

Ethical Matrix

Introduction

The Ethical Matrix is a versatile tool for analysing ethical issues. It is intended to help people make ethical decisions, particularly about new technologies. It is an aid to rational thought and democratic deliberation, not a substitute for them. This document summarises the philosophy behind the Ethical Matrix, explains how it can be used, evaluates its strengths and limitations and suggests how to find out more about it.

The matrix was devised by Professor Ben Mepham, Director of the Centre for Applied Bioethics at the University of Nottingham and a member of the Food Ethics Council. It has been further developed in several Food Ethics Council publications, including our reports on veterinary drugs, novel foods, farming animals for food and the future of British agriculture.

What is the Ethical Matrix?

The ethical issues that arise in food and farming defy simple resolution. For most people, no single concern such as maximising net benefits to the people concerned, protecting the environment or respecting human rights overrides all others. Indeed, there is often disagreement about whether some of the entities affected by a decision have ethical standing at all. For instance, do animals have rights and does the environment have an intrinsic value, or are they just means to human ends?

The Ethical Matrix sets out a framework to help individuals and groups to work through these debates in relation to a particular issue. It is designed so that a broader than usual range of ethical concerns is aired, differences of perspective become openly discussed, and the weighting of each concern against the others is made explicit. The matrix is based in established ethical theory but, as far as possible, employs user-friendly language.

Philosophy

The Ethical Matrix uses a ‘principled’ approach to ethics. This kind of approach was first developed by two US medical ethicists (Beauchamp and Childress), who aimed to help doctors and nurses deal with the ethical issues they faced in their daily work. The main traditions of philosophical thought sometimes conflict. For instance, the utilitarian imperative to maximise the net benefits of an action may clash with the deontological requirement to treat people with dignity.

An approach resting on prima facie principles recognises that it is difficult, indeed sometimes absurd, to try to make decisions based only on one ethical theory. Instead of arguing that one theory ultimately overrides the others, it translates them into a series of conditional principles. Unlike the out-and-out 'isms', these principles allow that a stronger case on one principle may outweigh a weaker case on another in particular circumstances.

The Ethical Matrix is based on three ethical principles, respect for wellbeing, for autonomy and for justice. These three principles are not mutually exclusive and they cannot be said to exhaust every legitimate ethical concern. However, most common ethical concerns can be expressed in terms of wellbeing, autonomy or justice. Arguably, they capture key elements of the 'common morality', the norms and assumptions that underpin contemporary society. It follows that the common morality is good starting point for discussing ethical issues in food and agriculture. In a sense, it is the lowest common denominator – because few people would disagree with the principles of respect for wellbeing, autonomy and justice – so it can provide a meeting place for different perspectives. But it is important to note that the common morality is just the starting point, it is not where ethical reasoning ends. The principles provide reference points against which agreements and disagreements, factual uncertainties and differing assumptions can be identified and tested.

Theory

According to the approach adopted here, respect for wellbeing corresponds to issues prominent in utilitarian theory, which characteristically employs a form of cost/benefit analysis to decide on 'right action'. Most famously articulated in the eighteenth and nineteenth centuries by Jeremy Bentham and John Stuart Mill, it can be epitomised as 'The greatest good for the greatest number'. While this might seem a worthy objective, naive forms of utilitarianism suffer from several defects e.g.:

They depend on predictions of outcome (which might be wrong) and (fallible) assessments of who or what counts in the cost/benefit analyses.

They can be held to justify gross inequality (as long as the majority 'are happy') or even crime (stolen money distributed to the needy).

Goods and harms are often incommensurable (how can we weigh the safety of a hair shampoo against the suffering of animals used to test it?).

Respect for autonomy corresponds to the notion of 'rights' advanced in the eighteenth century by Immanuel Kant, which appeals to our responsibilities and duties to 'treat others as ends in themselves': in essence, the Golden Rule: 'Do as you would be done by'. For Kant, ethics was about respecting others as individuals, not calculating costs and benefits (i.e. in contrast to utilitarianism, irrespective of outcome).

A major defect of this approach taken in isolation is that there is no rule by which to decide how to prioritise duties, e.g. the duties to protect others from harm and to tell the truth - if, as may happen, telling the truth is a cause of harm.

Respect for justice corresponds to Rawls' notion of 'justice as fairness'. Rawls writes in 'A Theory of Justice':

"Justice is the first virtue of social institutions, as truth is of systems of thought. A theory, however elegant and economical, must be rejected or revised if it is untrue; likewise laws and institutions, no matter how efficient or well arranged, must be reformed or abolished if they are unjust".

