
ISBN 0-9549218-0-1
Price £10

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FOOD ETHICS COUNCIL

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JUST KNOWLEDGE?

governing research on food and farming

The seventh report published by the Food Ethics Council

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Acknowledgements
This report develops discussions that took place at a workshop on *Agri-food research: participation and the public good,* which the Food Ethics Council held in March 2004. We are very grateful to everyone who took part in that workshop, and the many other people since who have contributed to our understanding of research on food and farming.

We owe a special debt of thanks to members of the external Review Panel for this report, who met twice prior to publication and contributed detailed comments on earlier drafts. The Review Panel members are:
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John Turner (Farm)
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In order to help open debate around the issues covered in this report, we invited the Review Panel members to write individual comments. These postscripts can be found at the end of the report. The Review Panel do not necessarily endorse this report.

We also wish to express our sincere thanks to Dr Christopher Stopes (Ecos Consultancy) and Dr Paul van Heyningen (Biotechnology Commission/AEBC), who attended Review Panel meetings as observers. The Biotechnology Commission has been gathering evidence for a report on Research Agendas and we thank the commission for its openness in sharing relevant information.

We gratefully acknowledge the support of the Joseph Rowntree Charitable Trust, the Allen Lane Foundation and the Polden Puckham Charitable Trust.

The working group for this project consisted of Helen Browning, Ben Mepham and Geoff Tansey. This report was drafted by Dr Tom MacMillan, with assistance from Shaila Seshia and Ann Baldridge. It was designed and printed by PDC Copyprint (Brighton).

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“Science is just knowledge.”

Tony Blair, 2002.

Just knowledge?

Public confidence in the governance of science and technology has been severely shaken by a succession of controversies about risk regulation, new technology and public health. The policy response has been to promote public engagement in research and ‘upstream’ in research planning.

But giving people greater access to decision-making about science will not alone earn public trust. The ethics of science and technology – the values and assumptions that get built in during research, innovation and regulation – must be opened to greater public scrutiny and challenge. This report explores how that can be done. We explain why the view that science is ‘just knowledge’ is a misunderstanding which presents a real barrier to a robust research policy.

Farming and food have been at the centre of public unease about science, in the wrangling over bovine spongiform encephalopathy (BSE), Foot and Mouth Disease (FMD), genetically modified (GM) crops and, of late, obesity. We focus on food and farming research, and on policy in the United Kingdom (UK), though much of our analysis and many of our recommendations apply more generally.

Research ethics

Research scientists cannot avoid ethical issues. In the first place, in the practice of research, they are faced with numerous ethical codes, guidelines and procedures, covering issues that range from confidentiality and data protection to the ethics of publication and animal experiments. Some of these codes must be followed by law, others as conditions of professional or funding bodies.

However, these requirements and guidelines only address a small subset of the ethical issues that arise in research. They focus on the conduct of research, and are largely blind to its social context and consequences. They do not address the ethical questions that many non-scientists care most about – what is the wider purpose of the research and what are its social implications?

It is essential for scientists to deliberate on the social consequences of their work. Funding bodies should reward applicants who consider the social context of their research. It is also important to encourage young people to reflect on the social and ethical implications of science. **Now that ethical and social objectives feature in science curricula, we recommend that science teachers in schools and universities are given the support, training and resources they need to achieve them (Section 2.2.3).**

Governing technology

Some official discussions of ethics and public concerns draw a line between science and its application. As the Prime Minister has put it, “Science doesn’t replace moral judgement… with scientific advance we need stronger analysis of how to *use* knowledge for good not ill”.[1] The implication is that if issues are *not* addressed during research, they will be addressed downstream.

This clear-cut divide is inconsistent with government policy on innovation, which recognises that the research, development, regulation and use of new technologies are inseparably linked. Nor does it fit with the government’s current focus on upstream public engagement, which aims to address concerns sooner rather than later. But the research-application divide is most misleading because many ethical issues and public concerns are not addressed downstream in technology regulation:

- Ethical issues have been systematically excluded from regulatory assessments for new products like veterinary drugs and GM crops, sometimes because it is considered that they would contravene international trade agreements. **We recommend the UK government to press in international trade negotiations for amendments to any clauses that are perceived to rule ethical or social considerations out of regulatory assessment for new products (Section 2.3.3).**

- The UK can boast nothing like the organisations for participatory technology assessment that operate in other European countries. **We recommend that a clear and cross-sectoral responsibility for participatory technology assessment is established by government (Section 2.3.3).** In any such public engagement process, decision-makers should be obliged to explain why they accept or reject the advice they recieve.

Stakeholders

The idea that non-scientists should be more involved in decision-making about research seems to worry many scientists and business people. They fear that public engagement will bog down scientific ingenuity and economic performance. The government, for all its talk of upstream engagement, seems to sympathise with this view. Its *Science and innovation investment framework* sees public concerns as a "brake" on progress. [2]

Although the vast majority of the public are often characterised as risk averse and morally conservative, that stereotype is rarely imposed on *all* non-scientists. Indeed, stakeholders from industry, many of them non-scientists, are already deeply involved in research and research policy, upstream, downstream and in between. Government policies highlight the crucial contribution these 'professional stakeholders' make to science and innovation – their involvement is seen as an asset to research and development (R&D) and not an impediment.

Wider public engagement cannot be confined to special 'science and society' initiatives. **Not only should public engagement play a greater part in the government's own science procurement and funding, but it should also be integrated into flagship policy initiatives to support business R&D (Section 3.2.3).** This is necessary for the sake of consistency and credibility, because we are all stakeholders in science. It is also advisable because citizens who are not professional stakeholders are a source of social intelligence and a potential asset to R&D.

Policies

Science policy and agricultural policy both bear on food and farming research. They intersect, for instance, in the work of a research institute that gains some of its funding from the research councils and some from the Department for Environment, Food and Rural Affairs (DEFRA). However, they centre on different aims and use different languages: science policy focuses on a narrowly conceived notion of wealth creation, whereas agricultural policy focuses on sustainable development.

The stress that science policy lays on the commercial returns of research spending and investment jars with sustainable development, which nominally places equal weight on economic, social and environmental objectives. Some commercially profitable technologies are environmentally damaging and socially regressive.

A concept of sustainable development is already prominent in UK policy, particularly in DEFRA, and is currently being further refined. **We recommend that the government develops a more joined-up approach to research and innovation around the theme of sustainable development (Section 3.3.3).** This would ease the conflicting pressures on publicly funded researchers and help to ensure better use of resources.

Public and private

The priority given to commerce in science policy is one of several factors behind the privatisation of research on food and farming over the past 20 years. Private spending has risen relative to public spending, in the UK and internationally, and public research institutions have been sold off. The distinction between public and private has also become increasingly blurred: public research is contracted out to private companies; public research organisations follow industry trends towards short-term staff contracts; regulatory agencies such as the Pesticides Safety Directorate (PSD) and Veterinary Medicines Directorate (VMD) are run like companies and gain income from licensing fees; and the outputs of public research are privatised through intellectual property (IP) protection.

This means less long-term research. It also makes it more difficult for public researchers and organisations to pursue the public interest, and sometimes generates conflicts of interest. In particular, there is a risk that public health will be compromised in some fields of product regulation, where regulators compete internationally for industry licence applications. **As a matter of priority we recommend that DEFRA restructures its regulatory agencies so as to ensure their financial independence from industry (Section 4.2.2).**

The government claims to address areas of 'market failure', yet official data on research spending defy comparisons between the public and private sectors. It is therefore difficult for anyone, including government decision-makers, to make informed assessments of the proportion of research in any field which is in the public interest. **We recommend that the Office of Science and Technology develops data categories which facilitate cross-departmental and public-private research comparisons (Section 4.2.1).** Furthermore, public researchers are increasingly under market pressures themselves, not least because many of the intellectual resources they rely upon are privately owned. We are concerned that IP rules, which govern the exploitation of knowledge, are currently contrary to the public interest. However, we recognise the value of regulatory incentives for knowledge creation. **We recommend that the Office of Science and Technology undertakes an international review of such incentives in order to inform UK policy (Section 4.5).** Policies governing the exploitation of intellectual resources should aim to reward collective creativity, combat the use of patents to block R&D, alleviate commercial pressures on public research, and strengthen the kinds of informal knowledge that are stewarded by rural and urban communities.

Towards a just research system

Greater public engagement is a crucial feature of a more robust research system, but it is only part of the answer. Research and research policy must meet four additional criteria in order to earn public trust. The governance of science and technology must be:

- Consistent – The double standard that gives professional stakeholders with vested interests a disproportionate influence in science must be resolved. Public engagement should be integrated into science education, technology regulation, international trade and innovation policy.

- Sustainable – Sustainable development should be the theme of a more joined-up science policy.

- Accountable – Policy advice should be transparent, independent and should open up the possibilities available to decision-makers.

- Fair – A serious restructuring of decision-making and a radical redistribution of research resources are both preconditions of a just research system.

We believe it is possible to meet these challenges. This government has both the components required: the 2004 *Spending review* demonstrated its clear commitment to research and innovation; at the same time, it has ratcheted up its policies on science and society. The time has come for the government to combine the two, to take the lead in promoting ethically robust science and technology, in the UK and internationally.

1. Introduction

1.1 Just knowledge?

The relationship between science and citizens has been severely shaken by a succession of controversies about risk regulation, new technology and public health. Food and farming research have been at the epicentre of this upheaval, in the wrangling over bovine spongiform encephalopathy (BSE), Foot and Mouth Disease (FMD), genetically modified (GM) crops and, of late, obesity.

In 2000, a House of Lords committee reported that there was a crisis of public confidence in the governance of science and technology. A consensus amongst science organisations and government officials has crystallised around the committee's view that citizens have an undiminished enthusiasm for science, but are deeply sceptical whether it is governed in the public interest. The policy response has been twofold: first, the evidence base for government decisions has been shored up with revised guidelines and processes for scientific advice; and, second, 'science and society' programmes have proliferated, intended to promote public engagement in science.

The *GM Nation?* debate of 2003 attempted to engage non-scientists in deliberating upon science and technology on an unprecedented scale. Its success has been widely questioned: not only has its methodology been criticised, but it also received from government neither the resources nor the thorough response that it warranted.[3] However, it has certainly helped to make food and farming research a central reference point for discussions of science and society across the board. The debate over GM crops was deeply divided and neither enthusiasts nor critics wish to see the same polarisation repeated over other new technologies such as nanotechnology. Part of the problem was that public engagement was left too late, facing citizens and consumers with a stark choice: did they want this technology or did they not?

A wide range of opinion is coalescing around the idea that citizens should engage in science further 'upstream', when choices remain open and research priorities are being set. Public engagement should take place during research and development (R&D), rather than near the regulatory end-of-pipe. Organisations such as the Royal Society and Greenpeace, at loggerheads over GM crops, agree on this.[4] Demos and Institute for Public Policy Research, two well-known think tanks, have also published calls for upstream engagement.[5] A recent editorial in the science journal *Nature* argues that scientists should welcome public involvement in setting priorities for research, and it emphasises that decision-makers "must explain why they choose to accept some pieces of advice and reject others".[6] The UK government has pledged to promote public engagement upstream, in its ten-year *Science and innovation investment framework.*[7]

However, the post-*GM Nation?* consensus on upstream public engagement conceals profound differences in approach. For many government agencies and science organisations, public engagement is primarily about improving dialogue between scientists and non-scientists, sensitising scientists to the concerns of non-scientists and vice-versa. The likes of Demos and Greenpeace, and the social scientists who introduced the idea of public engagement to policy makers, foresee a more radically reformed relationship between science and citizens. For them, the function of upstream engagement is "to expose to public scrutiny the assumptions, values and visions that drive science".[8] They would put questions about the purposes and framing of science and technology centre-stage in research decision-making.

The gap between these two approaches is partly down to the place they ascribe to ethics in science. The Prime Minister has asserted that:

> "Science is just knowledge. Science doesn't replace moral judgement… It allows us to do more but it doesn't tell us whether doing more is right or wrong… [W]ith scientific advance, we need greater moral fibre; better judgement; and stronger analysis of how to *use* knowledge for good not ill."[9]

If science is 'just knowledge', a neutral reflection of reality, then the proper moment for public input is when that knowledge is applied to social ends. It would follow that 'upstream' public engagement in science, prior to its application, should be about communicating science rather than changing its direction.

By contrast, proponents of more thoroughgoing upstream engagement insist that science is not 'just knowledge' in the neutral sense that the Prime Minister suggests. They argue that values and assumptions are built into the process of science and its products through the choice of research questions, through funding institutions and so on. As well as describing this ethical content they make a normative claim: it is neither fair nor in the public interest for a small minority of citizens, mainly scientists, politicians and business people, to shape values and make assumptions that affect all of us through science. According to this view, enabling the public to play a constructive part in science and science policy is a precondition of a just research system and a just society.

We intend this report to contribute to these ongoing debates about the future of science, focusing on food and farming. We explore what science would look like if it was not only technically rigorous but also ethically and socially robust. We began this chapter with the debate about public engagement both because it is the overriding theme of current policies on science and society, and because it highlights the central place of ethics in these debates about science. However, the scope of this report is broader. Our discussion centres on R&D but also touches upon the role of science in technology regulation, sustainable development and public health policy. Where we can, we talk about private as well as public sector research. We concentrate on the UK, primarily on England, with an eye to the international context and consequences of actions in this country.

1.2 Ethics and science

'Ethics' has two common meanings. It can refer to the standards and values that define what is 'good' or 'right'. It is also the term used to describe the study of those norms. In this report we study the standards, values and framing assumptions that are built into the research system for food and farming. We also make recommendations for change, based on our own assumptions about science and ethics. For the sake of clarity and credibility, it is important to explain our three main premises about ethics and science.

First, ethics is distinct from science. Science seeks to answer questions about what *is*, whereas ethics is more concerned with what *ought* to be. Science asks 'What is this and how does is work?', whilst ethics asks 'What should we do?'.[10] You cannot determine what ought to be simply from knowing what the world is like.

However, *second*, ethics and science are far from separate. Indeed, each would be nonsense without the other. Whilst ethical decisions do not simply follow from scientific knowledge about the world, we cannot decide what we ought to do without knowing about the situation we are in and how it might be changed. Equally, as Chapter 2 of this report discusses in greater detail, science is underwritten by shared standards and values such as honesty and objectivity. It is more helpful to treat ethics as a dimension of research and innovation, and as a set of questions to ask about those activities, than as a separate set of concerns.

A large body of research evidence supports this premise that science has an ethical dimension. Some of the earliest forays into science by philosophers and sociologists aimed to refine the scientific method by codifying the principles underpinning science. Most notably, Karl Popper argued that scientific knowledge advanced by deduction, rather than by making inferences from observations.[11] His best known insight was that scientific hypotheses should be 'falsifiable': however much evidence you gather in favour of an idea, you will never be able to prove it right; when you make a scientific conjecture, you should therefore identify what new pieces of evidence would prove you wrong; roughly speaking the more assassination attempts your idea survives, the more reliable we can take it to be.

Whilst Popper makes a compelling argument about the way science ought to be done, in an ideal world, detailed analyses of scientific literature and sociological observation of scientists at work have since shown that, in practice, the onward march of knowledge is less disciplined and more heavily laden with values than Popper supposed. This view that science is a social practice, deeply embedded with cultural norms and ethical assumptions, is usually associated with Thomas Kuhn, writing in 1960s.[12] Building on Kuhn's work, sociologists and anthropologists have examined in detail how scientific 'facts' are created and become standardised, they have examined how research questions are shaped, they have shown that social networks and technologies can make or break scientific projects, and they have illustrated that scientific uncertainty can increase over time rather than invariably diminish, as implied by the belief that 'the truth will out' through science.[13] This body of work does not deny the contribution of science to society, today or through history, but it challenges the common assumption that scientific progress charts a smooth trajectory, tending both towards a one-to-one depiction of reality and towards social consensus. Social norms and values do not only affect what we know about and when – in other words the rate of scientific progress – but also shape the very ways we come understand the world.

Our *third* premise is that the ethical dimension of research is not always plain to see. Indeed, sometimes the ethical content of science is emphatically denied. In particular, the rigour of the scientific method is sometimes mistakenly assumed to expel ethical values and social assumptions from scientific knowledge. But, just because scientific knowledge is relatively reliable – in contrast to an uncorroborated news report, for instance, we might be able to repeat a scientific experiment and get the same result – the ethical and social factors that shape research questions, that steer science funding or that inform accepted benchmarks for statistical significance do not diminish in importance.

Hardly anyone nowadays, least of all a practising scientist, would consistently claim that science is separate from ethics or free from value assumptions. Bestselling accounts of scientific discovery have made this view difficult to maintain. As James Watson puts it in *The double-helix*, his first-hand account of the discovery of the double-helical structure of DNA, "Science seldom proceeds in the straightforward logical manner imagined by outsiders".[14] Nevertheless, social scientists have described how more flexible claims that science is free from values and separate from ethics are used by scientists, politicians and business people to manage their responsibilities for science in society. In effect, a line is drawn between science and ethics when it suits, for example in defending the expertise of scientists compared with 'lay people', but erased at other times, as in discussions of funding pressures on scientists. The result is that responsibility is "flexibly embraced and abrogated", supporting the expert roles that scientists play in "guiding education and government policy, whilst at the same time deflecting ultimate responsibility for the use of knowledge on to an abstract and amorphous society".[15] Sociologists of science call this strategic behaviour 'boundary work'.[16]

Once we recognise that science has an ethical dimension, it no longer makes sense to think of robust science as being free from values.[17] Insisting that ethics is separate from science simply shields the framing assumptions of scientists and decision-makers from scrutiny by other scientists and citizens. It does not eliminate that ethical content.

The upshot of our three premises is that science, as well as representing the nature of things, often says something about society and the way things ought to be. Sometimes this social and ethical content will be entirely trivial, if the implicit assumptions are very widely shared, but as often as not, scientists and other experts will frame problems in different terms from other people. That distinctiveness can be a great benefit but it can also become a weakness if those expert assumptions are left undisclosed. Assumptions about 'human nature' and behaviour, or about realistic political and economic scenarios, inform the choice of research questions, analysis and the presentation of results. They are built into research institutions and technologies, and also reproduced by them. This social and ethical content is a routine component of science rather than an aberration. Indeed, without it scientific knowledge would be meaningless.

