project *Ethical Bio-TA Tools*.

The University of Nottingham Research Committee (2001) funded the development of an interactive computer model of the ethical matrix. The UK animal welfare organization, Compassion in World Farming (CIWF, 2002 - 2003) commissioned a study on 'Ethics and animal farming: Using the ethical matrix to make ethical decisions about animal farming' (www.ethicalmatrix.net), the purpose of which was to design and develop a teachers' pack. An important component of this was an interactive web site based on the ethical matrix, for use as a teaching aid for 16-20 year olds in schools and colleges. The web-based exercise provides simplified ethical theory and applies the ethical matrix to test cases e.g. broiler chicken production, pig production and salmon farming.

This section illustrates the use of the ethical matrix by summarizing is employment in the ethical analysis of a number of agri-food biotechnologies. The collective experience of these applications may provide useful background information for those wishing to use the ethical matrix to address new issues.

The following cases have been chosen for discussion, but other experiences with this method can be reviewed in the reference section:

- bovine somatotrophin (bST) use in dairy production systems;
- GM organisms in bioremediation;
- GM salmon.

5.1 The case of bovine somatotrophin (bST)

This example involves a hormone called bovine somatotrophin (bST), which increases milk yield when injected subcutaneous into dairy cattle. The hormone, which is produced by recombinant DNA technology (genetic engineering) in cultures of the bacterium *E. coli*, was the first GM product to be used (in the USA) in animal agriculture.

By injecting cows every two weeks with bST, farmers can expect an average increase in yields of 12-15%; and, although slight changes in nutrient content may result, the overall concentrations of nutrients in bulked milk are probably unaffected. However, because higher metabolic demands may lead to increased rates of illness, there is a risk that the welfare of injected cattle will be diminished. The treatment also leads to an increase in the milk concentration of insulin-like growth factor 1 (IGF-1), which is a potent mitogen (i.e. it stimulates cell division). If the increased milk concentration of IGF-1 was physiologically significant and if it were to remain biologically active at the level of the gut mucosa (a claim which is contested by some scientists), it might pose a public health threat to people consuming the milk or dairy products.

Figure 2 shows how the use of an ethical matrix can help to summarise the ethical issues raised by this technology in a systematic way that is based on the principles that comprise the common morality. Box 5 describes in more detail the ways in which the different principles are specified for each of the four identified interest groups. These formulations of the ethical principles in the ethical matrix have been used in workshops conforming to the top-down approach described in Section 4.1.

5.1.1 Ethical evaluation of bST use

Box 6 summarises the lines of evidence (see Section 2.1) that have been presented for the different cells of the ethical matrix applied to bST (Note: In the USA, bST was licensed for commercial use in 1994. In contrast, in the EU in 1999, an earlier moratorium on its use was extended indefinitely). According to different interpretations of the importance to be attached to this evidence, the governments of the USA and the EU reached opposing decisions on the acceptability of licensing bST for commercial use. Although in neither case were

the decisions expressed in terms of ethical acceptability, it is clear that each would be justified, if it was requested of their supporters, in ethical terms: hardly anybody admits to acting unethically.

Dairy farmers

Wellbeing: satisfactory incomes and working conditions for farmers and farm workers: ('satisfactory' is obviously debatable, but it is a better word than 'adequate', which might imply 'just enough to meet bare necessities')
Autonomy: allowing farmers to use their skills and judgement in making managerial decisions, e.g. in choosing a farming system
Fairness: farmers and farm workers receiving a fair price for their work and produce, and being treated fairly by trade laws and practices

Consumers
Wellbeing: protection from food poisoning (and harmful agents e.g. residues of veterinary drugs); this also refers to the quality of life citizens enjoy as a consequence of a productive and profitable farming industry
Autonomy: a good choice of foods, which are appropriately labelled, together with adequate knowledge to make wise food choices; this principle also encompasses the citizen's democratic choice of how agriculture should be practised
Fairness: an adequate supply of affordable food for all, ensuring that no one goes hungry of poverty

Dairy cows
Wellbeing: prevention of animal suffering; improving animal health; avoiding risks to animal welfare
Autonomy: ability to express normal patterns of instinctive behaviour, e.g. grazing and mating
Fairness: treated with respect for their intrinsic value as sentient beings rather than just as useful possessions (instrumentally)

The Biota
Wellbeing: protection of wildlife from harm (e.g. by pollution), with remedial measures taken when harm has been caused
Autonomy: protection of biodiversity and preservation of threatened species (and rare breeds)
Fairness: ensuring sustainability of life-supporting systems (e.g. soil and water) by responsible use of non-renewable (e.g. fossil fuels) and renewable (e.g. wood) resources; cutting greenhouse gas emissions

Box 5 A more detailed specification of the principles in an ethical matrix for bST use (See Figure 2)

Dairy farmers
Wellbeing: Some USA farmers using bST have increased their profits but economic data suggest other farmers use it at a loss.
Autonomy: Farmers in the USA have an opportunity to increase productivity, but some might feel economically obliged to use bST (exemplifying the so-called 'technological treadmill').
Fairness: Farmers in the USA are given the option of using a productivity-boosting technology. Farmers avoiding bST can label milk accordingly, but only at their own expense.