However, there is a problem in defining what fairness means: e.g. does it mean that goods should be distributed according to need, or ability, or effort?

In practice, all these theories are likely to contribute, to varying degrees, to people's attitudes on what should be done in specific circumstances. It seems unlikely that anyone could consistently act as an out-and-out utilitarian; or as an out-and-out Kantian. Instead, each of us blends these theories (consciously or unconsciously) with intuitive responses and cultural influences to achieve what has been termed a 'reflective equilibrium'.

Uses

The three principles of respect for wellbeing, autonomy and justice form the columns of the matrix.

The rows consist of the 'interest groups' caught up with the issue in question. These might include different groups of people, such as consumers and food producers, and also non-humans, such as farm animals or the environment.

Which interest groups are included in the matrix depends partly on the issue at hand. One criterion is that they should possess 'ethical standing'. In other words, they are subjects of ethical consideration in their own right, and not just means to other ends. Of course, there is sometimes disagreement over whether some organisms (like plants) have ethical standing. But if such a view is represented in society, it should be reflected in the Ethical Matrix. Thus, in the common morality, ethical standing usually extends to animals and to plants and the ecosystem.

So, it is appropriate to include a broad range of interest groups in the Ethical Matrix, lest legitimate concerns are ignored. As one works through the matrix, it should become apparent if a particular interest group was agreed to be irrelevant.

But there are practical limits to the number of different interest groups and concerns that can be tackled in any debate or deliberation. This is because the purpose of the Ethical Matrix is to help us consider each interest group in relation to each of the three principles. If there are three interest groups and therefore three rows, then the matrix would have nine cells; if there were six rows it would have eighteen different concerns to weigh up

Given these practical constraints it has usually been found possible to limit the Ethical Matrix to four interest groups. A generic version of the matrix, which can be adapted to address a range of different issues in food and agriculture, is shown below. Each cell specifies the main criterion that would be met if a particular principle (e.g. justice) were respected for a particular interest group (e.g. people in the food industry).

Respect for	WELLBEING (Health & welfare)	AUTONOMY (Freedom & choice)	JUSTICE (Fairness)
PEOPLE IN THE FOOD INDUSTRY	Income and working conditions	Freedom of action	Fair trade laws & practices
CITIZENS	Food safety & quality of life	Democratic, informed choice	Availability of affordable food
FARM ANIMALS	Animal welfare	Behavioural freedom	Intrinsic value
THE LIVING ENVIRONMENT	Conservation	Maintenance of biodiversity	Sustainability

At its simplest, the Ethical Matrix is just a checklist of concerns, structured around established ethical theory. However, it can also be used as a means of provoking structured discussion. The interest groups, the weighting of each cell and even the appropriateness of the principles may all be challenged or modified by those using it. At best, it helps those involved in making a decision to put themselves in the shoes of others. At the very least it ensures that more than the usual narrow range of concerns gets an airing.

Applications

The Ethical Matrix has been used to provide a structure for academic papers and reports, it has been adapted for use as a teaching tool, and it has been used in participatory research and policy processes. Links and references for these uses of the matrix are available on the Food Ethics Council website. www.foodethicscouncil.org.

According to Matthias Kaiser and Ellen Marie Forsberg, who have used the Ethical Matrix in consultations about the future of the Norwegian fishing industry, its main strengths are that it:

Does not constrain users to follow a single ethical theory, such as utilitarianism, or to prioritise one principle;

Focuses deliberation onto key concerns;

Makes abstract principles concrete and relevant to people who may well have little interest in ethical theory as such; and

Highlights the different implications of a particular decision for different stakeholders and helps decision-makers to find a solution in light of conflicts, rather than giving a false impression of consensus.

If the Ethical Matrix were to be used mechanistically – if each cell was scored and the positive or negative outcomes aggregated to determine the decision – then its limitations would be legion. However, when used to assist in deliberation and decision-making, and not substitute for it, many have found it a useful tool.

Resources

There are several detailed examples of the Ethical Matrix on the Food Ethics Council web site. It is central to our reports on veterinary drugs, novel foods, farming animals and the future of British agriculture. Our leaflet on drug use in farm animals provides a very brief example. Hard copies of these reports can be obtained by contacting the Food Ethics Council office (£10, £2 concessions, subject to availability).