1.3 Our approach

The way we have framed ethics and science puts us closer to the social scientists and campaign organisations who argue for thoroughgoing public engagement than to the government's more conservative approach. However, we do not leap straight from our premises to the same conclusions as these other commentators. This final section of the introduction explains our analytical approach and describes why we are convinced these abstract debates about the ethics of science matter to the future of food and farming.

The research system is so vast and varied, its outcomes so diffuse, and the lag between investment and results so long, that an aggregate ethical assessment of food and farming research would be of limited value, even if it were feasible. Instead, this report asks how the processes for producing scientific knowledge could be made ethically robust. We suggest how different aspects of food and farming research might be improved and we name the institutions we think should be responsible for taking the initiative. However, our priority is to raise constructive questions about the way research is done and we do not pretend to have all the answers.

We have already described how science contains assumptions about society and social values. Our main criterion for an ethically robust research system is that these assumptions should be open to social scrutiny. Just as Popper exhorted scientists to expose their technical and empirical claims to challenges by others, so should the value assumptions science makes on behalf of society be exposed to question. The mechanisms for technical and social scrutiny cannot be exactly the same: by definition you cannot simply 'falsify' life's great unanswerables; equally, social research can rarely be repeated in the same way as experimental science. So, whilst it might be useful to have social scientists or philosophers cross-examine scientific claims (which is, in a sense, what Popper, Kuhn and others have done), that does not resolve the problem. Another difference between the social and the natural sciences suggests a way out of this fix. Unlike atoms, ecosystems and the other phenomena studied by natural scientists, people can answer back without the help of researchers and experimental instruments. By opening science to scrutiny in the public sphere – through publication, through political institutions and through public engagement processes that bridge politics and social science – the tacit social and ethical claims built into science can be identified and challenged with evidence or argument.[18] Sometimes these claims will be trivial, often they will be contentious and occasionally they will be demonstrably wrong.

We believe that science and technology would be more robust if there was greater scope, both within the research system and in the public sphere, to question and challenge their in-built values and assumptions. In an ethically robust research system, the ethical assumptions and values of science and scientists should be explicitly acknowledged. The information and resources to debate and revise that ethical content should be readily available and fairly distributed. In the ensuing chapters, we therefore focus on three questions:

- What are the key standards and values that are explicit and implicit in research of food and farming?
- Are these norms rational and consistent with one another?
- How and by whom can this ethical content be scrutinised, challenged and revised?

This approach sets us apart from ethics committees set up to 'do the ethics' of science, on behalf of scientists and society. As we describe in Section 2.3.2, a booming bioethics industry has sprung up to help governments, research organisations and companies manage public concerns about science and technology. However, these bodies often close down ethical debate rather than open it up.[19] There is no harm in expert philosophers and social scientists advising scientists and decision-makers, so long as their learned pronouncements do not substitute for wider public scrutiny.

In contrast to many such ethics committees, we focus in this report on processes and mechanisms that would help to make science ethically robust. We emphasise public scrutiny because the ethical assumptions built into science are also assumptions about society, about social values and about what people take to be right and wrong. We elaborate on the relationship between social and ethical issues in Section 2.3.3. We focus on processes because the outcomes of science and social science are uncertain, and we realise that we do not have all the solutions any more than the government, scientists or ethics committees do.

However, we recognise there are practical limits to the extent people who are not professionally involved in science can routinely take part in it. Also, just because we focus on processes it does not mean we think 'anything goes' or that throwing open the gates of science will make ethical dilemmas disappear. On the contrary, our motivation for writing this report is to help scientists and policy makers to build a research system that satisfies three key ethical principles: that maximises the benefits of science and technology to society and the environment, and minimises their harmful side-effects; that enhances people's autonomy and freedom of choice; and that is as just and fair as possible.

Our previous reports have shown that research on food and farming is a long way from this goal. For example:

- Science and technology are not, for the most part, oriented towards addressing the greatest social and environmental challenges in food and farming. In particular, the research system puts profit and productivity, in a narrow sense, before hunger alleviation. Yet around 840 million people in the world are severely malnourished, and many more survive on diets that may be technically adequate but are very poor by UK standards.[20] Although new technology is not *necessary* to eliminate hunger or malnutrition, according the United Nations (UN) Food and Agriculture Organisation,[21] much research that could help goes un- or under-funded.[22]

- Meanwhile, heavy investment is directed towards science and technology that demonstrably harms people, animals or the environment. For instance, recombinant bovine somatotrophin, a synthetic hormone used in the USA to boost milk production, is banned in the European Union (EU) because it was found to harm cows.[23]

- Food processing technologies have enabled manufacturers to create an expanding array of differentiated products from a narrow range of ingredients, notably fats, sugars and salt. The choice of products available to consumers has increased but, as the availability of and information about other foods has declined by comparison, consumers' dietary self-determination has diminished.[24] This trend has been implicated in the global 'epidemic' of diet-related disease.[25]

- Key rule-making processes that shape farming and food research are unfair. For example, low-income countries and marginal rural communities were poorly represented during negotiations to create international rules on intellectual property, which affect how different kinds of knowledge are valued and who benefits from their exploitation.[26]

The report has five chapters, including this introduction. Chapter 2 compares the standards and values associated with different *activities* within the research system. Chapter 3 highlights the main *organisations* involved in UK food and farming research, and examines the personnel and policy themes that connect them. Chapter 4 explores how the financial, social, natural and intellectual *resources* for research are distributed, particularly between the state and private companies, in the UK and internationally. The conclusion draws together our argument and recommendations.

We are very grateful for the assistance we received from a Review Panel in writing this report. The panel members do not necessarily endorse the report. In the spirit of opening up debate, we have included short commentaries from the panel members immediately after the concluding chapter.

2. Activities

2.1 Science and technology

All of us are affected by research on food and farming indirectly, through the food we eat. Our food may have been produced using novel techniques or products, and its safety may have been assessed by expert regulators. Research, innovation and regulation are distinct activities, in as much as you can do one without doing the others. For example, people were creating new technologies thousands of years before science emerged in any form we would recognise today. Farmers in rich and poor countries continue to develop new crop varieties, machines and management techniques independently of formal scientific institutions.

Often, however, these three activities are closely linked. Commercial innovation in the food and farming sectors depends heavily on science-based R&D. Food safety regulation intended to prevent the spread of food-borne diseases relies on risk assessments by scientists. Research, innovation and regulation meet in procedures for licensing new products, which are mandatory for certain classes of technology. The products have been created through science-based innovation, their safety is assessed using scientific evidence, and the regulatory process sends signals back through the research system about the likely market for particular kinds of technology.

Government policies on science and innovation hinge on this idea that research, technology production and regulation are thoroughly interconnected. Innovation is characterised as a non-linear process, involving many iterations between scientists, business people and other actors. For example, the government-commissioned *Lambert review of business-university collaboration* states that:

> "Innovation processes are complex and non-linear. It is not simply a question of researchers coming up with clever ideas which are passed down a production line to commercial engineers and marketing experts who turn them into winning products. Great ideas emerge out of all kinds of feedback loops, development activities and sheer chance."[27]

Science policy does not only recognise the interplay between research, technology and commerce, but promotes initiatives, such as the LINK and Faraday partnership schemes, designed explicitly to promote this cross-over.[28]

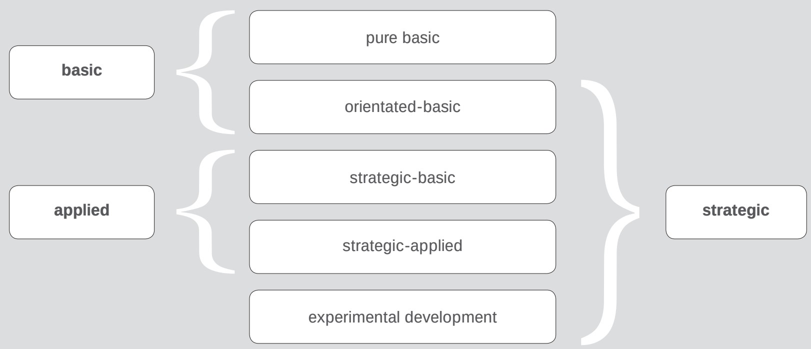
A White Paper on science and innovation published by the Department of Trade and Industry (DTI) explains that consumers also play a "vital role" in innovation:

> "Consumers do not stand at the end of the scientific pipeline passively waiting to consume new products. They are agents in the process of innovation. Innovations only succeed when they are taken up by consumers, who in the process of using a new product often discover or even create uses for it that the original inventors never deemed possible."[29]

The DTI may be overstating its case, in as much as the primary 'consumers' of many new technologies – probably most new farming and food technologies – are businesses. However, its basic point is correct: not only is research enmeshed with other processes during technology production, but the production of a technology is also connected with its use. It follows that the regulatory assessment of new technologies, which might otherwise be imagined to happen somewhere between production and use, must also be intertwined with research and innovation. For instance, trials of a new veterinary drug take place once the product has been initially formulated; depending on the findings, the results of this research may be used to improve the product or they may be submitted to regulators in support of a licence application to market the drug.

The complex picture of research, technology and regulation painted in government innovation policy seems common sense, and a large body of work studying science and innovation backs up the view that these three activities are often inextricably linked.[30] However, in other areas of policy the use and the application of knowledge are treated as fundamentally separate. The official classifications of R&D used to demarcate and measure public spending distinguish between 'basic' and 'applied' research (Figure 2.1). The definitions of these terms used in government recognise that in practice there is no clear-cut boundary between basic and applied research – the distinction is a matter of emphasis. For example, research following the FMD outbreak both posed basic questions about the modelling of epidemic diseases and will also inform public policy.[31] Yet, the implication of both terms is that any process of scientific investigation, whether or not it is use-orientated, is separate from the process of applying the scientific knowledge produced by that investigation.

Figure 2.1
Classifying research.[a]



The Office of Science and Technology defines these categories as follows:

"Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application in view;

"Applied research is also original investigation undertaken to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective; and

"Experimental development is systematic work…that is directed to producing new materials, products or devices…"

In principle, the state only funds basic research. It also procures applied research and experimental development, to assist in delivering public services. Applied research that is 'near-market' is supposed to be left to the private sector.

Official discussions of science in society make clear that this research-application divide has ethical implications. In Section 1.1 we quoted the Prime Minister, speaking to the Royal Society, saying that ethical issues arose when scientific knowledge was put to use, and implying that they did not arise in science as such.[32] Similarly, a major government consultation, published in March 2004, envisaged a future in which "the public is confident about participating in decision-making involving the *use* of science – and confident about the resulting decisions".[33] The claim that science is separate from its social uses is invoked to back up arguments that ethical debate and public engagement concern the application of scientific knowledge but not the processes by which it produced.

Although the Prime Minister may be right to suggest that science *should* not substitute for moral judgement, he is mistaken to claim that it *does* not. As we outlined in Section 1.2, science has an ethical dimension, and if the implicit values and assumptions of science pass without scrutiny, then they do substitute for reasoned moral judgement. Treating science as if it were free from values makes it more likely for this to happen.

[a] Based on: **OST** (2003) *SET statistics*. Accessed on-line: http://www.ost.gov.uk/setstats/index.htm, 20/02/04.

However, the Prime Minister is hardly alone in thinking that research and its applications are separate. Not only is this assumption built into the official system for classifying research, but it also shapes the institutions that exist for handling ethical issues in science, innovation and regulation, within government and beyond. Conventions and procedures exist for tackling some of the ethical issues that arise in food and farming research, yet they focus on the good conduct of the research. Like the Prime Minister, they assume that the immediate products of scientific research are ethically neutral until they are applied. But when it comes to product assessment, the logical moment to address ethical issues that have been neglected during research, regulatory bodies are denied the capacity to do so.

This chapter examines in more detail the different ways that ethical issues are handled in research and product assessment, and suggests how a more consistent and robust approach to the ethics of research, innovation and regulation might be developed.

2.2 Research ethics

2.2.1 An ethic of honesty

Scientific knowledge is never 100 percent certain – even the hardest facts and theories are revised as scientists find new ways of describing and explaining phenomena. Yet there are big differences between science and other kinds of knowledge, such as those we might pick up from a news article or an advertisement. On a specific occasion, each might be accurate and the information in question may even be the same. One of the main differences between them lies in the particular standards of truth that are shared by scientists.

Ever since a community of scientists first emerged, they have followed conventions to ensure their claims about the world meet agreed standards. In the infancy of modern science, these were more akin to trial by jury than to science as we know it.[34] Nowadays, conventions on statistical significance and concepts such as ‘falsification’ (Section 1.2) set shared standards, whilst the process of peer review plays an important part in upholding them and in reinforcing the communal identity of scientists. Of course, claims that meet these standards are not necessarily correct. Indeed, they may well be proved wrong by additional evidence. However, they are *scientific.*

Even the most elaborate quality assurance process could not guarantee that all research met the standards expected of ‘good science’. In practice, resource constraints mean that it is impossible for experiments to be routinely repeated by multiple research groups, the quality of peer review varies, and privacy laws or commercial concerns may restrict the publication of data, limiting external scrutiny. So, as well as quality assurance, science also depends on an ethic of honesty. The importance of honesty is highlighted by the exceptions when scientists have stretched or broken the trust placed in them by their colleagues and by society, making claims that have appeared to meet conventional standards of rigour but have turned out to be a sham on further investigation.[35]

Whilst honesty forms the ethical backbone of science, it is not the only value that plays an explicit part in present-day scientific research. The Second World War threw ethical concerns about the independence of science and about research on people into stark relief. Post-war, as evidence emerged of systematic human experimentation at Auschwitz and as allied scientists reflected on their own involvement in creating the atomic bomb, formal guidance on research ethics proliferated. By the late 1970s, around half the respondents to a survey of US science and engineering societies were governed by some kind of ethical code.[36]

2.2.2 Codes and guidelines

Rules and guidance on research ethics fall into three main categories. First, many professional bodies issue guidelines on ethics to which members must adhere. Professions ranging from fine art to software development are governed by codes of ethics and scientists are no exception. Members of the UK Nutrition Society, for instance, must sign up to nine professional standards. Table 2.1 lists other professional bodies with ethical codes that are relevant to food and farming research. In general, these codes concern the relationships of researchers to each other, to research subjects, to students and to the public at large. They include issues ranging from honesty and confidentiality to public education.

Table 2.1

Professional ethics: examples of professional bodies with guidelines relevant to food and farming research.

Organisation	Title of guidelines	No. of members
The UK Nutrition Society **www.nutritionsociety.org.uk**	Code of Ethics: Professional Conduct for Registered Nutritionists	
British Dietetic Association **www.bda.uk.com**	Best Practice Code including ethical guidelines	5,000+
Institute of Food Science and Technology **www.ifst.org**	Ethical Practices and Professional Conduct	
British Sociological Association **www.britsoc.co.uk**	Statement of Ethical Practice	2,500
Institute of Agricultural Engineers **www.iagre.org**	Code and Rules of Professional Conduct	2,000+
Institute of Biology **www.iob.org**	Royal Charter refers to professional integrity	14,000+
British Institute of Agricultural Consultants **www.biac.co.uk**	Code of Professional Conduct of the Institute	
Association of Independent Crop Consultants **www.aicc.org.uk**	Code of Conduct	175

Second, legal or institutional requirements exist that cut across different professions, but relate to particular research activities. There are numerous requirements relating to research on human subjects, which might include anything from obesity research to product taste tests (Table 2.2). Some principles, such as informed consent or the protection of privacy, apply in general. Other requirements relate to research involving particular categories of people, such as pregnant women or prison inmates.

Apart from research on people, the other major area of subject-specific ethical governance is animal experimentation. Research on animals is relevant to farming and food in at least two ways. On the one hand, animals are farmed for meat, milk and other products. Scientists conduct research to increase productivity and change product quality, and they also study the health and welfare of farm animals. On the other hand, animals are sometimes substituted for people in safety tests on foods for human consumption. Animal research comes under the Animals (Scientific Procedures) Act 1986, as well as being the focus of numerous other guidelines. Whether these rules suffice is a topic of heated and sometimes violent disagreement.

A third set of ethical standards and procedures relates to the institutional context of the research: where is it happening, what is its purpose and who is paying for it? Many research organisations, including universities, hospitals and companies, now have independent ethics committees that must approve particular categories of research project. There is government guidance on the structure and function of such committees.[37] Research for particular purposes, such as regulatory risk assessment, can be subject to special conditions. For instance, the Food Standards Agency *Guidelines on the use of human studies in pre-market safety assessment for novel foods* stipulate a number of requirements, including approval by an independent ethics committee. Organisations that pay for research on food and farming, ranging from the Biotechnology and Biological Sciences Research Council (BBSRC) to the European Commission, also issue ethical guidelines or requirements.

Table 2.2

Research on people: rules and guidelines.

Rules		
Title	**Coverage**	**Applies to**
UK Government Data Protection Act of 1998	The protection of information given by an individual to the data handler. It deals with the proper treatment of personal data and sensitive data, including: • Confidentiality. • Storage. • Use. • Destruction. Originally drafted in 1984, the 1998 revised Act covers data stored in manual files as well as computerised data.	Anyone who collects, handles, processes, or transmits data in the UK. It is enforced by the independent Information Commissioner.
Council of Europe, Committee of Ministers Recommendation R (90) 3 Concerning Medical Research on Human Beings	Sixteen principles concerning medical research on human beings, covering: • Informed consent. • Well-being of the participant. • Assessment of risks and benefits, and communication of these to the participant. • Performing research on legally incapacitated people, pregnant women, and those deprived of liberty. • Confidentiality.	All medical research within member states.
World Medical Association (WMA) Declaration of Helsinki Ethical Principles for Medical Research Involving Human Subjects 1964	Thirty-two guidelines covering: • The assessment of benefits and risks. • Adequately informing the subject on the aims of the research. • Obtaining consent from the individual or legally authorised other. • Confidentiality. • Respecting a participant's autonomy. • Protection of vulnerable participants. • Attention to animal welfare (where animals are used in medical research).	Physicians and researchers of WMA member states. All research proposals must highlight ethical considerations and indicate compliance with this document.
Guidelines		
Title	**Coverage**	**Applies to**
The Belmont Report Ethical Principles and Guidelines for the Protection of Human Subjects of Research	Three fundamental principles which should be adhered to when performing research involving human beings: • Respect for persons (including informed consent). • Beneficence (well-being of patients is the priority) • Justice (selection of subjects must be fair and not based on convenience).	Intended to guide researchers' and subjects' understanding of ethical issues in research on human subjects, and to provide a framework for resolving ethical issues if they arise.
Council for International Organisations of Medical Sciences (in collaboration with the WHO) International Guidelines for Biomedical Research Involving Human Subjects	Twenty-one guidelines for researchers dealing with human subjects, covering: • Ethical review, ethical justification and scientific validity of research. • Informed consent. • Vulnerable individuals or groups (e.g. children). • Women as research participants. • Confidentiality. Also includes ethical principles from Belmont Report (above).	Anyone undertaking research on human subjects. They are particularly intended to be of use to guide ethical policy in low resource countries.