Consumers
Wellbeing: An EU report by public health experts suggested possible (but currently poorly defined) risks of consuming IGF-1 (whose concentration increases in milk of treated cows). An FAO/WHO committee denied any significant health risk.
Autonomy: In the USA most milk is unlabeled, denying consumers a choice on whether to purchase milk from treated cows.
Fairness:There appears to be no clear evidence of an impact on milk prices.

Dairy cows
Wellbeing: Cattle suffer increased disease rates (such as mastitis, lameness, metabolic and digestive disorders), as noted on the bST product label, which lists 21 possible adverse side effects. The EU banned bST largely on animal welfare grounds, but the manufacturers claim the diseases are treatable by medication (e.g. antibiotics for mastitis).
Autonomy: Behaviour may be adversely affected by lameness, by reduced grazing opportunities due to increased concentrate feeding, and by decreased fertility.
Fairness: Some people claim that the excessively instrumental use of cows is an infringement of their intrinsic value. Others claim that the technology accords with accepted social norms.

Biota
As quantitative data are lacking, claims are largely speculative.
Claimed *positive* features of bST use are that reduced cow numbers (because fewer cows are needed to produce the required milk yield) will lead to less environmental pollution (e.g. fertilizer use for forage growth and reduced silage run off) and lower greenhouse gas emissions (methane is exhaled by ruminants).
Claimed *negative* features of bST use are that mergers in the dairy industry (as non-user farmers leave the industry), resulting in fewer but much larger dairy farms, will increase point-source pollution (e.g. excess fertilizer use, silage run off) and jeopardize biodiversity and sustainability by reliance on fossil fuels for fertilizer production etc and routine veterinary medication.

Box 6 A brief analysis of bST use in dairying with reference to Figure 2/Box 5

We can thus summarise the two positions, according to the ethical criteria that have been defined:

- the ethical acceptability of bST use for those who have licensed it (e.g. the USA) would probably cite the need to respect farmers' freedom to innovate; and the economic benefits to the manufacturers of bST, to the economies of countries producing it, to the farmers using it, and, were prices to fall, to consumers of dairy products. Moreover, if its use led to reduced cow numbers it might result in marginally reduced emissions of methane. This case also rests on perceptions that the welfare of treated cows is not affected significantly (or that increased disease can be effectively treated) and that there are no risks to human safety, so that labelling is unnecessary. Job losses in the dairy industry would not be seen as an ethical issue, being merely a feature of market economies, in which competition guarantees efficient production;
- the ethical case of those who have banned bST use (e.g. the EU) would probably focus on respects in which it appears to infringe commonly accepted ethical principles. They would point to authoritative reports suggesting that bST use substantially increases the risk of pain and disease in dairy cows, and that it might present a risk to human safety through ingestion of increased IGF-1 in milk. Moreover, they might consider that bST use would reduce farmers' autonomy; undermine consumer choice if milk products from treated cattle were not labelled; jeopardise public health if rejection of dairy products followed the licensing of bST (because milk is a valuable source of dietary nutrients); and increase local pollution through the intensification of dairying.

The above description provides a guide to people wishing to identify issues relevant to reaching a judgement on bioethical concerns. But employing a suitable tool for ethical analysis does not guarantee a genuine ethical evaluation. If users adopt a partisan position on the issue, e.g. allowing bias to influence the choice of scientific data, then the tool is unlikely to prove of value.

A conceptual device to counter this tendency is to try put yourself in the shoes of each interest group in turn as the different cells specifying its interests are considered. In essence, it amounts to recognising that ethics is concerned with caring about other beings with ethical standing that are described in the ethical matrix. It has been claimed that 'ethics in its full scope aims at care of the other', and while only certain occupations are conventionally classed as 'caring professions' it is implicit in the remit of ethics that care should be exercised in relation to others (necessarily, but not exclusively, people). If someone were not prepared to admit to caring about anyone or anything other than him- or herself,

it would be impossible for them to use the ethical matrix. But even if they expressed concerns for only one other cell of the ethical matrix, say, respect for farmers' profits or, alternatively, respect for animal welfare, that revelation would starkly expose the value system determining their choices. In fact, experience shows that most people do ascribe some value to all cells of the ethical matrix, although the degree of value ascribed varies both with the individual and with the issue being discussed.