The Ethics and Animal Farming web site (www.ethicalmatrix.net) – a collaborative project between the Centre for Applied Bioethics at the University of Nottingham and Compassion in World Farming Trust – is an interactive learning resource based on the Ethical Matrix. It encourages students and teachers to think through the ethics of science within the biology curriculum. It is aimed to appeal to students aged 16-20.

The following is a selection of academic books and papers that refer to the Ethical Matrix or provide useful background information:

Mepham, B (1996) Ethical analysis of food biotechnologies: an evaluative framework. In Mepham, B (ed) *Food ethics*. Routledge, London: 101-119.

Mepham, B (2000) A framework for the ethical analysis of novel foods: the ethical matrix. *Journal of Agricultural and Environmental Ethics* 12: 165-176.

Beauchamp, T L and Childress, J F (2001) *Principles of biomedical ethics (5th edition)*. Oxford University Press, Oxford.

Kaiser, M and Forsberg, E-M (2001) Assessing fisheries – using an ethical matrix in a participatory process. *Journal of Agricultural and Environmental Ethics* 14, 192-200.

Mepham, B (2001) Novel foods. In Chadwick, R (ed) *Concise encyclopedia of ethics and new technologies*. Academic Press, San Diego: 300-313.

Chadwick, R et al. (2003) *Functional foods*. Springer, Berlin.

Schroeder, D and Palmer, C (2003) Technology assessment and the ‘ethical matrix’. *Poiesis Praxis* 1, 295-307.

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BEN MEPHAM

A FRAMEWORK FOR THE ETHICAL ANALYSIS OF NOVEL FOODS: THE ETHICAL MATRIX

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ABSTRACT. The paper addresses the issue of how in democratic societies a procedure might be formulated to facilitate ethical judgements on modern biotechnologies used in food production. A framework for rational ethical analysis, the Ethical Matrix, is proposed. The Matrix adapts the principles described by Beauchamp and Childress for application to medical issues, to interest groups (e.g., producers, consumers, and the biotic environment) affected by these technologies. The use of the Matrix is illustrated by applying it to an example of a “novel food,” viz., a form of genetically modified maize.

KEY WORDS: Ethical principles, genetically engineered maize, novel foods, Rawls

NOVEL FOODS AND THEIR REGULATION BY GOVERNMENT

Regulation (EC) 258/97 of the European Parliament and Council, concerning Novel Foods and Novel Food Ingredients (European Community, 1997) requires companies wishing to market a novel food to submit an application to the Competent Authority in the Member State where they first intend to market the product, and it charges the Authority with the task of assessing the product and advising Ministers accordingly (MAFF/DoH, 1998). In the UK, for example, the Advisory Committee on Novel Foods and Processes (ACNFP) advises health and agriculture Ministers “*on any matters relating to ... the manufacture of novel foods or foods produced by novel processes having regard where appropriate to the views of relevant expert bodies*” (MAFF/DoH, 1998). Other committees whose advice is sought are the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) and the Food Advisory Committee (FAC). If a genetically modified crop is to be grown in the UK, applications have also to be assessed by (among others) the Advisory Committee on Releases to the Environment (ACRE).

These committees report to the Ministry of Agriculture, Fisheries and Food (MAFF) and/or the Department of Health and/or the Department of the Environment, Transport and the Regions. With such a wealth of



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expert advice, it might be imagined that consumers and the environment would be certain to receive adequate protection, but we need to consider the possibility that this is not so. For example, the recommendations of expert committees might be inadequate if the remit of the committees was not appropriate to consider all the relevant problems, or if the expertise represented on committees was biased to one viewpoint. Thus, it has been suggested that committees like the ACNFP concentrate on food safety aspects, whereas there are many other important ethical, economic, and social issues that receive inadequate attention. Moreover, the expertise on such committees is predominantly scientific, and since several members work in or with the biotechnology industry, it is not unreasonable to assume that their favorable predisposition to food biotechnology will influence their judgements.

Of course, some issues that would feature in any comprehensive ethical analysis are included in the ACNFP's agenda, notably food safety. But an analysis that focuses on chemical and physiological criteria and places much store by the notion of "substantial equivalence" (i.e., the product's chemical similarity to a non-novel food, irrespective of the way in which it is produced) is liable either to marginalize other important ethical concerns or to overlook them altogether. It is evident that ethical analysis needs to be comprehensive: it cannot exclude issues because they are complex or challenge the concept of the free market. It needs to subject the opinions of both proponents and opponents to rigorous examination in the light of agreed ethical principles. In short, an ethical assessment requires its own agenda: the question is, "How do we set that agenda and perform the ethical assessment?"