Research ethics, as it is understood in guidelines such as these, relates primarily to the conduct of the research process. Only in exceptional circumstances do guidelines consider the social consequences of research. For instance, the latest European funding round, Framework Programme 6, requires that:

> "The principle of sustainable development, socio-economic, ethical and wider cultural aspects of the envisaged activities, and gender equality, will be duly taken into account, where relevant for the activity concerned."[38]

Generally, however, only the direct consequences of research are considered, and they are addressed in guidance on risk assessment and not on research ethics.

In other words, research ethics is primarily concerned with the duties, rights and responsibilities associated with doing research, not with its wider social costs and benefits. A great deal of weight is also placed on the 'virtues' that make a good scientist, notably truthfulness.

This emphasis is apparent in guidance on the ethics of publication, one of the most usual outputs from research. For example, the BBSRC's *Statement on safeguarding good scientific practice* advises:

> "At the heart of all scientific endeavour, regardless of discipline or institution, is the need for scientists to be honest in respect of their own actions in scientific research and in their responses to the actions of other scientists. This applies to the whole range of scientific work, including experimental design, generating and analysing data, publishing results, and acknowledging the direct and indirect contributions of colleagues."[39]

The BBSRC's guidelines focus on the honest conduct of scientists in publishing their findings, rather than on the likely outcomes of publication. The guidelines do not suggest how scientists might weigh up the risks and benefits publication might bring to them and their colleagues, to their employers, to their sponsors and to the public. In practice, these kinds of evaluative judgement inevitably take place and are encouraged by the UK's current research assessment process, which uses data on publications to allocate funding to research departments. However, they are rarely codified in guidance on research ethics and therefore remain unduly insulated from critical reflection and scrutiny (Box 2.1).

Box 2.1

Dilemmas of publication.

Purposes: why publish?

In principle, there are two reasons for publishing scientific research. First, it makes new knowledge available so others can scrutinise or use it. Second, publication is a way for scientists to stake their claim to a new idea. Many academics are concerned at the way changing reward systems for research are shifting the purposes of publication, and changing the quality and quantity of published output. In the UK, funding allocations to university departments are now based partly on journal publication rates. This places pressure on research staff to publish short pieces of research frequently in designated outlets. It discriminates against the publication of monographs or user-oriented 'grey literature'.

Confidentiality: what can be published?

The imperative to 'publish or perish' is in tension with another pressure, to keep knowledge secret. A considerable proportion of commercial research remains confidential, whether it is conducted within companies or commissioned from tenured university scientists. Confidentiality and intellectual property agreements vary. However, they may require an academic to clear a journal article with his or her sponsor before submitting it, to delay publication until a patent has been filed or a product developed, or not to publish at all. By contrast open access publication licences, such as the one that applies to this report, allow very wide dissemination whilst reserving some rights.

Disclosure: how much background to publish?

Since the 1990s, concerns about authors' conflicts of interest have led some scientific journals to require financial disclosure statements.[a] The worry is that past industry employment or sponsorship may compromise a scientist's critical independence. Many researchers feel their independence is immune to such influences. However, statistical analyses have found strong correlations between industry sponsorship and reported findings.[b] Such journals as the Journal of Nutrition, The Lancet, the Journal of the American Dietetic Association and the British Medical Journal have disclosure policies, though they remain in the minority. There are also concerns about disclosure in mass media reporting on science.[c]

Peer review: what should be published?

Peer review is the process by which scientific papers are assessed for competence, significance and originality prior to publication in some scientific journals.[d] It is a form of quality control that many scientists regard as integral to their research. Some scientists have argued that public ignorance of the peer review process compromises the ability of non-scientists to discriminate between good and bad research, contributing to public controversies.[e] However, critics have noted that industry-sponsored referees may be a source of bias and have argued that the scientific establishment only tends to criticise non-peer reviewed research when it 'rocks the boat'.[f]

This focus on the individual conduct of research, as opposed to its social outcomes, is also evident in statements about the ethics of research in product assessment, such as the FSA guidelines on novel foods mentioned above. The guidelines focus on the conduct of the tests. They do not address ethical issues that might arise from the technology itself. Yet, as government policy on innovation highlights, product testing is an integral part of innovation and product development (Section 2.1).

[a] **Nestle, M.** (2002) *Food politics: how the food industry influences nutrition and health*. Univeristy of California Press, London.

[b] **van Kolfschooten, F.** (2002) Can you believe what you read? *Nature* 416: 360-363.

[c] **Center for Science in the Public Interest** (2004) Readers consider the source, but media don't always give it. *Press release*, July 7.

[d] **Sense About Science** (2004) *Peer review and the acceptance of new scientific ideas*. Sense About Science, London, May.

[e] **Sense About Science** (2004), see note d.

[f] **Matthews, J.** (2004) *Discussion on Sense about Science report*. Accessed on-line: http://www.gmwatch.org, 08/07/04. **van Kolfschooten, F.** (2002) Can you believe what you read? *Nature* 416: 360-363.

There are several possible explanations of why guidance on research ethics focuses on the conduct of research and not on its consequences. First of all, ethical approaches centred on duty and virtue lend themselves to guidance that is aimed at individual scientists, rather than at research communities. Second, the outcomes of research are inherently unpredictable, suggesting that a consequentialist approach to research ethics might compromise scientific objectivity.[40] Third, as described in Section 2.1, it is often assumed that the immediate outcomes of research are ethically neutral, and that the issues arising from their 'application' will be addressed by others, downstream.

2.2.3 Scientists in society

Existing codes and guidelines ensure that ethical issues around the conduct of scientists are routinely addressed. Yet the concerns covered by such guidelines are only a subset of the ethical issues that arise in research. They treat research as if it were an insular activity, more or less independent of its wider social context. Our vision is for a research culture that encourages scientists to reflect on the social implications of their work, and enlists the help of other citizens to do so.

One route towards this goal is for scientific research teams to recruit ethicists or social scientists to assist them. For example, the nanoscience laboratory at Cambridge University has employed a social scientist to help them reflect, in real-time, upon the social implications of their work.[41] Part of this person's role is to enable communication between scientists, social scientists and civil society organisations.

Projects in which large numbers of non-scientists play a major role in data-gathering or analysis present another opportunity for social reflection. Examples of mass participation research range from surveys like the *Big bug count*, undertaken by the Royal Society for the Protection of Birds, to the University of California at Berkeley's *SETI@home* project, which taps the power of people's home computers to analyse radio telescope data.[42] DEFRA recognises this trend in a recent consultation paper on its science needs.[43] This genre of research is also seen as a success story in communicating science to non-scientists.[44] But, beyond that, mass participation research has the potential to stimulate scientists to think through the value and meaning of their work to society at large.

The scope of existing guidance on research ethics looks increasingly narrow when it is seen against the changing place of science in society. The European Commission's social and ethical requirements for projects funded under Framework Programme 6 are exceptional for prompting scientists to think about the wider implications of their work. But even these guidelines have been criticised for treating ethical issues as secondary considerations, which can be addressed by funding applicants once their project proposals have passed the first stage of approval. We have mentioned two other means of encouraging greater social reflection amongst scientists, but it would probably not be appropriate for every project to have an in-house social scientist or to involve mass participation. Yet it is essential that scientists deliberate on the social consequences of their work. The question, then, is how can active research scientists realistically be encouraged to deliberate on the social implications of their work as a matter of course, before, after and during any project?

One approach is for professional bodies and other organisations that already issue ethical guidance to lead in stimulating scientists to deliberate on the social implications of their work. They could extend the focal range of existing codes of conduct to cover scientists' relationships with society at large, in addition to their immediate interactions with their research subjects and colleagues.

The reality is that scientists will only be able to engage in broader deliberation and reflection if they are afforded the resources and the time to do so. Organisations which disburse funding as well as advice should reward applicants who discuss the social context of their research and propose credible methods of ensuring ongoing social reflection. 'Carrots' are more likely to be effective than 'sticks' because stronger ethical requirements for funding are likely to be resented by applicants or treated as a box-ticking exercise.

It is difficult for scientists who have been brought up with the notion that science is free from values to appreciate the purpose of reflecting on the broader social context of their work. It is therefore important to encourage young people who will become scientists, and those who will not, to reflect on the social and ethical implications of science. A recent survey has detected a demand for a more reflective approach to science education amongst girls and women, including those who are keen become scientists.[45] Guidelines and requirements relating to ethical issues already exist in school and university science education. For example, A-level examining boards now give credit to Biology students who demonstrate an understanding of *Spiritual, Moral, Ethical, Social, Cultural and Other Issues* (SMESCI).[46] The Quality Assurance Agency for Higher Education benchmarks state that bioscience undergraduates:

> "should expect to be confronted by some of the scientific, moral and ethical questions raised by their study discipline, to consider viewpoints other than their own, and to engage in critical assessment and intellectual argument."[47]

We suggest that this aspect of science education should be treated as a high priority.[48] **Now that ethical and social objectives feature in science curricula, we recommend that science teachers in schools and universities are given the support, training and resources that they need to achieve them.**

2.3 Governing technology

2.3.1 Product assessment

Some new products based on food and farming research undergo regulatory assessment. One might expect regulatory assessment to have a well-developed ethical component: first, 'assessment' means 'evaluation' implying that all kinds of assessment, however technical, entail value judgements; second, when the Prime Minister and others within government insist that the production and use of knowledge are separate activities, they emphasise the need for moral judgement about the application of scientific knowledge (Section 2.1). Yet, for the most part, regulatory assessment has deliberately excluded any explicit evaluation of ethical issues, focusing instead on technical estimates of the risks associated with new products. Recent years have seen broader social assessments of new technology but these have been *ad hoc*, taking place outside of the statutory process of regulation.

For many types of new product there is no process of government assessment at all. Evaluation takes place formally or informally during innovation, commercialisation and use. An example of a technology that is not subject to regulatory assessment would be a new farm management software package.

The main reason that the state gets involved in product assessment is to license for sale innovations that consumers may be unable to evaluate accurately. For instance, the positive or negative effects of a technology may be so subtle as to be imperceptible to individual users. In food and farming, the classes of technology which are assessed by state regulators include pesticides, novel foods, GM crops and veterinary drugs. These forms of product assessment originate in rules on trading standards, intended to prevent cost-cutting but potentially harmful food adulteration by merchants during the nineteenth century.

Regulators receive advice from a network of scientific committees (Figure 2.2). Where regulatory assessment is mandatory, a precondition of licensing, regulators generally evaluate only the safety, quality and efficacy of new technologies. 'Safety' is assessed in terms of risk, or probability of harm, and is usually conceived in a medical or ecological sense. 'Quality' means manufacturing quality; for instance, can the product be produced to a consistent standard? Depending on the type of technology, 'efficacy' can be assessed just against the manufacturer's claims for their product or also against general standards on product performance.

Figure 2.2
Scientific advisory committees relating to food and agriculture.

Note: The lines of advice and responsibility amongst these bodies are complex and sometimes confused.

The boundaries of safety, quality and efficacy are vigorously policed. In principle, each of these terms might be open to more expansive interpretations than those actually used. In particular, safety could take into consideration questions of economic or social harm – does a new technology put farmers out of work or jeopardise reforms to agricultural policy? In the 1980s and 1990s, a broad-based campaign pressed for a socio-economic and ethical 'fourth hurdle', which would address such issues, to be added to regulatory assessment. It was repeatedly rebutted.[49] At the time, the UK Ministry of Agriculture, Fisheries and Food (MAFF) explained:

> "The main difficulty with socio-economic assessments is that they are essentially speculative and to a large extent dependent on political considerations as to what may or may not be a desirable form of social and economic development… [A] different group of assessors might well reach quite different conclusions… This degree of uncertainty… would likely discourage innovation and force innovators to move to countries with a more predictable regulatory regime. This would in turn reduce our competitiveness and limit consumer choice… Fourth hurdle issues lack precision, are often highly subjective and can in some cases be better left to the marketplace to determine. They are thus very different from the technical assessments already required by regulation."[50]

This logic for excluding broader social, economic and ethical concerns from regulatory assessments still prevails. It rests on four questionable claims:

- First, it assumes that the consumers of technology (be they farmers, food firms or people eating food) are capable of making informed and reasoned judgements about the economic and social implications of their choices. However, the effect on profitability of some new farming technologies is so marginal that it can only be made evident by statistical analysis of many farms over multiple seasons.[51] Excluding social and ethical concerns from product regulation overstates the actual autonomy of consumers in the marketplace.

- Other unregulated effects may be aggregate, rather than individual, and they may affect citizens who are not the consumers or immediate stakeholders of a technology. Thus, it is normal for new agricultural technologies that increase productive efficiency to reduce the total number of farmers, which affects the overall character of the countryside and the rural economy. This 'technological treadmill' is now widely accepted to exist, but it is assumed to be a concern for agricultural policy, not for regulatory assessment.[52] So, second, the logic for excluding a fourth hurdle assumes a social consensus in favour of undiscerning technological change, a consensus which has been absent since the first protests against nuclear power, if indeed it has ever existed.[53] The argument against this assumption is not that the social impacts of technology are always unwelcome or that social conservatism should determine regulatory decisions, but that the social consequences of new products should be openly deliberated upon by regulators and should not automatically be ruled out of their remit.

- Third, the argument for keeping out a fourth hurdle assumes that risk-based assessment is qualitatively more objective than other forms of product appraisal. MAFF's explanation implies that the outcome of risk-based assessments is independent of the assessors involved. The experience of products such as recombinant bovine somatotrophin, a milk production boosting hormone over which regulatory opinion was sharply divided, shows this not to be the case. Indeed, as a UN expert consultation has confirmed, the very process of risk analysis, let alone regulatory risk management, relies on subjective assumptions about what is known and unknown, and about the social significance of particular kinds of harm.[54] This is not to suggest that risk analysis is useless. On the contrary, product assessment depends on a sound analysis of risk. But it does undermine the notion that risk assessment is an entirely different ball game from fourth hurdle approaches to technology evaluation.

- Fourth, regulation is treated as an obstacle to commercial innovation. In practice, however, regulation can have an incentive effect, as the government highlights in its innovation policy – regulation creates a social necessity, which can in turn breed invention.[55] Product regulation appears most restrictive from the perspective of manufacturers with a narrow and inflexible R&D capacity. The fact that government appears to share the same view in this context suggests policy capture by the larger, more inert and more conservative companies within the food and agricultural sectors.[56] A fourth hurdle could stimulate research and innovation in smaller competing firms.

So, on the one hand, the state undertakes a narrow regulatory assessment for particular classes of technology on behalf of consumers. On the other hand, when the state *is* the consumer, it undertakes a broader assessment, focusing on value for money. For instance, the UK National Institute for Clinical Excellence (NICE) evaluates whether new health treatments should be subsidised and made available on the National Health Service (Box 2.2). As if to emphasise that this is the exception which proves the narrowness of product licensing, the only current use of the term 'fourth hurdle' is by pharmaceutical industry insiders, who use it refer to NICE cost-effectiveness criteria.[57]

Box 2.2
NICE assessment of an obesity treatment.

The National Institute for Clinical Excellence (NICE) is a branch of the National Health Service that makes recommendations on medical treatments based on the available evidence.[a] It assesses the value for money afforded by treatments by estimating the 'quality adjusted life years' (QALYs) they promise to patients.

An assessment report for the use of Sibutramine, a drug for the treatment of obesity, shows that the drug significantly affects weight loss and weight maintenance. The cost per QALY gained, based on the manufacturer's original price for the drug (£28 per 28 tablets of 10mg) was £7,900. When the manufacturer raised the price of the drug to £35 per 28 tablets of 10mg, the cost per QALY gained rose by about 30% to £10,500.[b]

NICE recommends the prescription of Sibutramine "only for people who have made previous serious attempts to lose weight by diet, exercise and/or other behavioural modifications".[c]

[a] **NICE** (2004) *About NICE*. Accessed on-line: http://www.nice.org.uk/page.aspx?o=aboutnice, 10/08/04.

[b] **Fischer, A. J.** (2001) *Appraisal of the assessment of Sibutramine for obesity: a note*. NICE, London.

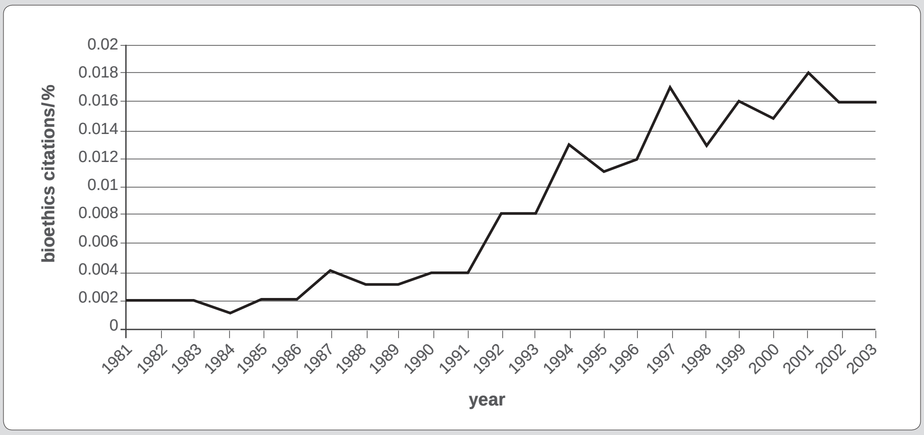
[c] **NICE** (2001) *Guidance on the use of Sibutramine for the treatment of obesity in adults*. NICE, London, October.