Putting yourself in the shoes of others (developing 'an imaginative conception of others' predicaments') may not be easy, especially when the interest group concerned is non-human (although there is increasing scientific evidence e.g., on the welfare of farmed animals, to add substance to our imaginative conceptions). But it is arguable that genuine ethical insight depends on conscientious attempts to empathise in this way.

The relative importance of the impacts recorded for each of the cells is ideally only revealed at the evaluation stage, when the separate impacts are weighed. This step involves the attempt to seek the proper balance between the right and the good, and between intellect and intuition. In the words of philosopher Nagel, 'The capacity to view the world simultaneously from the point of view of one's relations to others, from the point of view of one's life extended through time, (and) from the point of view of everyone at once ... is one of the marks of humanity'.

5.2 The case of using GM organisms in bioremediation

This case focuses on the use of bioremediation technologies. This one-year study was commissioned by the Biotechnology and Biological Sciences Research Council (BBSRC) as part of their on-going stakeholder engagement work (www.bbsrc.ac.uk).

Bioremediation is a collective term used to describe the use of micro-organisms and/or plants to detect, degrade or remove environmental pollutants from soil, water or air. Decades of industrial and waste disposal activities have left the UK (and many countries in Europe) with a significant contaminated land problem, affecting as much as 360,000 ha (1.3% of the UK land area). In 2002, this contamination was believed to be distributed over as many as 100,000 sites, with a predicted clean-up cost of over £15 billion. The preferred remediation approach is to send contaminated material to landfill sites for disposal. However, this method is increasingly viewed as an unsustainable option. Bioremediation, used on less than 5% of sites in 2002, is promoted as a possible sustainable and cost effective method for dealing with a variety of environmental pollutants.

The study focused on emerging bioremediation technologies being developed from recent advances in plant and bacterial genomics, as a case study to map potential social and ethical issues. The work explored the use of the ethical matrix and its value in aiding the management of issues raised by GM bioremediation technology development. Ways of facilitating dialogue and identifying issues and potential concerns raised by these emerging biotechnologies were also explored by using the ethical matrix. The ethical matrix set out below was used by participants to explore the key issues:

Respect for:	**Wellbeing**	**Autonomy**	**Justice**
Users	Efficacy, safety and remuneration	Freedom to adopt or not adopt	Fair treatment in trade and law
Affected citizens	Safety and quality of life	Democratic decision-making	Individual and regional justice
Technology providers	Commercial viability and working conditions	Ability to innovate	Equitable trading (market) system
Environment	Protection of the environment	Biodiversity of biotic populations	Sustainability of the environment

Figure 5 An ethical matrix used in the ethical analysis of bioremediation

5.2.1 Methodology

Five focus groups and a final workshop (n=12) were conducted during the study, with an NGO group (n=5), a national women's organisation (NCW group; n=7), a technology/regulator group (technology group; n=11) and two general public groups (n=8 for both). The ethical matrix was used by each group to map the potential impacts (positive and negative) of these technologies for various interest groups. Participants considered whether the application of the technology might infringe or respect the principles as applied to each of the interest groups. Participants were also asked to examine the types of formal and informal policies that might enhance respect for the ethical principles for the chosen interest groups (e.g. enhance respect for citizens' autonomy by improving local community dialogue).

5.2.2 Findings from the consultation

In terms of findings from the study, the majority of participants demonstrated a very precautionary approach to the use of GMOs for bioremediation. The importance of demonstrating a clear need for GMO use was discussed in the focus groups, particularly the industry group, and the workshop. As a result of the UK GMO crop trial reviews, the characterisation of risks (safety and societal) and the perceived alternative research trajectories (e.g. [i] improved classification and use of non-GM organisms and [ii] improved conventional plant breeding strategies) participants perceived only a limited requirement for GMO bioremediation applications for specific persistent pollutants.

All focus group participants were asked to evaluate the ethical matrix as a participatory tool and clarify their judgements by means of a SWOT analysis. Over 85% felt the ethical matrix positively aided the discussions, with other participants expressing a neutral view on its use. The ethical matrix clarified the issues, both conflicts and concords, in order to allow policy-makers a greater confidence in their decision-making and to facilitate defensible biotechnology assessment procedures. Rather than being seen as restrictive, feedback indicated that the framework was well received by the study participants. All participants who commented also felt that it was important that research bodies and funders are involved in broad stakeholder engagement programmes. A number of participants commented on the need to initiate early engagement programmes in order to maintain confidence in the research funding strategies and research management.