DEVisING AN ETHICAL FRAMEWORK

In considering that question, an early paper of John Rawls (1951) provides useful insights. The paper addresses the question, "Does there exist a reasonable decision procedure which is sufficiently strong . . . to determine the manner in which competing interests should be adjudicated, and, in instances of conflict, one interest given preference over another; and, further, can the existence of this procedure, as well as its reasonableness, be established by rational methods of enquiry?" (Rawls, 1951: 177).

For Rawls, the procedure depended on the existence of "*a class of competent moral judges*," who should have the following characteristics: normal intelligence; reasonable knowledge of world affairs; a capacity to "reason," i.e., see both sides of a question, making allowance for personal bias; and an imaginative appreciation of other people's predicaments.

Certain constraints were attached to the judgement procedure, viz., the judge must be immune from, and have no vested interest in, the judgement; which must only be arrived at after a careful enquiry into the facts of the case, be delivered with appropriate certitude and be stable.

Finally, it is required that the judgement be intuitive with respect to ethical principles ... What is required is that the judgement not be determined by a systematic and conscious use of ethical principles. The reason for this restriction will be evident if one keeps in mind the aim of the present enquiry, namely to describe a decision procedure whereby principles, by means of which we may justify specific moral decisions, may themselves be shown to be justifiable. (Rawls, 1951: 183)

This latter constraint is required by the logic of the argument, but Rawls proceeds,

Then an explication of these judgements is defined as a set of principles, such that, if any competent man (*sic*) were to employ them intelligently and consistently to the same cases under review, his judgements, made systematically nonintuitive by the explicit and conscious use of the principles, would be, nevertheless identical, case by case, with the considered judgements of the group of competent judges. (Rawls, 1951: 184)

Rawls's heuristic device, foreshadowing by twenty years his appeal to the "veil of ignorance" (Rawls, 1972), has the object of discovering reasonable and justifiable principles that are embodied in "common sense morality." Appeal to the "common morality" is also fundamental to Beauchamp and Childress (1994), whose "four principles approach" has achieved wide currency in the field of medical ethics. The approach involves *prima facie* duties to respect certain principles, viz., nonmaleficence, beneficence, autonomy, and justice. Thus, in treating patients, a doctor is regarded as having ethical duties to, respectively, cause no harm (enshrined in the Hippocratic Oath); to effect a cure (or at least provide palliative treatment); to respect patients' autonomy (and not regard them merely as "cases"); and to treat patients fairly (e.g., without sexual or racial discrimination).

This principled approach has its critics, but many opposing arguments fail through misunderstanding or misrepresentation. For example, it has recently been claimed that the approach lacks content and that "*these principles can be invoked to support all kinds of moral conclusions*" (Verweij, 1998: 38). But it needs to be recognized that the framework is not an ethical theory and does not aspire to be a decision-making procedure. What it does provide is a set of "*substantive moral premises upon which to base reasoning in health care ethics*" and, moreover, (with reference to critics who imply it has a Western cultural bias) it "*offers a transcultural, transnational, transreligious, transphilosophical framework for ethical analysis*" (Gillon, 1994: 332) by allowing differences of emphasis within a scheme

of universal applicability. So, although the common morality is hardly likely to provide the last word in moral judgement, it would be difficult to conceive of a better starting point for the development of ethical theory. Moreover, use of the principled approach would appear to satisfy as closely as any other procedure Rawls's "nonintuitive" means of moral judgement.

In recent years, I have attempted to extend the applicability of the Beauchamp and Childress principles in order to assess the ethical impacts of biotechnologies in the fields of agriculture and food technology (e.g., Mepham, 1996a, 1996b), and thereby provide a means of ethical analysis that might facilitate political decision-making. Despite sharing a common dependence on biological science, agriculture differs substantially from medicine in the pervasive impact of its activities at the production, distribution, and consumption stages, so that application of the principles to this different field requires that they be translated into terms appropriate to a wide range of different "interest groups." In Table I, suggested interpretations of the ethical principles as they apply to four such interest groups (treated organisms, producers, consumers, and biota) are summarized in the form of an "Ethical Matrix." The Matrix permits analysis of the ethical impacts of any production system (e.g., application of a biotechnology) from the perspective of the different groups affected by its employment. In true Rawlsian fashion, actors (e.g., members of a regulatory committee) are asked to imagine themselves to be members of each specified interest group in turn, and to assess the ethical impacts of the introduction of the proposed technology.