2.3.2 Technology assessment

It is against this backdrop that the recent explosion of public concern about the governance of new technologies, particularly genetic technologies for food and agriculture, has prompted policy makers to think again about the ethics of new technology. Numerous new bodies have been established in the UK and across Europe to examine public concerns about technology and to issue authoritative assessments of the ethical issues.[58] Bioethics has boomed to service this demand, prompting concerns that the discipline's critical independence is being eroded (Figure 2.3).[59]

Figure 2.3

Bioethics citations: academic papers about bioethics as a percentage of all papers on the ISI Web of Science database, 1980-2003.[60d]



Note: The total number of papers increased from 780,382 in 1981 to 1,289,230 in 2003

The UK government has also been developing institutions for technology assessment (TA). TA is broader in scope than risk-based licensing regulations, and it generally focuses on a field of technology rather than a specific product. To date, the nearest equivalents to public interest TA bodies in this country are:

- The National Institute for Clinical Excellence (NICE), discussed in Section 2.3.1, which assesses the value-for-money of medical technologies on behalf the National Health Service.

- The Parliamentary Office of Science and Technology (POST), which analyses policy issues around science and technology on behalf of both Houses of Parliament.

- The Agriculture and Environment Biotechnology Commission (AEBC, now called the Biotechnology Commission), established by the government in June 2000 with a broad remit to provide advice on the environmental, social and ethical implications of agricultural biotechnology.

Since an influential report on *Science and society* was published in 2000 by the House of Lords Committee on Science and Technology, 'public engagement' has become the catchphrase of UK government policies on science and society, and it is likely to be feature of future TA processes instituted in this country (Box 2.3). The old 'deficit model', which assumed that public mistrust of science was based on ignorance, has fallen out of fashion, and it is increasingly thought that citizens without scientific expertise can play a valuable role in TA. Although the *GM Nation?* public debate that the AEBC prompted has been widely criticised, as we mentioned in Section 1.1, it was probably the most ambitious attempt at public dialogue about technology that there has ever been, involving 36,000 people.[60]

[d] Citation searches were conducted using the ISI Web of Science database, accessed through http://wos.mimas.ac.uk/. All citations containing 'bioethic' were counted.

Box 2.3
Rationales for public participation.

There are three main reasons why organisations encourage public participation in their decision-making.[a]

Instrumental
The instrumental rationale is that public participation is an improved means to a particular end. For instance, the UK government argues for increased public engagement in science in order that public concerns about science should not act as a "brake on social and economic development in the UK".[b] This implies that public participation would make no substantive contribution to the direction of scientific, social and economic development. In effect, this is public participation as public relations.

Normative
An alternative reason for supporting public participation is that it is right for citizens to have a say in decisions about science, irrespective of the consequences. This might be because they help to pay for the research, through taxes if it is publicly funded or as consumers of commercial technologies, or because the research will affect them, directly or indirectly. Another way of putting this is to say that there is currently a 'democratic deficit' in decision-making about science and in politics more generally, which responsible public participation can help to correct.[c]

Substantive
The substantive rationale for public engagement is that it will make for better decisions. Involving citizens who are not scientists or immediate stakeholders can bring new perspectives and information to the attention of decision-makers. Given that scientific advice is always uncertain and the outcomes of decisions about research are inherently unpredictable, decisions can never simply be made by weighing up the outcomes. Other factors inevitably enter the frame of decision-making; the fuller this 'social intelligence' is, the better a decision is likely to be. The logic is clearer when we turn this argument around: systematically ignoring relevant insights and information is a sure way to make bad decisions.

In crucial ways, however, the growth in the UK of ethical assessment and the embryonic initiatives to engage the public in TA represent business as usual. Because these processes remain detached from product regulation, the ethical issues and public concerns that they address are kept separate from issues of risk, which remain the unchallenged centrepiece of regulatory product assessment. The think tank Demos has called this the "tyranny of risk assessment", suggesting that "perhaps the biggest risk is that we never get around to talking about anything else".[61] To focus on risk in assessing a new product is not to exclude questions of value or principle, but rather to prioritise one form of consequentialist ethics over others. It is not necessarily a problem to focus on one form of ethics, because that approach may be particularly suited to addressing the problems at hand. The danger arises in denying that this ethical choice is happening, thereby closing it to question, public scrutiny or reassessment.

When ethical assessments of new technologies have been undertaken, public concerns have all too often been reframed by 'ethical experts' in binary terms: either public concerns are thought to hinge on the outcomes of the technology in question, or to relate to its violation of the intrinsic value of nature.[62] The former are recognised to be of public consequence, but are thought to be better addressed by experts in risk assessment and economics than by citizens. The latter are considered to be better addressed by citizens and consumers themselves, but they are usually thought to be highly personal. The effect is that citizens are cut out of the 'public' discussion. The clearest exception to this is the debate over stem cell research, where concerns about intrinsic value are of unambiguous social importance, because they concern human life rather than plants or animals.

Social scientists have argued that it is mistaken to characterise public concerns about technology in these binary terms, either about risks and consequences, or based on the 'yuk factor'.[63] Instead, they emphasise that the social consequences of technology are radically uncertain. Risk estimates only form a robust foundation for decisions about technology when there is:

> "*high certainty* with respect to the knowledge base to be relied upon, and *high consensus* with respect to the parameters of the scientific issues to be addressed, the analytic methods to be applied, and the values to be protected."[64]

[a] **Stirling, A.** (2004) Opening up or closing down? Analysis, participation and power in the social appraisal of technology. In: Leach, M., Scoones, I. and Wynne, B. (eds), *Science, citizenship and globalisation*. Zed, London: forthcoming.

[b] **HMT, DfES and DTI** (2004) *Science and innovation investment framework 2004-2014*. HMSO, London, July: 156.

[c] **POST** (2001) *Open channels: public dialogue in science and technology* (Report No. 153). POST, London, March.

When there is low certainty and low consensus on the risks, as in the case of GM crops, it is particularly important that decisions take non-consequentialist considerations into account: for instance, will citizens be able to choose whether a technology affects them? Even when the consequences of technology are considered highly certain it is appropriate to debate what counts as a good outcome, and the potential for surprises beyond the scope of risk assessment always exists. Social scientists insist that public concerns are based on a strong appreciation of this uncertainty, rather than on risk aversion or moral conservatism. The participants in their studies link concerns about unanticipated consequences to questions about the purposes of a technology – 'why are we doing this rather than that?':

> "If the purposes driving research and innovation are sound, then uncertainty will likely be tolerated; but if they are not, or simply unaccountable so that no-one can even tell, then why should it be tolerated?"[65]

2.3.3. Towards social assessment

A crucial similarity between current mechanisms for product assessment and technology assessment in the UK, whether they are risk-based or 'ethical', is that they give insufficient weight to the social context and purposes of science and technology. The most extreme defence of this approach is that 'ethical issues', which have a legitimate place in policy debates about science and technology, are categorically separate from 'social issues', which are best addressed in other fields of policy or through the market. Amongst other people the Science Minister, Lord Sainsbury, has been heard to express this view.

Whilst it is important to understand the difference between ethical and social concerns in the abstract, very few philosophers, if any, consider them to be separate in practice. For instance, the Nuffield Council on Bioethics is emphatic that "[s]cientific, ethical and social issues cannot be wholly separated from each other; nor should they be so".[66] Although none of this precludes such issues from being discussed separately, we hope that the discussion in this chapter has illustrated the extent of their interconnection. We envisage a future in which the UK's institutions for technology assessment and product assessment are better equipped to cope with it.

Both the government's *Science and innovation investment framework* and the Prime Minister himself have stressed the need for public engagement and ethical analysis to play a greater part in decisions about the use of science.[67] Government policies have yet to live up to this promise. **We recommend that a clear and cross-sectoral responsibility for participatory TA is established by government.** This does not necessarily mean establishing a new TA institution. Rather, a participatory TA function, and the resources needed to fulfil that responsibility, could be assigned to an existing body such as the Parliamentary Office of Science and Technology or the Council for Science and Technology, the government's senior advisory body on science. Another option would be to expand the remit of the AEBC so that it becomes a fully-fledged TA body. Any of these approaches would complement the recent recommendation of the Royal Society and the Royal Academy of Engineering that the government initiate a public dialogue on nanotechnologies.[68]

Whichever option is pursued, TA in the UK should draw on the experience of TA organisations that have existed for many years in other European Countries, of which the Dutch Rathenau Institute is widely regarded as the most successful. They use a wide range of established and new techniques for involving citizens in technology appraisal. Most of the methods used centre on 'juries' or 'panels', where citizens come to a series of conclusions after cross-questioning scientists, business people and campaigners involved with a technology. Some of these TA bodies also use scenario workshops and role play exercises to help the participants think about the future implications of technological choices from a variety of perspectives. Others frame public participation in explicitly ethical terms. For example, the Norwegian Committee for Research Ethics in Science and Technology has used a tool called the Ethical Matrix, which was devised by a member of the Food Ethics Council, to address ethical issues in the fisheries sector.[69]

TA in the UK should also build on the positive and negative lessons that can be learnt from the AEBC, the *GM Nation?* debate and a number of independent participatory TA processes which have already taken place in this country (Box 2.4). Participatory TA processes should be designed for maximum effectiveness, satisfying the following six criteria:

- Purpose – The purpose of involving members of the public should be clear to the organisers and to the participants.

- Participation – The participants should be selected fairly and in a way that is appropriate to the purpose. They may be selected using statistical sampling techniques, but this is not always necessary. In some cases it will be suitable for people to take part as individual citizens and, in others, as representatives of stakeholder groups.

- Methods – An appropriate method of participation should be used. There is wide range of methods for public policy participation, ranging from quantitative surveys to deliberative and inclusive processes such as citizens' juries. Sometimes more than one method may be appropriate.

- Resources - The organisers should have the money and skills that their chosen method demands. Depending on the method, costs may include travel and bursaries for participants. Under-resourcing can jeopardise success and alienate participants.

- Learning – The House of Lords Select Committee on Science and Technology argues that there is a need to "go beyond event-based initiatives like consensus conferences and citizens' juries" and calls for "genuine changes in the cultures and constitutions of key decision-making institutions". Feedback processes to help institutions learn from their own and others' experiences are one means of encouraging this culture change.

- Outcomes – The intended outcomes should be clear to participants and to observers. According to the government, public participation "is a waste of everyone's time unless the decision-maker is willing to listen to others' views and then do something which it would not have done otherwise".[70]

Of course, the government would not have to follow the advice it received from the body it makes responsible for participatory TA. However, it is crucial that the advice is published and that the government is obliged to respond publicly to it. If either of these elements is missing, the TA process is rendered ineffectual.

Box 2.4

UK participatory processes relating to food and farming.

Animals and Biotechnology (2002)

In 2002, the Agriculture and Environment Biotechnology Commission published a report on *Animals and biotechnology*. In the producing the report, the AEBC "wanted, through qualitative social research, to explore in greater depth the subtleties of the different perspectives people have on animals and in particular about applying GM and cloning to animals".[a] The AEBC commissioned Phil Macnaghten, a social scientist from Lancaster University, to hold a number of small discussion groups, aiming to include a spread of social groups in the north and the south of England:

> "situations were set up in which people could talk about animals in different spheres of daily life, in their own terms, and subsequently to explore how people responded to potential human uses of animals arising from biotechnological applications, and the factors shaping such responses."[b]

Citizen Foresight (1999)

Citizen Foresight aimed to combine the most successful elements of existing deliberative and participatory processes, such as citizens' juries. The process was led by civil society organisations and overseen by a panel of stakeholders from the food and agricultural industries:

[a] **AEBC** (2002) *Animals and biotechnology: a report by the AEBC.* AEBC, London, September: 8-9.

[b] **AEBC** (2002: 65), see note a.

> "Using a procedure approved by the stakeholders as fair and competent, twelve randomly-selected citizens discussed their visions for the future of food, guided by advice from an expert panel and a balanced range of witnesses."[c]

Amongst other verdicts, the participants concluded that "GM crops are unnecessary" and that "regional production, processing and distribution of food should be encouraged".[d]

Consensus Conference (1994)
The BBSRC commissioned the Science Museum to organise the UK's first national consensus conference, on plant biotechnology.[e] The consensus conference is process originating in the US, in which the citizen participants set the agenda, select the experts who will give evidence and report on their own conclusions. The BBSRC-sponsored conference, which drew an audience of over 300, has been criticised for taking place "in a political cul-de-sac", having no clear mechanisms with which to influence subsequent public and political debates.[f]

Feeding the Debate (2002)
The Food Chain and Crops for Industry Panel of the UK government's Foresight programme ran an experimental process called *Feeding the debate*. It asked "Can consumer concerns be raised before investment in the technology and product is made?". Based on focus group discussions, a deliberative conference, an internet consultation and a postal questionnaire it concluded, subject to certain conditions, "YES, and you can do so at a very early stage in the application of the technologies".[g]

FSA Citizens' Jury (2003)
The UK Food Standards Agency conducted a citizen's jury on GM food involving 15 participants.[h] The FSA has been heavily criticised for its handling of the jury's findings.[i] The agency's news release at the time announced: "citizens' jury says GM food should be available to buy in the UK".[j] Critics say this was a misrepresentation of the jury's conclusions, which included unanimous agreement that:

> "More time is needed to understand the long-term environmental implications of GM crops before farmers start to grow them in the UK. Growing GM crops in the UK would be irreversible and might eventually reduce choice."[k]

GM Jury (2003)
The Consumers Association, the Co-operative Group, Greenpeace and Unilever co-financed two parallel citizens' juries on GM crops, one in Tyneside and one in St Albans. Both juries called for:

> "A halt to the sale of GM foods currently available, and to the proposed commercial growing of GM crops… Long-term research into the real risks of damage to the environment and the potential for harm. An end to blanket assertions that the GM crops are necessary to feed the starving in the Third World, given the complex social and economic factors that lie behind such hunger."[l]

GM Nation? (2003)
The *GM Nation?* public debate was prompted by the AEBC, paid for by government and managed by an independent steering board.[m] The aim was to ensure that a wide range of voices were heard in discussions on GM crops.[n] The debate consisted of two strands: an open debate and a series of 'narrow-but-deep' discussion groups. The open debate happened on three 'tiers': there were six national level events, around 40 regional events organised in partnership with bodies such as county councils, and an estimated 629 local events, stimulated by a toolkit consisting of papers, a CD-Rom and a specially commissioned film. The debate involved around 36,000 people and cost £650,000. Critics say the debate was rushed and underfunded because the government failed to commit to it fully.[o]

Weekends Away for a Bigger Voice (2001)
The National Consumer Council (NCC) held two Weekends Away for a Bigger Voice, one in the North East and one in the South West of England:

> "The purpose of the workshops was to ensure that the views of low-income consumers were represented in the debate on the future of farming and food. The aim was to involve ordinary people in qualitative research that could then be fed into the Policy Commission [on the Future of Farming and Food] as well as inform the NCC, the FSA and DEFRA. Subsequently, participants requested and were granted a meeting with DEFRA Minister, Lord Whitty, and Suzi Leather, Deputy Chair of the FSA." [p]

The NCC reports that the greatest challenges were to fit the process in with a tight policy timetable and to provide feedback to the participants. The total cost of this process was £25,000.

Whilst there are many models in other countries for participatory TA, there are fewer precedents for licensing processes that explicitly assess the social and ethical implications of new products. Indeed, international trading rules, enforced through the World Trade Organisation's (WTO) dispute settlement procedure, are sometimes seen as barrier to increasing the scope of product assessment. The WTO rules are intended to harmonise regulation in different countries and to prevent unfounded regulatory

[c] **Wakeford, T.** (1999) *Citizen foresight: a tool to enhance democratic policy-making.* LoGIS, Genetics Forum, London: 3.

[d] **Wakeford** (1999), see note c.

[e] **UK National Consensus Conference on Plant Biotechnology** (1994) *Final report of the lay panel.* November 2-4. Accessed on-line: http://www.ncbe.reading.ac.uk/NCBE/GMFOOD/conference.html 04/10/04.

[f] Robin Grove-White, quoted in: **Wilsdon, J. and Willis, R.** (2004) *See-through science: why public engagement needs to move upstream.* Demos, London, September: 22.

[g] **Foresight** (2002) *Feeding the debate: a report from the Debate Task Force of the Food Chain and Crops for Industry Panel.* Department of Trade and Industry, London, February.

[h] **Opinion Leader Research** (2003) FSA citizens' jury: should GM food be available to buy in the UK? Final report. FSA, London, April.

[i] **Soil Association** (2003) Food Standards Agency condemned again over GM bias. *Press release*, May 25.

[j] **FSA** (2003) FSA citizens' jury says GM food should be available to buy in the UK. *Press release*, April 7.

[k] **Opinion Leader Research** (2003), see note h.

[l] **PEALS** (2003) *The people's report on GM.* PEALS, Newcastle, September: 1.

[m] **AEBC** (2001) *Crops on trial: a report by the AEBC.* Department of Trade and Industry, London, August.

[n] **GM Nation** (2003) *GM Nation? Findings of the public debate.* Department of Trade and Industry, London, September.

[o] **Mayer, S.** (2003) *GM Nation? Engaging people in a real debate?* GeneWatch UK, Buxton.

[p] **National Consumer Council** (2002) *Involving consumers in food policy: a case study for the Involving Consumers project.* NCC, London, September: 21.

restrictions covering for trade protectionism. The agreement on Sanitary and Phytosanitary Measures, which regulates trade in plant and animal products, requires members to base their regulatory decisions on scientific evidence regardless of whether those decisions are likely to have a discriminatory effect on international trade. This is often taken to mean that regulation should be based solely on risk assessment, and that broader ethical and social considerations are out of the question.

However, in WTO case law the Disputes Settlement Body has taken a more realistic approach to the parts that science and other factors play in regulatory decisions.[71] Codex Alimentarius, the UN-administered body that sets the safety standards used in WTO disputes about food, is increasingly explicit that 'other legitimate factors' than risk may play a role in product assessment. An expert panel convened by Codex has concluded that risk assessment cannot be separated from ethics and that value judgements enter into each risk analysis:

> "There is broad international agreement that food safety standards and related guidelines must have an objective basis in science. It is also evident, however, that risk analysis, and especially risk management, require that numerous subjective and value-laden factors be considered in determining the appropriate level of protection and in guiding the choice of the optimal risk-management option(s)."[72]

We recommend the UK government to press in international trade negotiations for amendments to any clauses that are perceived to rule ethical or social considerations out of regulatory assessment for new products.