AFFECTED CITIZENS	**ENVIRONMENT**
• Once a contaminated site has been designated, concerns expressed about the time it could take to remove the contamination if bioremediation was used instead of landfill. Concerns were also raised regarding the safety of the site during this process (Public B) • The significance of the health risk from the contaminated site was seen to be the most important factor in site neighbours' acceptance of any time delay with bioremediation (Public B)	• Concerns expressed regarding potential impacts from the effects of metabolites or by-products from the introduction of microbes (NGO) • Concerns expressed regarding potential impacts on ground water quality and air pollution from bioremediation techniques (NGO) • Concerns expressed regarding potential impacts on wildlife from phytoremediation (e.g. poisoning, bio-accumulation) (NGO; NCW)

• When building houses on bioremediated sites, concerns were raised that not all the contamination may be 'removed' (Public A and B). Concerns expressed regarding impacts on vulnerable groups (e.g. children) and possible risks from growing fruit and vegetables (Public A) • Bioremediation technologies, particularly *in-situ* technologies, may reduce transport aggravation factors (Industry) • With phytoremediation, concerns were raised about contaminates 'getting back' into the food chain (NGO; Public A) • Where there is scientific uncertainty, it is important that a comprehensive risk assessment is conducted which is then available to interested parties (NCW) • Need to be able to demonstrate that this is a safe solution for cleaning up contaminated land particularly if the land will be used for new houses (Public B) • When dealing with a contaminated site there needs to be a system of decision-making where local communities have a real input into the process so that the most appropriate method for all interested parties can be applied (NGO) • Biological processes were characterised as being unpredictable. Questions raised about who would be liable if a long-term problem arose due to the use of bioremediation techniques, particularly for land subsequently used for leisure purposes or housing (NGO, NCW) • In order to ensure confidence in bioremediation techniques long-term monitoring and adequate application of current legislation will be extremely important (NCW)	• Concerns expressed regarding potential impacts on soil microbial ecology from the introduction of microbes (NGO) • Concerns raised about the use of non-indigenous organisms and impacts on soil microbial ecology (NGO) • Concerns raised over the lack of microbial knowledge particularly in relation to soil ecology, and the possible environmental impact from the use of microbes (e.g. in bioaugmentation) (NGO; Public A) • Concerns expressed regarding the use of GM technologies and potential impacts on ecosystems, particularly concerns regarding unpredictability (e.g. gene flow) (NGO; NCW) • Need to ensure reliable containment of any GM and non-indigenous organisms (NCW) • Need to assess the environmental impact of GM options on a case by case basis (NGO; Public A; Public B; Industry) • There is a significant need to explore GM options to deal with more persistent environmental contaminants (Public A) • Bioremediation was characterised as being a sustainable technology if certain conditions were met (NGO; Industry; Public A; Public B; NCW) • The real environmental benefits cannot be clearly defined at present (Public B) • These biotechnologies should not be used to allow polluters to continue to pollute, on the grounds that these biological methods could be applied to clean-up contamination at a later stage (NGO; NCW)

TECHNOLOGY PROVIDERS	TECHNOLOGY USERS
• Important that providers conduct comprehensive studies and field trials should be carried out before specific technologies are used commercially (Industry) • At present, site liability is the responsibility of the contractor. This is hindering field scale projects especially for SMEs (Industry) • Comprehensive funding of demonstration projects is needed in order to stimulate the bioremediation market (Industry) • The use of GM organisms do not appear to be necessary. Indigenous organisms could be adequately harnessed (NGO; Industry) • GM technologies are unlikely to meet current risk assessment and safety requirements (Industry; Public A) • There is a need to explore/investigate the potential of these technologies, including GM options, through investment in research programmes, however, there are concerns about a number of the potential risks (NGO; Public A and B) • A number of companies are conducting low value remediation contracts that are not delivering the promised results. This is affecting the overall view of bioremediation as an effective method (Industry) • There is very little assistance (from central government) to help local authorities encourage sustainable remediation methods (Industry) • Due to the overall benefits of bioremediation, comprehensive government funding for research and development should be encouraged (Public A)	• Bioremediation will only be effective and economical for particular contaminated sites (Industry) • There are opportunities for bioremediation to be used to treat sites that are currently problematical (Industry) • More information is needed on the efficacy of the various methods and detailed information is needed to predict its applicability in a wide range of situations (Industry) • Widespread use of bioremediation will depend on changes in legislation that will affect the economic advantage of landfill (Industry) • Concern that users will always choose the cheapest option. Without changes in legislation cost will continue to be the key remediation driver (NGO) • Landfill tax system is not effective for encouraging technologies such as bioremediation and discouraging 'dig and dump' (NGO) • Recent changes in legislation (Part IIA) will allow regulators to encourage the use of certain types of remediation (e.g. bioremediation) (Industry) • Timescales will always be a problem for bioremediation, there is a need to find ways to help overcome this barrier possibly through proactive legislation (Industry) • The application of novel bioremediation methods need to be further validated for UK sites (Industry) • Bioremediation is being applied in other European countries successfully, the UK should learn from these successes (Industry)