In the form of the Matrix discussed here, the principles of "beneficence and non-maleficence" are combined as "respect for wellbeing," partly because it simplifies the framework, but also because in terms of human stewardship over organisms used in agriculture, these two principles are inextricably related: combining them in no way diminishes the importance that attaches to them separately. According to Gillon (1994: 323) "... If one is certain about them being one principle one is not debarred by the four principles approach from treating them as one." The, now, three principles may be considered to correspond to three major theories of ethics, viz., utilitarianism (wellbeing), Kantianism (autonomy), and Rawlsian theory (justice) (Winkler, 1993). However, in some circumstances, it might be preferable to retain the original distinction between the two utilitarian principles, as for example in Mepham et al. (1996).

It is clear that principles employed in medical ethics need to be appropriately translated if they are to be effective in this different context. For example, in relation to animals treated in biotechnology, respect for wellbeing, autonomy, and justice are interpreted as respect for welfare

(freedom from pain and stress); freedom of behavioral expression; and for *telos* (see below), respectively (see Table I). In the case of consumers of food produced by biotechnology, these principles are interpreted as respect for food safety, consumer choice (e.g., by appropriate labeling), and affordability, respectively. By extending the number of affected groups, an Ethical Matrix of any desired degree of complexity can be constructed. The object here is simply to propose and illustrate a methodology. Rigorous analysis would require much fuller treatment.

It is important to appreciate the aims and limitations of the Matrix.

- The impacts defined for each of the separate “cells” depend on rigorous examination of objective (often scientific) data.
- The duties described are *prima facie* duties. Circumstances will frequently arise when there are conflicts of interest between different duties and compromises will have to be made.
- Construction of the Matrix is in principle ethically neutral, i.e., it is an *analytical* tool. In accordance with Beauchamp and Childress’s account, the principles “are general guides that leave considerable room for judgement in specific cases and that provide substantive guidance for the development of more detailed rules and policies” (Beauchamp and Childress, 1994: 38).
- By contrast, ethical *evaluation* requires a weighing or ranking of the different impacts, so that, e.g., an animal rights activist might consider *any* exploitation of animals inadmissible, while a more utilitarian view might accept that substantial human benefits outweigh minor harms inflicted on animals.
- The Matrix records ethical impacts in one set of circumstances (e.g., the prospective introduction of a technology) with another set of circumstances (usually, the *status quo*). Hence, the impacts recorded are *relative* to a pre-existing condition, which itself might be far from ethically acceptable by reference to some other actual or possible condition.
- While it might guide individual ethical judgements, the principal aim of the Matrix is to facilitate rational public policy decision-making by articulating the ethical dimensions of any issue in a manner that is transparent and broadly comprehensible.

TABLE I
The Ethical Matrix

Respect for:	Wellbeing	Autonomy	Justice
Treated organism	e.g., Animal welfare	e.g., Behavioral freedom	Telos
Producers (e.g., farmers)	Adequate income and working conditions	Freedom to adopt or not adopt	Fair treatment in trade and law
Consumers	Availability of safe food; acceptability	Respect for consumer choice (e.g., labeling)	Universal affordability of food
Biota	Protection of the biota	Maintenance of Biodiversity	Sustainability of Biotic populations

The Table illustrates, in the twelve cells of the Matrix, the specification of the three ethical principles for four interest groups.

APPLICATION OF THE MATRIX TO A NOVEL FOOD: GM MAIZE

Within the space available, a single example must suffice to merely illustrate the way in which the principles of the Matrix may be specified in a particular instance. Here, the Matrix is used to assess ethical impacts of the genetically modified (GM) maize produced by Novartis, which has been designed as a production aid: there are no claimed advantages in terms of the quality of the food product. Novartis's transgenic maize is present in food ingredients used for brewing, bakery products, salad dressing, snack foods, and margarine.

The maize contains three transgenes, viz., for i) herbicide resistance; ii) pest resistance, i.e., the gene for *Bacillus thuringiensis* (Bt) toxin to protect from attack by the European corn borer; iii) ampicillin (antibiotic) resistance, i.e., a marker that facilitates the laboratory selection of the transgenic plants (IGD, 1998). Thus, farmers growing this herbicide-resistant crop (HRC) are able to spray it with the herbicide glufosinate, which kills competing weeds but not the crop itself; and because the plants contain the Bt toxin, losses from infestation with corn borer should also be reduced.