The challenge is to develop a product assessment system that takes social and ethical concerns seriously, yet is also operable, is based on robust scientific evidence and does not become a back door for unjust trade protectionism. The precautionary principle, which features in relevant international trade rules, EU law and UK product assessment, provides a potential mechanism for meeting this challenge. Definitions of the precautionary principle vary, and the versions enshrined in EU law and in WTO rules do not fulfil this potential because they purport to focus solely on risk, albeit risks that are not yet known. Contrary to the evidence we cited in Section 1.2, they assume that scientific uncertainty will diminish given additional research and that consensus will increase over time.

By contrast, we venture that the most basic formulation of the precautionary principle is that the *burden of proof* should lie with proponents of a potentially risky course of action (Box 2.5). Of course, assessments of safety can never be 100 percent certain. What *standard of evidence* counts as 'proof' of safety depends on such factors as the type of risk and the likely distribution of benefits from a new technology. Standards of evidence in regulatory assessment inevitably imply judgements about the social and ethical acceptability of the risk in question. Taking the standard of evidence for granted, at a particular statistical confidence level for example, hides this ethical content rather than eliminates it. Opening up the standards of evidence for product regulation to ethical analysis and public discussion promises to be an orderly and practically viable way of combining risk-based and social evaluation. It would allow a higher standard of evidence of safety to be required when the social purposes and likely consequences of a product were widely questioned. The standard of evidence required of particular classes of product would be decided and justified by the existing regulatory authorities, drawing on the social intelligence gained from stakeholder consultations and public engagement processes.

Box 2.5
The precautionary principle.

The precautionary principle is nowadays widely used in policy, at the national level and internationally. It features, for instance, in the United Nations Framework Convention on Climate Change, in the Convention on Biological Diversity and in WTO rules relating to trade in food.[a] However, it is defined and implemented differently by different governments and organisations. The most notable differences are between the EU and the US approaches to precautionary decision-making. The WTO is the arena in which many of these differences are played out.

The WTO, in Article 5 (7) of the Agreement on Sanitary and Phytosanitary Measures, states that:

> "in cases where relevant scientific information is insufficient, a Member may provisionally adopt sanitary or phytosanitary measures on the basis of available pertinent information... In such circumstances, Members shall seek to obtain the additional information necessary for a more objective assessment of risk and review the sanitary and phytosanitary measure accordingly within a reasonable period of time".[b]

This definition assumes that member countries should base decisions relating to human, plant or animal health 'purely' on scientific advice. It allows that they may wish to restrict the use of an animal or plant product if there is scientific uncertainty about its safety. It requires the country that makes the restriction to attempt to reduce that uncertainty through further scientific research. According to this view, the precautionary principle offers regulators a temporary stop-gap when scientific evidence falls short.

It is more logical and more practical to see the precautionary principle as a guide to help decision-makers balance scientific evidence with other forms of knowledge and advice.

The precautionary principle hinges on two precepts: first, that the burden of proof should lie with the party in favour of a potentially risky action, creating a presumption in favour of safety; second, that the standard of evidence they are required to demonstrate should depend on the context and the social acceptability of the risks in question.

For example, the threshold of evidence that the proponent of a new food technology is required to demonstrate might depend on the types of risk it appears to entail, its likely benefits and beneficiaries, and the degree of choice people would have in taking a risk.[c] In attempting to answer these subsidiary questions and thereby decide on the appropriate standard of proof, decision-makers could usefully be assisted by advice from non-scientists, including citizens. In practice, non-technical factors are built into all science-based decisions about risk in any case – this approach would allow them to be addressed more openly and robustly.

[a] **Commission of the European Communities** (2000) *Communication from the Commission on the precautionary principle* (COM(2000) 1), February 2.

[b] **GATT** (1994) *Agreement on the application of sanitary and phytosanitary measures*, April 15.

[c] **Commission of the European Communities** (2000), see note a. **Royal Society of Canada Expert Panel on Food Biotechnology** (2001) *Elements of precaution: recommendations for the regulation of food biotechnology in Canada*. Royal Society of Canada, Ottawa, February 5.

3. Organisations

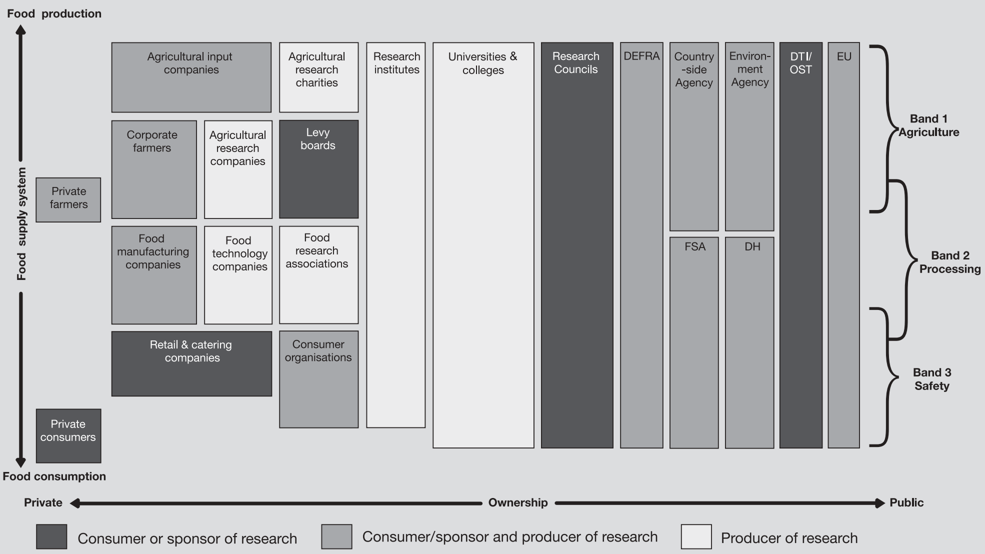
3.1 Food and farming

Guidelines on research ethics focus on the kinds of ethical decisions that individual scientists face. But research is not a solitary activity. Science and innovation take place in organisations, ranging from universities and research institutes to hi-tech start-ups and multinational companies.

Figure 3.1 illustrates the main groups of organisations involved in food and farming research. three features of the diagram are worth highlighting. First, many of the organisations that actually undertake research are neither commercial enterprises nor state-owned. Between the private companies on the left of the Figure 3.1 and the government departments on the right, there are not-for-profit research associations, research institutes and universities. There is no simple public-private divide.

Figure 3.1

Food and farming research: key players in England.



Research organisations: examples by category

Agricultural input companies
Bayer CropScience
Dow AgroSciences
Elanco Animal Health
Monsanto
Syngenta

Agricultural research charities
Chadacre Agricultural Trust
Frank Parkinson Agricultural Trust
Elm Farm Research Centre

Agricultural research companies
ADAS

Consumer organisations
Consumer Association
National Consumer Council

Corporate farmers
Bernard Matthews
Co-op Farmcare

Food manufacturing companies
Cadbury Schweppes
Northern Foods
Patak Foods
Unilever

Food research associations
Campden & Chorleywood Food Research Association

Food technology companies
Leatherhead Food International

Levy boards
British Potato Council
Horticultural Development Council
Home-Grown Cereals Authority
Milk Development Council
Meat & Livestock Commission
Quality Meat Scotland

Research councils
Biotechnology and Biological Sciences Research Council
Economic and Social Research Council
Medical Research Council
Natural Environment Research Council

Research institutes
Babraham Institute
Hannah Research Institute
Institute for Animal Health
Institute of Food Research
Institute of Grassland & Environmental Research
John Innes Centre
Roslin Institute
Rothamsted Research
Silsoe Research Institute

Retail & catering companies
Asda Walmart
Co-operative Group
McDonalds
Tesco
Sainsbury
Compass Group

Universities and Colleges
Harper Adams University College
Royal Agricultural College
Scottish Agricultural College

Whether these organisations are private companies, not-for-profits, executive agencies or government departments affects how they are legally accountable and to whom. There are other differences too. For instance, private companies tend to obtain their revenue through commerce, whereas government agencies are financed through taxation. Yet, in practice, accountability and resources are transferred between organisations, from the 'public' to the 'private' sector and vice versa. For example, it is common for private companies to undertake contract research to support government policy. The public-private distinction runs through organisations rather than simply mapping onto them, and the line it takes varies according to whether one focuses on their legal accountability or on their finances.

The second noteworthy feature of Figure 3.1, is that different groups of organisations tend to be involved in research on food and research on agriculture. Since the 1950s, there have been three main 'bands' of activity. The first band (1) has centred on agricultural productivity. Agricultural input manufacturers, such as seed, chemical and machinery companies, have taken part in this band and larger farmers have been its main clients.

Band 1 has involved a wide spectrum of research organisations besides companies. Research institutes, agricultural colleges and university departments have conducted 'basic' research and also developed technologies that are directly relevant to farmers. The main research councils involved are the BBSRC and the Natural Environment Research Council (NERC). Previously it was the domain of the Agricultural Research Council (ARC), which became the Agricultural and Food Research Council (AFRC) in the 1980s. DEFRA, formerly the Ministry of Agriculture, Fisheries and Food, is the government department most involved in this band. DEFRA's top ten research contractors, who have together undertaken almost 50 percent of the department's 4,700 plus projects, conduct much of the research in Band 1 (Table 3.1).

Table 3.1

Top 20 DEFRA research contractors since June 2001.[a]

Contractor	No. of Projects	Cumulative % of projects
ADAS Consulting Ltd	525	11.14
Central Science Laboratory	399	19.60
Horticulture Research International	296	25.88
Veterinary Laboratories Agency	236	30.89
CEFAS	221	35.57
IGER, Inst. of Grasslands and Environment	181	39.41
Rothamsted Research	150	42.60
IAH, Institute of Animal Health	109	44.91
Natural Environment Research Council	93	46.88
Silsoe Research Institute	91	48.81
Roslin Institute, Edinburgh	67	50.23
University - Reading	63	51.57
University - Bristol	62	52.89
University - Scottish Agricultural College	49	53.92
Warwick - HRI	49	54.96
University - Nottingham	45	55.92
Centre for Ecology and Hydrology	43	56.83
National Institute of Agricultural Botany	43	57.74
Campden & Chorleywood Food Research Association	41	58.61
University - Cranfield	40	59.46

Note: The total number of projects in this period is 4,714. The total number of contractors is 692. The top ten contractors carry out almost half of DEFRA's research contracts.

[a] Data from: **DEFRA** (2004) *Science and research projects*. Accessed on-line: http://www2.defra.gov.uk/research/project_data/Default.asp, 12/08/04.

Band 2 is concerned with food processing. The companies involved range from milling, packaging and confectionary firms, right through to large retailers. Campden and Chorleywood Food Research Association (CCFRA) and Leatherhead Food International (LFI), two research associations established by the government but now privatised, perform specialist research on behalf of these other companies. Although the ultimate clients are consumers, the immediate customers for most research within this band are food businesses. Government departments and research councils have not been heavily involved in food processing research.

Band 3 centres on food safety. It has been the focus of government-commissioned research on food. The FSA is the principal government body involved, awarding research tenders to organisations such as CCFRA and LFI, and to university toxicology and epidemiology departments. Food companies also conduct or commission research in this area, both to support their products through regulatory safety assessment and to reduce the commercial risks associated with marketing a harmful product.

Before the FSA was set up in 2000, responsibility for food safety fell to MAFF and to the Department of Health. Food safety research has never been an equal concern to agriculture for the research councils, although government support for it increased when the ARC was changed into the AFRC.[73]

Many of the same organisations are involved in Bands 2 and 3. However, commercial and public interests have never aligned to the same extent in research on food as in agriculture. Whereas the state has supported research explicitly to promote agricultural technologies, it has largely focused on research to assist in regulating commercial food technologies (Table 3.2). Post-war, boosting agricultural production to increase food supply and help the balance of payments was seen as priority in the UK and other European countries. Although government has sometimes been concerned about the competitiveness of UK food processing this was not considered to be as central to the national interest as agricultural production, and industry was thought capable undertaking its own applied research. As concerns about food supply have declined and the focus of UK and EU agricultural policy has shifted towards the social, cultural and environmental value of farming, agriculture has remained closely associated with the national interest in minds of policy makers in a way that food processing has not. The differences in public support for agricultural and food industries may also have been reinforced by the greater political power of agricultural interests until the 1990s.[74]

Table 3.2

The main categories under which DEFRA and the FSA procure food and farming research.[a]

DEFRA	FSA
Plant health control	Nutrition, diet and food choices
Arable crop science	Foodborne illness
Horticulture science	BSE research
Animal health and welfare	Safety of food components
Livestock science	Chemical contaminants in food
Chemicals and biotechnology	Radiological safety of food
Food technology	Consumer choice and standards of food production

[a] The categories are taken from, respectively: **DTI** (2003) *The forward look 2003*. DTI, London. **FSA** (2002) *Research and survey programmes annual report 2002*. Food Standards Agency, London.

The signs are that these three distinct bands of research are coalescing and that some research topics which previously fell into the spaces between them will receive greater attention in future. The government has explicitly committed to addressing some of the key areas of neglect. Research on food and public health, which has largely fallen outside the three bands described above, is set to increase as public and policy concern grows about obesity. In the aftermath of the Wanless Report on *Securing good health for the whole population*, HM Treasury and the Department of Health (DH) have highlighted public health research as a priority.[75] The DH is encouraging food companies to treat health oriented innovation as a commercial opportunity.[76] The FSA has also signalled that it will be extending its previous concern with food safety into a broader focus on public health.[77]

DEFRA and the research councils are trying to foster connections between research on food and research on agriculture, and to gain understanding about the place of food and farming in contemporary society. Following the BSE and FMD outbreaks, the links between farming practices, public safety and the rural economy have become a major concern for DEFRA.[78] Furthermore, one of the priorities of DEFRA's Sustainable Food and Farming Research Priorities Group (RPG), established in 2004 to guide the department's medium-term strategic research, is to build cohesion between food science and farming research. The membership of the RPG reflects this ambition, including experts from both sectors of industry (Box 3.1). DEFRA's Horizon-Scanning Unit has commissioned a project on *The future of the UK food chain*, which will explore the 'national interest' in relation to food production and consumption. Under the *Cultures of consumption* programme, the Economic and Social Research Council (ESRC) is paying for academic research on the social dimensions of producing and consuming a range of commodities, including foods. Jointly with NERC and the BBSRC, the ESRC has also financed a £20 million *Rural economy and land use* programme, in which projects must have both natural and social science components.

Box 3.1

Membership of DEFRA's Sustainable Food and Farm Research Priorities Group.[b]

Chair
Prof. Chris Pollock – Director of IGER (Institute of Grassland and Environmental Research)

Agriculture
Mr. Robert Campbell - Farmer
Mr. David Piccaver - Managing Director of J E Piccaver & Co
Mr. Bill Madders - Dairy Farmer

Food Manufacture
Dr. Gail Smith - Sustainable Agriculture Manager, Unilever Research and Development
Miss Kaarin Goodburn - Secretary General of the Chilled Food Association

Retail
Mr. David Gregory - Head of Food Technology at Marks and Spencer

Consumer Affairs
Prof. Joyce Tait - Director of ESRC Innogen Centre University of Edinburgh

Food Safety
Prof. Colin Dennis – Director-General of Campden and Chorleywood Food Research Association

Agri-environment
Prof. Valerie Brown - Director of the Centre for Agri-Environmental Research, The University of Reading
Dr Les Firbank – Head of Land Use Systems, Centre for Ecology and Hydrology

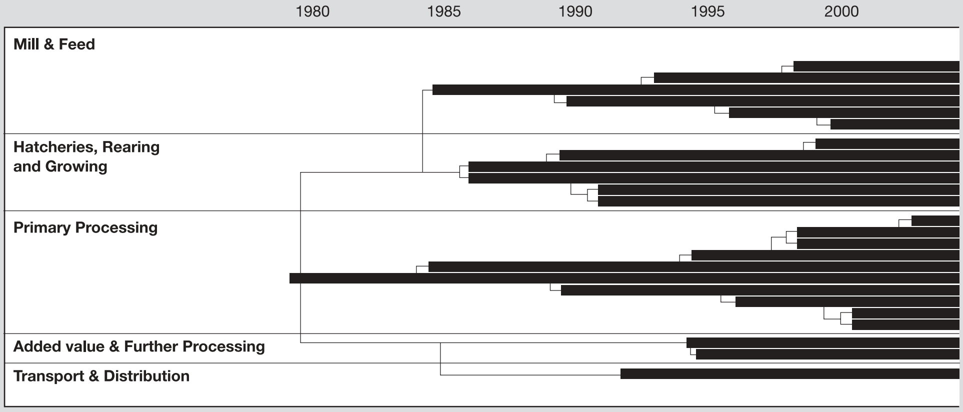
Whilst government is taking welcome measures to promote closer links between food and farming research on the one hand, economic trends are also driving further integration on the other. Recent decades have seen rapid vertical integration and co-ordination within the food chain. Agricultural chemical manufacturers have bought seed companies, large retailers have consolidated their relationships with farmers and suppliers, and so on. This has generally been a dual process, with integration occurring upstream and downstream of the farm, but rarely bridging it. However, the barrier that the farm represented between agricultural input suppliers and food companies is rapidly being eroded (Figure 3.2). This creates new priorities and possibilities for research: breeding for fruit varieties that match retail display requirements; creating oil crops with a fatty acid profile that suits industrial frying processes or the marketing of premium health foods; 'functional foods' with high-value micronutritional qualities; pesticide and fertiliser management to address consumer demands for reduced chemical inputs; the list could go on. Increasingly, food companies and not farmers are the

[b] **DEFRA** (2004) *Sustainable Food and Farming Research Priorities Group*. Accessed on-line: http://www.defra.gov.uk/science/RPG/default.asp, 29/07/04.

principal clients of agricultural research organisations. Food retailers clearly depend on consumers but the power of consumers is highly diffuse compared with that of supermarkets, and consumers do not have as direct an influence on commercial research priorities.