• Bioremediation has the potential to be a valuable remediation technology but it is at risk of not being widely applied because of our current poor development strategies (Industry) • Commercial bodies and local authorities should ensure that all bioremediation risk assessment data produced by technology providers is available to the public (NCW)	• The media response to bioremediation will affect users' views and use of these techniques (Public B) • Any issues of uncertainty (e.g. biorisks) will affect users' willingness to use bioremediation (NGO) • Bioremediation could encourage a more combined reclamation (reuse) approach rather than sending to landfill (NGO)

Example issues raised during the group discussions (Potential impacts for sample interest groups)

5.3 The case of GM salmon

Research groups in Norway have used the ethical matrix in order to explore ethical aspects of GM salmon, modified for growth enhancement. A bottom-up approach was used with lay-people. The details of the case are not discussed here, but a simplified ethical matrix is presented in order to illustrate: a) the approach and the use of principles, and b) how the use of the ethical matrix can clarify important ethical considerations to such an extent that proponents and opponents can identify how different value judgements influence the ethical acceptability of one major consideration.

This form of the ethical matrix used four prima facie principles, i.e. the principle of wellbeing was explicitly defined as the prima facie duty to reduce harm, and increase benefit. This was done to clarify the consideration of risks of the GM technology use against the potential benefits. Thus the initial ethical matrix is represented in figure 6. The participants explored how the proposed technology would affect the specified principles in the different cells. In Figure 7 the negative impacts are marked with '-' and the positive impacts are marked with '+'. The justification for the choice of the descriptions/translations for each cell is not included here, as this would go beyond the purpose of this section.

5.4 Alternative ways in which the ethical matrix may be used

As noted earlier, the ethical matrix is a versatile tool for ethical assessments. Different groups have therefore developed variations of the ethical matrix that may be further adapted to either the topics under discussion or the specific socio-political culture of deliberation. The best way to find out what suits one's

purposes is to start with one of the more standard versions and develop variations in light of one's experiences. We refer to the cited literature for further examples of such variations.

Respect for:	**Increase of benefits**	**Reduction of harm**	**Dignity**	**Fairness**
Fish producers	Profit and work conditions	Dependency on natural resources and supplies	Freedom to choose technology	Fair trade conditions
Consumers	Nutritional quality	Safe food	Consumer choice	Availability
Treated fish	Disease resistance	Animal welfare	Freedom of movement	Respect for telos (natural capacities)
Environment	Preservation	Pollution	Biological diversity	Regional sustainability

Figure 6 An ethical matrix used in the ethical analysis of GM Salmon

Respect for:	**Increase of benefits**	**Reduction of harm**	**Dignity**	**Fairness**
Fish producers	+ quick harvest + less use of expensive resources	+ less strain by long cold periods - some added costs for improved control	+ may choose to produce GM salmon or not	+ possibility to compete if others start production
Consumers	None (assume nutritional value identical?)	Assumedly no risk (Allergies?)	Depending on labelling or not	+ some reduction in price + availability also in weak markets?
Treated fish	No benefit	- animal welfare: some deformities? - no good fish feed for such growth? - less disease resistance?	Unchanged in relation to ordinary farmed fish	- less ability to manage stress? - change of behaviour?
Environment	None	- potentially reducing variability in wild stocks - more transmission of diseases?	- possibility for reduced biodiversity	- cannot be integrated into natural system - needs more separation

Figure 7 Simplified consequence matrix for GM salmon

6. Further information and resources

This section provides potential users with additional information on the method and on potential training events and further contacts.

6.1 Training

In September 2005, members of the Centre for Applied Bioethics, University of Nottingham, UK and NENT, Norway conducted a two-day training event with the Lithuanian Bioethics Committee and members of Ministry of the Environment. A separate report of this event can be downloaded from the project website (www.ethicaltools.info). If you are interested in training events or organising a workshop please contact:

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6.2 References

Further reading and references (general papers and information on methodology)

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6.3 Further contacts

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