Taking the cells of the Matrix (Table I) in turn we can identify the following ethical impacts, where □ indicates respect for the principle and ● indicates infringement of the principle. Generally, the comments below refer to “likely” outcomes or “risks,” but it must be appreciated that the treatment here is summary in the extreme. The recent report of the Royal Society (1998) *Genetically modified plants for food use* is used as an authoritative source of information and opinion on many of the issues raised.

1. *Producer Wellbeing (Income and Quality of Life of Farmers)*

- Early adopters of the technology may benefit financially.
- There should be reduced need for spraying the crop with pesticides and herbicides.
- Farmers may encounter several problems, e.g., HRCs may be transformed into weeds; HRC “volunteers” may act as reservoirs of pests and diseases, undermining the principles of crop rotation (Royal Society, 1998: 10); and genetic erosion may make HRCs vulnerable to pest and disease epidemics (Gates, 1995: 158).
- Bt toxin may increase the evolution of resistant strains of corn borer. According to the Royal Society (1998: 9) “*there is no reason to assume that this problem (encountered with conventional insecticides) will not be repeated for GM crops.*”
- Risks to farmers are associated with herbicide use; e.g., glufosinate poisoning may cause convulsions and short-term memory loss (Watanabe and Sano, 1998).

2. *Producer Autonomy (Freedom to Adopt or Not Adopt)*

- Farmers are free to exploit a new technological opportunity.
- However, characteristically, late adopters tend to suffer financially, being forced onto the, so-called, “technological treadmill.” Non-adopters may go out of business unless they can establish a “niche market” for their product.

3. *Producer Justice (Fairness in Trade and Law)*

- According to the Royal Society (1998: 7), “*Transfer of genes from GM to non-GM crops may also have unwanted effects if the latter are grown organically. . . . Crops able to outbreed, such as maize . . . , will be affected to the greatest extent.*”

- The Bt toxin is the *only* form of pesticide permissible in organic farming systems: thus, development of Bt resistance through use in GM organisms might undermine organic farming.

4. *Consumer Wellbeing (Food Safety)*

- ☐ The European Commission has approved the human safety of GM maize.
- The risk that transfer of the antibiotic resistance gene to humans will compromise effective treatment of patients means that “*it is no longer acceptable to have antibiotic resistance genes present in a new GM crop*” (Royal Society, 1998: 8).
- “[P]otential allergenicity problems ...are impossible to predict.” (Royal Society, 1998: 12).
- Risk assessments do not consider the possibilities of cumulative impacts on human health as numerous HRC crops are introduced.

5. *Consumer Autonomy (Choice, e.g., through Adequate Labeling)*

- ☐/• Foods containing ingredients from GM maize (and soya) must be labeled as such (following the introduction of a new EU Regulation) on delivery to the “final consumer.” But, as the Royal Society report (1998: 16) points out: “*no officially validated methods for determination of GM materials ... exist.*” Voluntary labeling to indicate the absence of GM ingredients is permitted and several supermarket retailers in the UK have declared that their own-brand foods are “GM-free.”
- In the absence of mandatory segregation, labeling does not ensure consumer choice if consumers do not understand the label or if there is no available option.

6. *Consumer Justice (Affordability)*

- ? Cost savings in production do not appear to have been passed on to consumers.

7. *Biotic Wellbeing (Conservation)*

- ☐ HRC crops might lead to reduced overall use of herbicides, which would be beneficial to the environment.
- However, there may be an *increased* use of glufosinate (a clear commercial objective). Glufosinate, a broad-spectrum weedkiller, is

highly soluble and can be leached from soil, so contaminating ground or surface water (MAFF, 1991).

- HRCs may be transformed into weeds or HR genes may spread to wild relatives (Gates, 1995: 153–154).

8. *Biotic Autonomy (Biodiversity)*

- “The major adverse effect of HRCs is the more effective destruction of weeds which is likely to reduce the availability of habitats for various insects and invertebrates” (Royal Society, 1998: 10).
- Bt toxin also reduces numbers of other, beneficial, insects, e.g., lacewings and ladybirds, which “highlight(s) the importance of further research on this topic” (Royal Society, 1998: 9).
- Resistance genes (e.g., herbicides and antibiotics) move between organisms so that “it is inevitable that some gene transfer will occur from certain crops” and “There are insufficient research data (on) possible effects (of HRCs) in the field environment” (Royal Society, 1998: 10).