Figure 3.2

A case study of vertical integration in the food chain: meat supply and production in Grampian Country Food Group.[a]



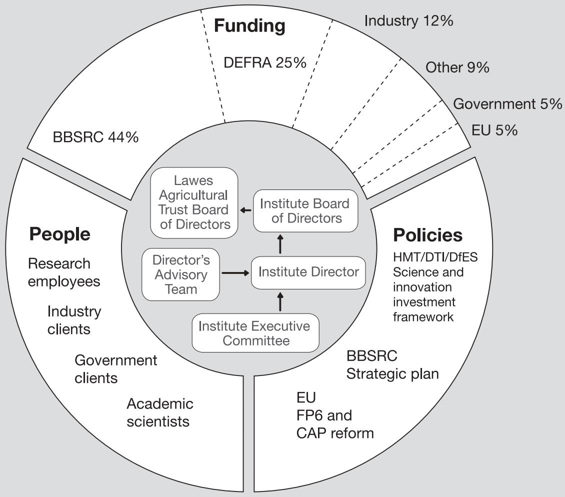
Note: The company that is now Grampian Country Food Group formed in 1980 as Grampian Country Chickens. The Group has steadily acquired and formed new firms since. It has three international processing firms, including Grampian Foods Siam, which is based in Thailand. It is now involved in all levels of the meat supply chain except chemical input manufacture and retail. This diagram shows the dates when the group acquired or formed companies at different levels of the meat supply chain. Each horizontal band represents a company.

A third key feature of Figure 3.1, implied by the previous two points, is that the character of each research organisation is not determined by its formal remit or structure. Both these factors matter, of course, but so do an organisation's institutional links with other bodies, and the flows of people and resources that lend those links substance.

Figure 3.3 zooms in schematically on one of the organisations in Figure 3.1. The diagram illustrates the formal process for setting research priorities within the organisation and highlights three major components of that process. The organisation directly involves different people in decision-making and is accountable to different groups. Their priorities are developed in relation to broader policies and are often expressed in the language of those policies. They are shaped by the availability of different material resources, knowledge and finance.

Figure 3.3

Rothamsted Research: income, people and policies.[b]



[a] **Grampian Country Food Group** (2004) *Acquistion strategy*. Accessed on-line: http://www.gcfg.com/acquisition.cfm, 10/08/04. **Grampian Country Food Group** (2004) *Welcome to Grampian Country Food Group*. Accessed on-line: http://www.gcfg.com/index.cfm, 10/08/04.

[b] Figures on funding from: **Rothamsted Research** (2003) *Annual report 2002-2003*. Rothamsted Research, Harpenden.

In short, research organisations are never entirely autonomous. In order to appreciate the ethical content of research on food and farming, it is necessary to unpack the values and assumptions of the people, policies and resources that link one organisation to another. The remainder of this chapter focuses on the people involved in research organisations and on the policy areas that have the greatest bearing on food and farming research. Chapter 4 looks at the distribution of research resources.

3.2 Stakeholders

"Who is a scientist?", is the question Professor Dame Julia Higgins asked of her audience in her presidential address at the 2004 Festival of Science. She described how research workers in academia and industry - the group we normally think of as scientists – are outnumbered by others, including doctors, government advisers and "the invisible people who have scientific training but are not using it in their professions".[79]

Similarly, research scientists are not the only people involved in research organisations. The organisations also employ managers and support staff. In addition, many scientists and non-scientists who are not employed by these organisations routinely participate in decision-making, often at a strategic level. Generally, these outsiders are representatives of the research organisation's primary client group or experts with specialist knowledge of the issue at hand. They often have a formal place within the organisation's structure, as members of the board or of an advisory panel. Otherwise, they may come from companies or campaign groups that cover the costs of their participation in 'public' meetings or consultation processes. If you have regularly taken part in such meetings you will be able to think of the 'usual suspects' who regularly attend these events in their field. In this report we call those people 'professional stakeholders'. You will probably also have noticed that very few people who do not have a professional interest in science, whether as researchers, business people or campaigners, take part in nominally 'public' events.

This section describes how many public and private sector research organisations involve professional stakeholders in decision-making. We discus how momentum is building behind the idea that members of the wider public who pay for technology through their taxes or as consumers, and who are affected by new technologies, could make an important contribution to research decision-making in their capacities as citizens.

3.2.1 Professional stakeholders

The research commissioned, sponsored or undertaken by government departments and agencies is broadly circumscribed by their remits and by ministerial diktat. Civil servants, some of them scientists, are usually responsible for translating these broad edicts into more specific objectives and research priorities. As the following examples from across the public sector show, they are assisted in this task by a large number of professional stakeholders.

a) The *Science and innovation investment framework*

Alongside the 2004 *Spending Review*, HM Treasury, the DTI and the Department for Education and Skills published a ten-year *Science and innovation investment framework*.[80] This framework outlines science-related policy priorities for departments across government and for the research councils. Over 150 outside responses were received to a consultation document that was issued four months in advance of publication of the framework. The vast majority of these were from companies, industry associations or research organisations that have an immediate stake in UK science policy, with only a handful submitted by civil society groups and none from individuals without a professional interest in this field. In drawing up the framework, ministers and officials:

- Met with representatives from 27 stakeholder organisations based in the UK, including companies, research institutes and science lobby groups.

- Met separately with a group of executives representing 21 major companies, from sectors including telecoms and pharmaceuticals.
- Consulted 32 US organisations, including companies, universities and federal government departments.
- Received perspectives on UK science from 11 other countries as diverse as France, India and Singapore.

The government is also advised on science policy by the Council for Science and Technology, a group of eighteen academics and business people who report to the Prime Minister.

b) Department for Environment, Food and Rural Affairs

DEFRA's three-year *Science and innovation strategy* was launched in June 2003.[81] It was the product of a similar process combining internal review, meetings with major interest groups and consultation amongst professional stakeholders. DEFRA has also commissioned an expert *Forward look* at its future science needs, which will inform its next science strategy, and circulated a publicly available consultation document to its network of professional stakeholders.[82] The current strategy sets out six interconnected science themes. The second largest of these, on Sustainable Food and Farming, is most directly relevant to this report.

Research under the Sustainable Food and Farming theme is intended to help DEFRA fulfil its *Strategy for sustainable food and farming*.[83] Section 3.1 mentioned that DEFRA has convened the Research Priorities Group (RPG) to advise on medium-term priorities in this area. The RPG has headed a series of six stakeholder workshops, between April and September 2004. The workshops were predominantly attended by people working in the farming and food industries. At the 2004 Festival of Science, DEFRA held a public communications event based on the same model.

In February 2004, DEFRA established a new Science Advisory Council to provide advice to its Chief Scientific Adviser. The panel consists of 11 academics and one person with knowledge and experience of consumer affairs.[84]

c) Food Standards Agency

The FSA inherited a varied research portfolio when it was established in 2000. It therefore commissioned an external review of its research, which reported in 2001.[85] Amongst other recommendations, the review report suggested establishing an Advisory Committee on Research (ACR). Set up in 2002, the ACR advises the FSA on its management and use of research. The committee consists of twelve academic, industry and government scientists. Broader groups of stakeholders, including consumers, are consulted 'upstream' of the ACR on the agency's overall priorities, and may be involved 'downstream' in specific research projects.

Unlike DEFRA, where officials answer to ministers, the FSA is governed by a board that meets publicly, whose members are supposed to act directly in the public interest. Whether this makes the agency more or less accountable to the public in practice remains an open question. The responsibility for managing research lies with FSA staff within the relevant departments.

d) Biotechnology and Biological Sciences Research Council

The BBSRC has several layers of committees, each combining academic scientists with members from government and industrial client organisations.[86] The senior BBSRC body is a Council of ten to eighteen members appointed by the Secretary of State for Trade and Industry, half of whom represent government or industry and half of whom work in academia. A Strategy Board provides advice to the Council and decides which proposals for research the BBSRC should finance. The Strategy Board is in turn advised by seven topic-based Scientific Committees, each with twelve members drawn from academic and client groups.

The BBSRC also has an Advisory Group on BBSRC Response to Public Concerns, which includes social scientists and civil society representatives as well as scientists and business people. This group informs the Council but plays no direct part in decision-making. The Advisory Group will soon be superseded by a new Strategic Panel on Science and Society, which is due to play a more central role in BBSRC business.[87] The BBSRC has consulted broader groups of stakeholders on specific areas of its research remit, such as crop science and farm animal genetics.[88]

As we describe in the next section, the BBSRC stands out amongst other public research organisations involved in food and agriculture for its attempts to listen to citizens who are not professional stakeholders.

e) The European Commission
The European Commission sponsors research across the EU through its four-yearly Framework Programmes (FPs). The FPs are intended to encourage research collaboration between member states, rather than substituting for national research support systems that already exist. Whereas the early FPs were nominally focused only on scientific excellence, recent programmes have become more oriented towards the contribution that science can make to commerce and to society.[89] Food Quality and Safety is one of the seven thematic areas within the current FP6.

The research promoted under each FP is decided by three nested processes.[90] Every four years, the Commission proposes a new FP to the Council of Ministers, who represent member state governments. The Council makes a decision following a series of consultations involving EU committees and stakeholders in individual member states. Every one or two years a second process takes place, to decide on specific work programmes within the overall framework. Consortia of scientists make proposals, which are reviewed by numerous experts at the EU level and nationally, before a decision is taken by a Management Committee. Finally, every time there is a call for proposals, each project is assessed and revised in a series of iterative exchanges between the group of scientists involved, the Commission and a group expert advisors. It is at this final stage that the ethical and social funding criteria described in Section 2.2.2 come into effect.

Thus, a certain amount of information is available about the people who are involved in setting research priorities for organisations that purport to conduct, commission or finance research in the public interest. However, private companies are less generous with such information. They are accountable primarily to their shareholders and may see a commercial interest in withholding management details from their competitors. In smaller companies, the decision-making process may not formally be codified.

Nonetheless, based on recent research by the Royal Society of Arts (RSA), it is possible to make three generic claims about the people who are involved in corporate R&D decision-making with reasonable confidence:[91]

- First, R&D decisions are generally business-driven. Within many research-oriented companies, scientists and technical staff have forfeited some of the power they previously enjoyed in steering their companies' activities. Whereas the boards of many such companies used to be dominated by people with technical expertise, they increasingly involve members with a greater diversity of interests and backgrounds. The balance of power between the boards and individual business units depends largely on company structure.

- Second, research-oriented companies place great emphasis on consulting customers on decisions about research. However, their customers are usually other businesses or public bodies. Their immediate clients are rarely the end consumers of their products.

- Third, only a small minority of companies in the RSA study attempt to engage a wider public in research and research decision-making. In some cases where they do, the 'public' in question are analysts and investors rather than citizens. Other companies consult with non-governmental organisations, industry experts and regulators. Few have procedures in place to make use of the views and knowledge of outsiders, relying instead on 'osmosis'.[92] The RSA found that hardly any companies:

  "looked beyond their primary stakeholders – customers and shareholders – to the general public; with one or two exceptions, there was little effort to anticipate the likely reactions or expectations of society at large".[93]

  Some companies in the RSA study recognised that they might benefit commercially from broader involvement, or that they might have a corporate responsibility to engage with members of the public. They highlighted commercial confidentiality, competitive advantage, stock exchange rules and physical security as constraints. Many of the companies saw no value in broader engagement.

So, in general, research organisations across the public-private spectrum heavily involve non-scientists in steering their activities. Some of these non-scientists are employees of the organisations in question whereas others are not. With few exceptions, however, the people involved in this process are a fairly closed network and involvement depends on their resources and power as professional stakeholders. Most professional stakeholders, clients and 'external' experts come from organisations that are already involved in the research system. The views and science needs of relatively marginal stakeholder groups, such as smallholder farmers or community food organisations, are only rarely taken into account. People who are not professional stakeholders are barely ever involved at all.

It is difficult to demonstrate a correlation between the people involved in decision-making and the kinds of research that get done because there is no obvious point of comparison, there is only a small data set, and much would hinge on the criteria used to classify research. However, it is very likely that the influence of professional stakeholders is strong, because the logic of involving them and their motive for taking part is precisely that they should help to steer research priorities.

3.2.2 Citizens

The rationales for broader public engagement in technology assessment apply also to decision-making about research (Box 2.3). People who are neither scientists nor professional stakeholders may be able to contribute valuable knowledge to decisions about science. Furthermore, they may be affected indirectly by the research or technology, without being its primary clients – decision-makers should therefore be accountable to them, irrespective of whether the people concerned are paying for the research as taxpayers or as consumers.

In the aftermath of the *GM Nation?* debate, the view has become popular amongst policy-makers that members of the public who are not professional stakeholders should directly inform R&D priorities, in their capacities as citizens rather than just as consumers in the marketplace. The government's *Science and innovation investment framework* captured the current mood when it pledged the government would encourage public debate (Table 3.3):

> "'upstream' in the scientific and technological development process, and not 'downstream' where technologies are waiting to be exploited but may be held back by public scepticism brought about through poor engagement and dialogue on issues of concern."[94]

2004 | A Food Ethics Council Report

A September 2004 report produced by Demos, which fleshed out and extended this argument, was picked up by the national media.[95] As if to prove that this thinking is now mainstream, no longer the preserve of sociologists and policy think tanks, the science journal *Nature* has since published an editorial asking "Should scientists let the public help them decide how government research funds are spent?", and answering "Yes they should, because the consequences are to be welcomed, not feared".[96]

Table 3.3

Moving 'upstream': extracts from selected responses to the government's March 2004 consultation on *Science and innovation.*[a]

Organisation	Statement or recommendation
British Association for the Advancement of Science	"Support, on a national basis, dialogue processes (discussions and consultations) that establish beliefs, views and evidence that are openly discussed in the public domain and in the media at earlier stages, generally, than at present." "Establish procedures that indicate how policy-making processes will consider public and stakeholder views at the initial stages of process development."
GeneWatch UK	"Public involvement can significantly improve research investment decisions by identifying important public needs and concerns before significant funding, training and infrastructure commitments are made."
Nuffield Council on Bioethics	"Ethical, legal and social issues raised by developments in medicine and biology are of direct concern to society and should be discussed from an early stage."
Research Councils UK	"We are developing a strategy on science and society… [which includes consulting] with the public on the priorities and policies of the Research Councils."
Royal Society	"In order to achieve increased levels of public confidence in decision-making about issues involving science, areas of potential concern need to be identified early (e.g. by Foresight panels, Departmental Chief Scientific Advisors, regular consultations with groups like supermarkets, NGOs who are sensitive to public concerns, horizon scans involving scientists and the public of the type organised by the Royal Society in 2003). In issues of clear public interest, the public will need to be involved. The Government should seek to fund such involvement and take its results seriously."

The BBSRC is the food and farming research organisation that has made the most progress in engaging with citizens who are not professional stakeholders, but who may have relevant views or concerns. It is a considerable way ahead of DEFRA in this regard. The BBSRC has organised a number of participatory processes, beginning in 1994 with a Consensus Conference on Plant Biotechnology.[97] Until now, however, these public engagement exercises have not been clearly connected into the BBSRC's own decision-making. Indeed, as a draft paper from the AEBC notes, a "recent House of Commons Science and Technology Committee report on the work of the BBSRC called for the Council to distinguish between its public engagement and PR activities[98]".[99]

To date, most initiatives to engage members of the public 'upstream', ahead of technology assessment, have focused on improving dialogue between scientists and non-scientists. Public engagement has not been integrated into decision-making about science and technology in a comparable way to the professional stakeholder engagement processes that are routine within the research system, and nor does it look set to become so.[100] We detect a double standard, whereby well-resourced professional stakeholders play an integral role in decision-making whilst other non-scientists are kept peripheral, on the specious grounds that members of the public will be less able to grasp the science. In particular, the government's *Science and innovation investment framework* places special emphasis on the positive contribution that professional stakeholders, especially from business, can make to science (Section 2.1); by contrast, it treats the involvement of other non-scientists as an impediment to progress, albeit a necessary one. It assumes that citizens who are neither scientists nor professional stakeholders are morally conservative and risk averse, arguing for public engagement in science to ensure that "that society's understanding and acceptance of scientific advances moves forward, and does not become a *brake* on social and economic development in the UK."[101] This view of the public is no more plausible than the discredited 'deficit model', which put public concerns about science down to ignorance (Section 2.3.2).

[a] Responses to **HMT, DfES and DTI** (2004) *Science and innovation investment framework 2004-2014*. HMSO, London, July. Copies of responses can be requested from scienceframework@hm-treasury.gov.uk

3.2.3 Engagement and accountability

We share the government's aspiration to engage citizens 'upstream' in science. We emphasise that this must be in addition to the improvements in 'downstream' technology assessment and product assessment outlined in Section 2.3.3. Public engagement is an iterative process. It would be naïve to think that effective upstream engagement would eliminate the need for subsequent social and ethical appraisal.

To help realise this ambition, the government must take a lead in meeting two challenges. The first is to be consistent in its approach to involving non-scientists in R&D. Neither the government nor research organisations can credibly maintain one attitude to involving professional stakeholders and another to engaging other citizens. Measures to promote 'upstream' public engagement should start from the assumption that the involvement of non-scientists in R&D is currently grossly uneven, not that it is absent. Of course the electorate and consumers already have a diffuse, aggregate influence on public and private research, but a minority of voices representing a narrow range of stakeholder interests additionally has a hot-line to decision-makers.

When we discussed the rationales for public engagement in technology assessment (Box 2.3), we explained that the reason for involving citizens who were not professional stakeholders was not simply that it would be fairer, but that the social intelligence gained in the process would make for better decisions. Despite the increasing weight this 'substantive' argument for upstream engagement carries in government and amongst scientists, it is sometimes rebutted with one of three arguments:

- *'Professional stakeholders are also citizens and consumers, so no extra insights would be gained by involving other people in decision-making.'* But, in practice, few of us are as good as we might like to think at putting ourselves in others' shoes. That is one of the reasons why diversity is important in committees and decision-making bodies. Anecdotal evidence suggests that most experts and professional stakeholders in the UK are not only white and male, but also have relatively high incomes. Obtaining input from people with a broader range of life experiences – such as feeding a family on low income – will enrich the knowledge-base available to decision-makers. Furthermore, when people acquire a professional stake in an issue they usually forfeit some of their capacity to see both sides of an argument – the group dynamic of expert committee is quite different from that of a citizens' jury. Hence, in court cases, juries are composed of randomly selected citizens rather than expert witnesses.[102]

- *'Representative public engagement processes would have to be on such a large scale that they would either be (a) prohibitively expensive, or (b) so superficial that neither the participants nor the organisers would gain anything.'* Some scientists and government officials are particularly concerned that public engagement in science through the media would be counterproductive, fearing a repeat of media reporting on 'Frankenstein foods'. However, this concern is based on a false paradox that derives from taking an instrumental approach to public engagement. It assumes that public engagement is about creating a dialogue on science with as many people as possible, thereby building public trust in science and reducing public concerns. It also seems to treat public engagement as a substitute for political representation rather than a supplement to it. By contrast, a substantive approach focuses on the significant social intelligence that traditional, politically representative decision-makers can gain by listening often only to a small number of people who are not members professional stakeholder groups. There is an advantage in ensuring that the public they engage includes a diversity of perspectives, as already explained, but the role of participants is advisory and so they do not need to be politically or even statistically representative.[103]

- *'Public engagement is little more than market research – if it was worth it, companies would be doing it already.'* The main incentive for companies to engage a wider public is indeed that it will benefit their businesses. Although there are overlaps between public engagement processes and conventional market research there are also methodological differences: both may use focus groups, for example, but market research would seldom afford participants the kind of autonomy and creative space that characterises a citizens' jury. Market research usually focuses on target customer groups, whereas public engagement focuses on the broader social context of a product or technology, and might help to forecast the overall reception it would receive. As to why companies are not already doing this, the easy answer is that businesses can often survive with sub-optimal processes. In fact, the Royal Society of Arts reports that a small number of companies are already moving towards greater public engagement. However, it would probably require a number of successful case studies to be well-publicised and methods to become more refined before public engagement is adopted as a standard business practice.

From a substantive perspective it makes no sense to confine upstream public engagement to 'science and society' initiatives. Whilst there may be a case for championing public engagement through such initiatives, it should also be an integral part of research and research policy across the board. **Not only should public engagement play a greater part in the government's own science procurement and funding, but it should also be integrated into flagship policy initiatives to support business R&D.** Failing to do this is not only to miss a trick that could contribute to commercial science and innovation, but it is also to risk the government undoing with one hand what it is achieving with the other.

It would therefore make sense for the new Technology Strategy Board (TSB), the centrepiece of the government's *Science and innovation investment framework*, to promote public engagement both in its own activities and in those of public and private research organisations.[104] It should treat public engagement as a potential asset to R&D.

Companies and industry associations would also be well-advised to develop public engagement as source of social intelligence, which can assist them in tailoring products and services to areas of high latent demand and low reputational risk. The UK government's Technology Foresight Food Chain and Crops for Industry Panel has concluded, based on a pilot study, that "it *is* possible to engage with the public using a range of methodologies *before* major application of new technologies to product development".[105] Within the UK food sector, both Unilever and the Co-operative Group have paid for high-quality participatory technology appraisals.[106] Inspiration can also be found in other countries and sectors. The think tank Demos looks to Finland, where an ethic of 'open innovation' has given birth to Nokia and Linux, both global success stories.[107] The UK Office of Science and Technology (OST) could play a valuable role in drawing together case studies of good practice in public engagement for commercial R&D.

The second challenge that the government faces is to maintain a clear distinction between public engagement and public accountability. Greater public engagement is a necessary but insufficient response to the challenge of taking ethical and social issues seriously in R&D. Whether a process 'opens up' or 'closes down' decision-making matters more than whether it centres on the public, on experts or on stakeholders.[108] Processes that open policy up produce 'plural and conditional' advice, raising neglected issues and including marginalised perspectives, whereas processes that close it down produce 'unitary and prescriptive' recommendations. Far from being radical or impractical, 'open' processes leave the responsibility for policy decisions clearly with traditional decision-makers, rather than with the public or with expert advisers.

This logic clearly applies to the way public sector research priorities are set, as well as to the participatory TA processes outlined in Section 2.3.3. All public research organisations should report on who they engage with to inform their strategic decisions about R&D, on the advice they receive and on how they draw on the options suggested to them. The umbrella body Research Councils UK (RCUK) should co-ordinate efforts to improve public engagement and accountability amongst funding organisations. RCUK should publicise examples of good practice from the BBSRC and the Medical Research Council, which lead the research councils on these counts.

We believe that private companies also ought to be more accountable for their R&D. Most businesses are primarily accountable to their shareholders. However, they also have responsibilities to other citizens, including consumers of their products. The market and existing risk-based regulation are not sufficient to hold companies to account for these broader responsibilities.

One reason for this is that the choice available to consumers in the marketplace is limited to a preference between available products and is constrained by price. The market only gives them a very diffuse and aggregate influence on future R&D. It is too late for them to contribute creative input. The rhetoric of consumer choice that underpins many business accounts of technology will only become credible if consumers are given a greater input into R&D. A second reason why businesses should be more broadly accountable for their R&D activities is that the market is incapable of holding companies to account to citizens who are not their potential customers. Yet, new products can have widespread economic and social externalities.

In addition to the self-interest companies have in gathering social intelligence through public engagement, they therefore also have a responsibility to canvass a much broader diversity of public input than most currently obtain.[109] We therefore advise the government to encourage corporate accountability for R&D by other means in addition to incentives for public engagement. One possibility is that companies should be obliged to report on their public engagement activities, and the input they recieved, under the proposed *Operating and financial review* (OFR).[110] This would benefit shareholders, the intended beneficiaries of the OFR, because unanticipated technological controversies pose a serious commercial risk, as some companies have found to their cost over GM crops in Europe.

3.3 Policies

Government policy plays a major part in shaping the research activities of public and private sector organisations. Of course, just as the scientists and professional stakeholders who take part in research decision-making do not determine the outcomes, neither does policy. Nevertheless, policy discourses are influential and achieve widespread currency. The framing assumptions and ethical perspectives of government policy become incorporated into the discussions, decisions and actions of a wide range of other organisations.

It is important to stress that these policy discourses, or themes, are not decided only by civil servants or elected officials. They are products of the kinds of stakeholder networks described in Section 3.2.1. The shared language and norms that policy statements embody can be thought of as social glue, helping to hold networks or ‘communities’ of experts and stakeholders together.[111]

Numerous areas of policy bear directly on food and farm research, including trade, environment, health and transport. For example the EU Water Framework Directive, which requires a significant cut in water pollution by 2015, is expected to affect research and innovation in agriculture.[112] The two most relevant policy areas, which are the focus of this section, are science and agriculture.

3.3.1 Science policy

The primary aim of science policy has always been to promote science and technology in the national interest. The pursuit of knowledge and the betterment of humankind have consistently come second to more temporal interpretations of this interest, usually in military or industrial terms. The precise language and the ethos of science policy have shifted over the years, from Wilson's post-war talk of the 'white heat of technology' to the stress on economic 'competitiveness' that has prevailed since Thatcher.

A 1993 White Paper, *Realising our potential*, set the mould for science policy today, pitching science and innovation as means of improving "wealth creation and quality of life".[113] Wealth creation and quality of life can both be very broad concepts – wealth need not refer only to finance or to privately-owned goods, but can also include public goods and non-material benefits. In the White Paper, however, they came to signify commercial success in the international economy. New Labour has pursued this theme, increasing spending on the science base, on science education and on initiatives to promote business R&D. Its 2004 *Science and innovation investment framework* states that:

> "The nations that can thrive in a highly competitive global economy will be those that can compete on high technology and intellectual strength – attracting the highest-skilled people and the companies which have the potential to innovate and to turn innovation into commercial opportunity. These are the sources of the new prosperity."[114]

UK science policy treats the main value of science to society as indirect, commercial and instrumental. Science is primarily about advancing UK businesses. Science is also seen as a way of improving public services, but first of all it is treated as a means to commercial innovation. Thus, in another recent report, the government describes science as contributing "the raw material for innovation".[115] In a similar vein, the Department of Trade and Industry's earlier White Paper on *Excellence and opportunity* exhorted universities to "embrace a new entrepreneurial role, bringing forward the businesses of the future".[116]

The strengths of this commercial focus for science policy are that it can have relatively clearly defined outcomes (principally "to increase the level of knowledge intensity in the UK… from its current level of around 1.9 per cent to 2.5 per cent by around 2014")[117] and can harness the market to steer science towards meeting consumer preferences. However, it also suffers from at least three serious weaknesses:

- First, the notion that science benefits society indirectly, via commerce, implies that the quantity of science is more important than its direction. This understates the diversity of possible futures that are opened and closed by decisions about research. It corresponds to the view that scientific knowledge is devoid of social or ethical content, which the two previous chapters of this report have argued is untenable.

- Second, whilst the emphasis placed on commerce and market mechanisms makes the research system more accountable to some stakeholders, it makes it less responsive to the needs and expectations of others. Promoting an entrepreneurial spirit within universities and research institutes reinforces the influence of their stakeholders from industry, relative to consumers and citizens who have fewer resources and less bargaining power. In Chapter 4, we consider in more detail how the privatisation of research resources affects capacity to produce public goods.

- Third, focusing on the instrumental value of research leaves the broader social and cultural value of science and technology as an afterthought. One contrary view emphasises that science is inherently unpredictable and that it is counter-productive to attempt to steer research.[118] Another view is that science should be seen as means to broader ends than just wealth creation, such as sustainable development. Yet another perspective is that we should not attempt to understand the world in instrumental terms at all. It holds that a science based on controlling and managing things is blind to much of the world's meaning, and is socially and culturally regressive.[119]

There is a long-running debate about how far science should be the 'handmaiden of society'. We recognise that intellectual curiosity drives many scientists, and we accept that the pursuit of knowledge is compromised when it becomes no more than a means to social, political or economic ends. However, our main concern here is that wherever instrumental ends do steer science, whether through policy or through the social shaping of scientific curiosity, those ends should be conceived broadly and not simply in terms of commercial success.

3.3.2 Agricultural policy

Agricultural policy directly shapes the research priorities of government departments, and it also shapes the economic and political environment for commercial R&D. Within the UK, this is largely the domain of DEFRA and, previously, MAFF. But, to a greater extent than science policy, agricultural policy is developed at the European level.

The past thirty years have seen a painstaking shift in emphasis within the EU's Common Agricultural Policy (CAP). When the UK joined the European Economic Community, in 1973, CAP focused on subsidising farm production.[120] The rationale for focusing on production had initially been economic, to combat post-war food shortages and to help correct the balance of payments. Once food imports ceased to be such a worry the logic shifted to focus on preserving a particular model of rural life, though the policy mechanisms remained broadly similar. This focus on agricultural production has proved destructive to the rural environment. It also became sharply apparent that the EU's agricultural subsidy schemes were inconsistent with its vigorous efforts to reduce non-tariff barriers to trade in other countries through the WTO.

EU farmers still receive large subsidies, amounting to 37 percent of the value of EU farm production in 2003.[121] However, agricultural policy in the EU and the UK today puts environmental sustainability before farm production, at least on paper. CAP nowadays promotes 'agri-environment' initiatives and a 'multifunctional' rural economy, which gains income from tourism and environmental services as well as from farming.[122] The range of stakeholders involved in agricultural policy formation has expanded accordingly, diminishing the overwhelming influence formerly commanded by agricultural lobby groups.[123]

This green theme within agricultural policy underpinned the dissolution of MAFF and the creation of DEFRA in 2001. It featured prominently in the Curry Commission report on *Farming and food: a sustainable future.*[124] It also ran through DEFRA's *Strategy for sustainable farming and food*, and the *Science and innovation strategy* that followed it.[125] Box 3.2 reproduces part of DEFRA's Public Service Agreement, showing how prominent the sustainable development theme is within the department's aims.

Box 3.2

DEFRA's aim, excerpted from its Public Service Agreement, 2003-2006.[a]

Sustainable development, which means a better quality of life for everyone, now and for generations to come, including:

- a better environment at home and internationally, and sustainable use of natural resources;
- economic prosperity through sustainable farming, fishing, food, water and other industries that meet consumers' requirements;
- thriving economies and communities in rural areas and a countryside for all to enjoy.

The theme of sustainable development feeds into DEFRA's research commissions and the LINK private-public partnership schemes that it runs (Box 3.3).[126] Officially, the UK government's brand of sustainable development gives equivalent weight to the environmental, social and economic aspects of sustainability. Thus, since 1999, UK sustainable development policy has focused on meeting four objectives, nationally and internationally:

[a] **DEFRA** (2002) *Public service agreement 2003-2006*. Accessed on-line: http://www.defra.gov.uk/corporate/busplan/psa2002.htm, 29/07/04.

- Social progress which recognises the needs of everyone.
- Effective protection of the environment.
- Prudent use of natural resources.
- Maintenance of high and stable levels of economic growth and employment.[127]

In 2005 the UK's sustainable development strategy is due to be strengthened and revised, probably giving rise to five objectives.[128] The environmental, social and economic elements will each remain.

However, sustainable development is a notoriously slippery concept which allows its proponents considerable interpretive flexibility.[129] In practice, it appears that agricultural policy is under pressure from its traditional client groups to frame environmental and social concerns in economic terms, reducing sustainable development to 'ecological efficiency' (or 'eco-efficiency', as it is known to its proponents) and attempting to measure it against a single economic value such as 'total factor productivity'.[130]

Box 3.3

DEFRA's LINK programmes.

LINK is a non-competitive research scheme designed to bring industry and academic research closer together. It is a matched funding scheme, with the government funding up to 50% and industry or other co-funders covering the remaining costs. The scheme aims to accelerate the development of new technologies, to link research and industry so that research better reflects industries' needs, and to increase industries' willingness to invest in research.[b]

DEFRA is involved in three LINK programmes, Agriculture LINK, Aquaculture LINK, and Food LINK. The research covers a wide array of product areas. In 2002-3, 18% of DEFRA's farming and food research budget was spent on the LINK programmes.[c]

Such a narrow approach writes crucial components of sustainable development, such as social justice, completely out of the picture.[131] It goes against the grain of efforts by DEFRA, the government's Sustainable Development Unit and the Sustainable Development Commission to make UK policy on sustainable development stronger and more coherent. The new Research Priorities Group (RPG) provides an opportunity for DEFRA to promote a more even-handed approach to sustainable development in science and innovation, by increasing the range of organisations and individuals who are involved in policy formation beyond the usual stakeholders. The RPG has expressed disappointment at the inability of key experts and stakeholders "to think outside existing paradigms".[132] Research on policy formation suggests that to get new research ideas from 'outside the box', the RPG should look outside the box for its advice, to those farmers and other citizens who have previously been marginal to policy formation.[133]

3.3.3 A sustainable science policy

Science and innovation cut across many other fields of policy. The language in which policy-makers from these different areas currently communicate focuses on the success of UK businesses in the international economy. We believe that the government's objectives for science policy should be broader. In theory, either the concept of sustainable development or an expanded notion of wealth creation could form the guiding theme for this broader approach. What matters is that the theme will mean more or less the same thing to decision-makers in different departments and that it can be pinned down to a specific set of clearly defined objectives. In practice, this makes sustainable development the more realistic theme because, despite all the different versions of this term that exist in other fora, the UK government has developed and is further refining a co-ordinated sustainable development strategy. **We recommend that the government develops a more joined-up approach to research and innovation policy around the theme of sustainable development.**

[b] **DEFRA** (2004) *What is LINK?* Accessed on-line: http://www.defra.gov.uk/Science/LINK/Information/default.asp, 10/08/04.

[c] **Murphy-Bokern, D.** 2004 DEFRA sustainable food and farming research. *Presentation,* DEFRA, February 18.

The stress that science policy currently lays on the economic returns of research spending has arguably led to a neglect of some fields of research, for example into low-external input farming techniques, which do not promise marketable products but which would contribute to sustainable development. In general, the priority given to a narrow range of economic objectives in science policy jars with the government's explicit commitment to sustainable development, which places equivalent weight on economic, social and environmental objectives. This disconnection is manifest in conflicting pressures on public research organisations which gain part of their income through science policy and part through agricultural policy. Thus, the research institutes gain income from DEFRA to undertake research relating to sustainable development, and from the BBSRC to promote economic competitiveness. The concept of sustainable development is premised on the fact that these two objectives are not always compatible.

We are not saying that science policy should be against wealth creation, but that the government should be more selective about the means of wealth creation it promotes. It should ask what kind of wealth it is creating, on what timescale and for whom. It should consider whether science and innovation are likely to have unaccounted costs or benefits for human health, animal welfare or the environment.

In the *Science and innovation investment framework,* the government proposed a new cross-departmental horizon-scanning system to co-ordinate policies on science.[134] The government's Foresight team have been charged with developing this proposal. Such a horizon-scanning system could begin developing a joined-up approach to science across government around the theme of sustainable development. DEFRA's existing Horizon-scanning Unit could assist in this regard.

The precautionary principle is one of the cornerstones of sustainable development and is likely to be mentioned in the government's five revised objectives for sustainable development.[135] A sustainable science policy would presuppose precautionary product and technology assessment, of the kinds that we outlined in Section 2.3. At the very least, precautionary TA asks, 'What are the risks and benefits of using this technology *compared* with not using it?'. Because precautionary TA entails an inevitable element of comparison between alternative technological possibilities, a sustainable science policy designed to complement such a TA approach would aim to stimulate a diversity of technological options. By contrast, the government's current science and innovation policy tends to focus on 'picking the winners'. A cross departmental horizon-scan would assist in identifying other changes that would be required to build a more sustainable science policy.

4. Resources

4.1 Public and private

Irrespective of the organisations involved in R&D or the policies against which it is framed, research on food and farming requires financial, human, natural and intellectual resources. The way that control of these resources is shared between the state and private companies is an important factor affecting the kind of research that gets done, because public and private ownership are usually associated with different responsibilities, to different groups of people. In this chapter we suggest that the benefits of current policies to promote broader public engagement in research and research policy will be largely cosmetic unless control of the resources for research is radically redistributed.

The UK government's innovation policy is premised on a public-private partnership (PPP) model.[136] It aims to increase commercial R&D activity, increasing the ratio of private to public spending. This will increase the concentration in private hands of research resources, reproducing one of the conditions that creates an apparent need for PPPs. In Section 4.2.2 we argue that this concentration of resources places market pressures on public sector researchers and regulatory agencies, diminishing their capacity to provide an accountable public service.[137] We are concerned that a science policy focused on PPPs will compromise regulatory capacity and public safety, and diminish research leading to public goods.

In many ways, PPPs are an important departure from previous ways of doing research, and they warrant closer scrutiny by governments and research organisations than they are currently getting. However, the novelty and the risk are in the detail of PPPs, in the new contractual relationships, the shifts in accountability and the changes in access to knowledge that they imply. In evaluating PPPs it is crucial to remember that partnerships as such are not new. As described in Chapter 2 of this report, the processes of innovation and regulation involve both public and private research, even in the absence of formal partnerships. Chapter 3 described how many research organisations are neither wholly commercial nor state-owned; Section 3.2 described how networks of scientists and non-scientists link them together. With or without PPPs, public accountability needs to be strengthened across the research system.