9. *Biotic Justice (Sustainability)*

- Genetic erosion may make HRCs vulnerable to pest and disease epidemics (Gates, 1995: 158).

TELOS

By choosing a transgenic crop as the subject of analysis, it has been considered unnecessary to discuss ethical impacts on the “treated organism,” although not all would agree that this omission is appropriate. However, if one were to consider applications employing transgenic animals, it is clear that ethical impacts on such principles would demand a fuller analysis (e.g., see Mepham, 1996a, 1996b). An important consideration in that case would be respect for the principle of justice, which has been interpreted in the Matrix as respect for “telos.”

According to Aristotle, every creature possesses a goal in life, which he designated its telos. Rollin (1989: 146) proposed a definition of telos as “the unique, evolutionarily determined, genetically encoded, environmentally shaped set of needs and interests that characterize the animal in question,” but according to Alan Holland, this definition is mistaken. In “Aristotelian science ... it is with reference to the telos of a creature, the full flourishing stage of its existence (“that for the sake of which it

came to be”) that one explains the nature and existence of all its major characteristics” (Holland, 1995: 298).

Because it shares many qualities with the concept of “intrinsic worth” or “intrinsic value,” telos assumes paramount importance in the case of humans. In Kant’s terms, each of us is “*an end in himself*,” and has “*an intrinsic worth, that is, dignity*,” which it is incumbent on us to respect in all other human beings (Kant, 1930: 239). But “if this principle applies in the case of human relations with one another, it is hard to see why an analogous principle should not apply in the case of human-animal relations as well . . . this principle is what chiefly lies behind the appeal to animal rights.” (Holland, 1995: 296). Such interpretations accord with the claim that “*the intrinsic value of an animal is connected with its telos*,” a view that has “*much in common with Clark’s concept of ‘self-realization’ and Regan’s concept of ‘inherent value’*” (van der Tuuk, 1999: 35).

Thus, respect for the telos of non-human animals extends the Kantian principle by ascribing to them rights analogous to, if not identical with, those acknowledged for humans. The association drawn between the Kantian principle of respect for others as ends in themselves and the original Aristotelian notion of telos provides the basis of a coherent specification of the Rawlsian concept of justice as fairness employed in the Matrix. For many people, such as animal rights activists, this principle captures an important deontological requirement. For some, plants should also be accorded such respect.

CONCLUSION

So concise a listing of possible impacts of this technology on the range of ethical principles identified in the Ethical Matrix fails to do justice to the depth of enquiry that is required in order to perform a comprehensive analysis.

“Scoring” perceived ethical impacts on a numerical scale (positive and negative scores representing respect for, or infringement of, the principle concerned) may serve as a means of establishing relative perceptions in a committee setting, but the framework should not be viewed as a decision model. Rather it guides ethical deliberation and identifies areas of dispute. It is, however, apparent that while, typically, certain ethical principles may appear to be respected, others are infringed and any rational decision procedure will require that the relative weights assigned by different parties to the different impacts be made explicit. Key issues of disagreement might thereby be identified. It is even conceivable that, in a qualitative sense, opponents and proponents of a prospective technology

might agree as to the nature of the impacts (i.e., whether positive or negative) but differ in the significance assigned to them. Of course, it is also a basic prerequisite for using the Matrix that there is general agreement on its validity and usefulness; but even disagreements at this stage can be constructive steps in the overall process of democratic decision-making.

It is essential to appreciate that the Matrix is only one of the important ingredients in making ethical judgements. Rawls's requirement for "competent moral judges" is critical. In the UK, following the recommendations of the Nolan Committee on Standards in Public Life (see British Council, 1999), government committees are in process of being reconstituted on the basis of openness and requirements for personal integrity, which may be seen as a change consistent with Rawls's proposal.

The question of how the differing ethical evaluations that are evident within society, particularly multicultural, democratic societies, are to be accommodated within public policy decisions is beyond the scope of this paper. But in essence, policy makers have a range of strategies at their disposal, from proscription, to limitation, to prescriptions on labeling, to reliance on market forces. Justice demands that such decisions be made only following full public consultation. The Ethical Matrix is proposed as a means by which that process might be facilitated.

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