Private and public organisations are also already mixed together in policy formation. Commercial farmers and food companies have been deeply implicated in developing the agricultural policies discussed in Section 3.3. Companies have been heavily involved in science policy too. For instance one of the key initiatives in the government's latest *Science and innovation investment framework*, a £150 million per year Technology Strategy, was proposed by the Confederation of British Industry.[138] Private companies have also played important roles in devising policies that have privatised research resources, both nationally and in international fora such as the WTO.[139]

Not only are public and private research more closely intertwined in practice than is generally appreciated, but they are also continuous in principle. The responsibilities of public and private research organisations to citizens are not as different as it is often imagined. Both are financed by members of the public, whether via taxation or via the marketplace. Both of their research outputs affect citizens who are not their immediate customers or stakeholders. Neither currently satisfies the responsibilities that these public inputs and outputs imply.

4.2 Financial resources

4.2.1 R&D spending

Public spending on food and farming R&D in the UK amounted to around £300 million in 2001-2, about four percent of total public spending on R&D (Table 4.1). The bulk of this amount was directed towards agricultural research.[140]

Table 4.1

Public spending on food and farming R&D, 2001-2002: a conservative estimate.[a]

Organisation	Spending / million pounds
Biotechnology and Biological Sciences Research Council	101.3
Department for Environment, Food and Rural Affairs	96.4
Scottish Executive Department of Environment and Rural Affairs	56.4
Department for International Development	21.6
Food Standards Agency	19.9
Northern Ireland Department of Agriculture and Rural Development	5.9
Food Standards Agency Scotland	0.7
Total	302.2

Note: Department and agency spending is recorded by category in the DTI's *Forward look*. These figures are the totals, by department or agency, of all spending in categories that appear directly related to food and agriculture (e.g. 'Food safety and nutrition'; 'Food technology'; 'Arable crop science').

The total given here is likely to be a considerable underestimate of actual public spending on food and farming-related research. Excluded from the table are the Department of Health, the Natural Environment Research Council and other bodies which finance research in this area. This is because the available figures on their spending are not categorised in a way that allows us reliably to estimate what proportion relates to food and farming.

Total civil R&D spending in the same year was £4,716.9 million. The combined civil and defence R&D spend was £7,166.9 million.

In the same year, private research spending in categories *related* to food and farming amounted to £4.3 billion (Table 4.2). A direct comparison between these figures for public and private spending is impossible for three reasons:

- First, private R&D spending relating to food and agriculture is included in much broader categories within the OST's official statistics. The figure of £4.3 billion includes tobacco and non-food chemical research.
- Second, the state and private companies finance different kinds of research (Section 3.1). To some extent, the broad categories used by the OST reflect real overlaps in commercial R&D activity.
- Third, private and public research spending are organised on different scales. The largest companies make some strategic decisions about R&D on an international scale. Although international research collaborations do take place in the public sector, they are on a smaller scale and generally report to national governments rather than supranational bodies.

Table 4.2

Business R&D spending in categories broadly related to food and agriculture.[b]

Business enterprise by sector	Spending / million pounds
Agriculture, hunting, forestry & fishing	122
Food products and beverages; tobacco	299
Chemicals, man-made fibres	583
Pharmaceuticals, medical chemicals and botanical products.	3,304
Total	4,308

Note: It is not known what portion of spending in each category relates to food and agriculture.

It is therefore more useful to compare public and private spending on a *global* scale, not simply within the UK alone. Whilst it is difficult to arrive at precise figures on public and private spending, there is broad agreement about national and international trends in the ratio between them. Public sector spending on agricultural research, which has traditionally been high compared with public research spending in general, has declined relative to private spending over the past decade or so:

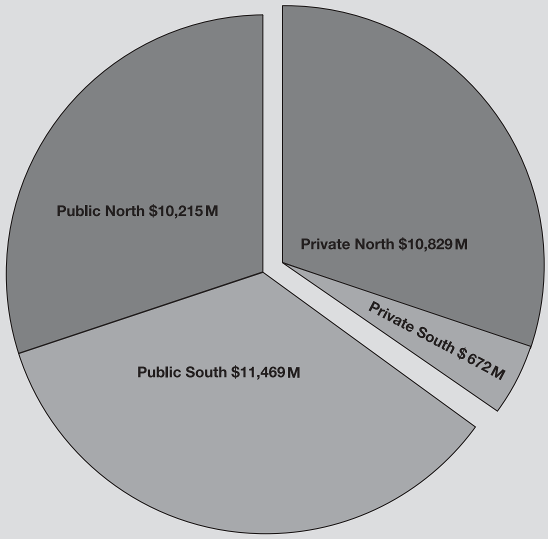
[a] **DTI** (2003) *The forward look 2003.* DTI, London. Accessed on-line: http://www.ost.gov.uk/research/forwardlook03/tables/index.htm,05/10/04.

[b] **OST** (2003) *Research and development in UK businesses: business monitor MA14 data for 2002.* TSO, London.

> "Governments everywhere are trimming their support for agricultural R&D, giving greater scrutiny to the support that they do provide and reforming the public agencies that fund, oversee and carry out the research… The similarities derive from a set of common 'vectors for change' that have come into play… including the advent of political administrations with more market-oriented, *laissez-faire* views of the role of government in the management of the national economy, the changing nature of scientific research, the development of a more sceptical view of the potential benefits from agricultural R&D, and the growing influence of 'non-traditional' interest groups (such as agribusiness, food industry, environmental and food safety lobbies) on the agricultural R&D agenda."[141]

Global public spending on agricultural R&D is estimated to have risen in real terms from $11.8 billion in 1976, to $21.7 billion in 1995.[142] Whereas the rate of growth in public expenditure was four and half percent per year between 1976 and 1981, by 1991-1996 it had dropped to two percent. By the mid-1990s, the private sector was spending around $11.5 billion per year, accounting for one third of total global agricultural R&D expenditure. This private spending was heavily concentrated in rich countries, where private spending now exceeds public spending on agricultural research (Figure 4.1).[143]

Figure 4.1
Public and private, North and South: spending on agricultural R&D in high income versus low and middle-income countries, circa 1995, in 1993 international dollars.[c]



The focus of private spending varies considerably from country to country, with food processing research dominating in most rich countries.[144] In the UK, research into agricultural chemicals accounts for the largest share of private spending, over 40 percent. In the USA, where many of the world's largest agricultural and food companies are based, the share of private research expenditure on food processing and agricultural machinery has diminished over the past 30 years compared with spending on plant breeding and veterinary drugs.

The social, economic and technological consequences of the relative drop in public spending are not straightforward. Privately financed research can benefit a range of people aside from its investors, such as the users of its products or the public at large. Conversely, publicly-financed research can be undertaken for profit.

Nevertheless, the relative decline in publicly financed research has prompted considerable concern (Box 4.1). This is because there is no incentive for private investors to finance research into 'public goods' or agricultural technologies for which there would only be a small market, sometimes called 'orphan' technologies. Public goods are both 'non-rival', meaning that consumption by one person does not detract from that by another, and 'non-excludable', meaning that it is difficult for one person

[c] Adapted from: **Pardey, P. G. and Beintema, N. M.** (2001) *Slow magic: agricultural R&D a century after Mendel.* International Food Policy Research Institute, Washington DC, October 26: 10, table 2.

to prevent another from enjoying them. They provide benefits for many individuals and yet they are unlikely to be produced without collective action. Education, food security and knowledge are examples of public goods. By definition, research leading to public goods and orphan technologies does not yield a significant return on investment.

Box 4.1

Rising concerns about falling public spending on agricultural research and biotechnology.

Gordon Conway (Rockefeller Foundation, USA)
"Private interests now dominate all aspects of research, production and the marketing of biotechnology. Even the regulatory systems favor big corporations with cadres of lawyers… This new world of research has made the work of public agencies traditionally responsible for virtually all of the products made available to the poor considerably more difficult across the board, but more so for agricultural research."[a]

Food and Agriculture Organisation of the United Nations
"Who will develop biotechnology innovations for the majority of developing countries that are too small in terms of market potential to attract large private-sector investments and too weak in scientific capacity to develop their own innovations?"[b]

Nuffield Council on Bioethics
"Much of the current privately funded research on GM crops serves the interest of large-scale farmers in developed countries. Consequently there is a serious risk that the needs of small-scale farmers in developing countries will be neglected. It appears that research on these crops will have to be supported primarily by the public sector."[c]

Prabhu Pingali (International Maize and Wheat Improvement Centre, Mexico) and Greg Traxler (Auburn University, USA)
"Over the past decade the locus of agricultural research and development has shifted dramatically from the public to the private multinational sector… The benefits of private sector investments in agricultural research have, to date, accrued mainly to farmers in favourable production environments in a few developing countries, and have been restricted to a very few crops… Private sector research activity is likely to expand only very slowly in areas where it is difficult to appropriate benefits."[d]

Yet much of the research that is perceived to be most urgently needed, on a global scale, falls into one or other of those two categories. At the 2002 Earth Summit it was agreed that creating 'global public goods' was a precondition of sustainable development.[145] The free availability of 'basic' knowledge about plants and animals is crucial to maintaining the momentum of public and private research in areas such as plant breeding.[146] Pro-poor agricultural technologies could assist in addressing the persistent problem of hunger, which affects hundreds of millions of people worldwide, but there is little money to be made from developing them.[147]

As the ratio of public to private R&D spending has changed, so has the relationship between the public and private sectors. As we explained in Chapter 3 there has never been a clear divide between the organisations and people involved in each. However, the boundaries that exist have become increasingly blurred. State resource cutbacks have combined with other factors to promote public-private interactions:

> "The state recasts its own role, towards a purchaser of goods and services, or even a facilitator of 'internal markets' and output-auditing systems, which replace explicit planning as a basis for public accountability[148]."[149]

The effect of this, as an EU-funded study of public sector agricultural research concludes, is that:

> "Even a small proportion of industry funding can influence overall research priorities: the tail can wag the dog."[150]

In other words, the considerable boost in the ratio of private to public research spending signals a much greater amplification of private influence. The proportion of research that puts private interests before

[a] **Conway, G.** (2003) *From the green revolution to the biotechnology revolution: food for poor people in the 21st century.* Woodrow Wilson International Center for Scholars, Director's Forum, March 12: 16-17.

[b] **FAO** (2004) *The state of food and agriculture 2003-2004.* Food and Agriculture Organisation, Rome, Italy: 87.

[c] **Nuffield Council on Bioethics** (2003) *The use of genetically modified crops in developing countries: a follow-up discussion paper.* Nuffield Council on Bioethics, London, December 28: xvi.

[d] **Pingali, P. L. and Traxler, G.** (2002) Changing locus of agricultural research: will the poor benefit from biotechnology and privatization trends? *Food Policy* 27: 223-238: 223, 233.

public interests will have risen more sharply than the proportion of private to public spending.

The configuration of public and private research resources is clearly changing. This affects the kinds of research that gets done in the UK and internationally. It also appears to compromise the public accountability of research decision-makers. However, it is impossible to chart accurately how public and private research priorities have shifted in this country, and to show which fields of food and farming R&D have won and lost through these changes. This is because the classifications that the OST uses to gather and present data on private research spending aggregate food and agriculture-related R&D into categories which preclude comparison with those used by government departments and the research councils.[151] For example, in attempting to review public research relating to agricultural biotechnology, the AEBC has also experienced difficulties in comparing data from different funders.[152] We believe that the difficulty of comparing research spending across departments and between the public and private sectors presents a major barrier to intelligent and accountable decision-making about food and farming research, particularly when public spending is justified in terms of 'market failure'. **We recommend that the Office of Science and Technology develops data categories which will facilitate cross-departmental and public-private comparisons of research spending.**

4.2.2 Infrastructural investment

As the UK government cut back public funding for research on food and farming, from the late 1980s onwards, a growing number of research facilities became wholly or partly owned by private companies. Starting in 1987, the government sought to eliminate public sector involvement in 'near-market' science that would substitute for or compete with commercial R&D. The logic behind this ambition was that "industry should make a greater contribution towards the cost of R&D from which it benefits".[153] David Shannon, then Chief Scientist at MAFF, explains that R&D in agriculture was targeted for particularly heavy cuts:

> "It was well known by this stage that there was over-production of food as a result of modern agricultural methods and that this was being sustained by the EU Common Agricultural Policy (CAP). While the UK Government could not alter CAP expenditure unilaterally, it could look critically at all other forms of Government support for agriculture which might be exacerbating these perceived problems. R&D on production was perceived as being such an area…"[154]

Around £30 million worth of 'near market' MAFF research activity was cut, nominally 'transferred' to industry, and there were also reductions to the AFRC's portfolio.[155] Accordingly, industry-oriented public sector research enterprises (PSREs) either had their statutory funding cut, requiring them to compete for public and private research contracts, or were divested altogether.

In the late 1980s both the National Seed Development Organisation and a large part of the Plant Breeding Institute were sold to a company, Unilever.[156] A number of smaller experimental farms and research stations were sold off over subsequent years. In 1997 the Agricultural Development Advisory Service, which had previously done the bulk MAFF's extension work, became a private company. Central government support for the food research associations, Campden and Chorleywood Food Research Association and Leatherhead Food International, also diminished considerably.[157] Not all of the holes left by this policy could be filled by industry. The report of the *BSE inquiry* notes that the overall public spend on animal disease research was reduced by about 20 percent.[158] Soil research was also subject to major cut backs.[159]

In the early 1990s two regulatory bodies, the Pesticides Safety Directorate (PSD) and the Veterinary Medicines Directorate (VMD), and three laboratories, the Veterinary Laboratories Agency, the Central Science Laboratory and the Centre for Environment, Fisheries and Aquaculture Science, became executive agencies of MAFF, now DEFRA.[160] They are run like businesses and are responsible for generating much of their income through fees.

That the VMD and the PSD acquire 60-70 percent of their budgets through approval fees and sales levies is not a problem in itself.[161] However, increasing harmonisation of EU product assessment processes puts these UK regulatory agencies into competition with equivalent licensing bodies in other countries – since not all member states need approve many types of product for them to become available across the EU, regulatory bodies that depend on licensing fees compete for product applications. Plans to reduce total number of regulatory agencies in the EU will increase this competitive pressure.

VMD officials have been known to claim that if a competition exists between EU regulators then it is to be as stringent as possible. They have argued that industry favours strict regulation because it acts as an extra round of quality control for their products. However, we know of no evidence to back this up as a general claim, whereas there has been at least one instance where companies have reportedly targeted European veterinary drug applications to regulatory bodies (including the VMD) that are perceived a 'soft touch'.[162] Even if that case was an exception rather than the rule, it is both dangerous and absurd for the structural independence of UK regulatory institutions to depend on strategic decisions in multinational companies. **As a matter of priority we recommend that DEFRA restructures its regulatory agencies so as to ensure their financial independence from industry.**

Thus, it appears to us that the privatisation of the UK's research infrastructure, which began in the 1980s, has not only reduced the resources available for 'orphan innovation' in fields such as soil science, but has also compromised the capacity of regulators to ensure the safety of the UK food supply. We advise that the DEFRA Horizon-scanning Unit commission a retrospective study to identify fields, such as animal disease research, where greater public research effort would have been likely to have offset subsequent public costs and risks. This study would assist DEFRA and HM Treasury in weighing up the current costs and future benefits of major reinvestment in public facilities for research on food and farming.

4.3 Human resources

The privatisation of research facilities has been accompanied by cut-backs in public sector employment. The number of government personnel in departments doing significant food or farming R&D halved during the 1990s (Table 4.3). Research is increasingly out-sourced to the private sector, nationally and internationally. Recent years have seen three other shifts in the availability of skilled labour.

Table 4.3

Personnel engaged in R&D in government departments, and research councils involved in significant food and farming research, 1990-1 and 2000-1.[a]

Organisation	Total Personnel (full-time equivalent) 1990-1	2000-1
Agriculture and Food Research Council	4,000	-
Biotechnology and Biological Sciences Research Council	-	3,164
Department for Environment, Food and Rural Affairs	-	1,843
Department for International Development/Overseas Development Agency	189	51
Department of Health	634	702
Economic and Social Research Council	113	94
Ministry of Agriculture, Fisheries and Food	2,514	-
Natural Environment Research Council	2,836	2,576
Total	10,286	5,266

Note: A significant portion of the decrease in DFID/ODA staff results from the transfer of the Natural Resources Institute to the Higher Education Sector. AFRC and BBSRC figures include staff employed at sponsored institutes.

[a] **OST** (2003) *SET statistics*. Accessed on-line: www.ost.gov.uk/setstats/index.htm, 20/02/04: Table 8.4.

First, there has been a general decline in the rate at which people with engineering and related skills have been entering the UK workforce from higher education.[163] This is a major concern for the government, which has announced numerous initiatives intended to push and pull students towards the physical sciences.[164] The biological sciences have not experienced this decline.[165]

Second, by contrast, government concerns about scientists *leaving* the workforce are most acute for the biological sciences. The worry is that protests over genetic engineering research and animal testing are driving skilled scientists to leave the UK.[166] This issue was given publicity in November 2003 when an open letter to the Prime Minister, co-ordinated by a lobby group called Sense about Science, suggested that scientists, along with biotech investment, might flee the UK because of protests against GM-related research.[167] In July 2004, the company Syngenta announced that it would be moving its GM crop research from the UK to the USA. Its laboratories at Jealott's Hill were the only major centre of commercial GM-crop research remaining in the UK. The move was expected to result in the loss of 100 scientific posts.[168]

A third factor affecting the availability of skilled scientists is their terms of employment. The Association of University Teachers (AUT) union reports that during "the last two decades, higher education staff have seen their pay fall by 40% compared to the rest of the workforce".[169] The AUT argues that in universities the biggest incentive for scientists to move abroad is not public protest in the UK but the prospect of better pay in other countries, particularly the USA. In addition, researchers in universities and other public sector organisations are employed on short-term contracts.[170] This has created greater flexibility and mobility within the research system. However, it also generates job insecurity and is a major disincentive to people considering a research career.

A recent report by the science union Prospect is highly critical of the effects that private and short-term contracting have on the delivery of publicly financed research. Prospect argues that:

> "Dispersal of work among different contractors can lead to fragmentation, discontinuity and short-term perspectives. These can severely damage the service provided, e.g. long-term data gathering and research and development."[171]

Prospect cites the *Anderson inquiry* into the lessons learned from the FMD outbreak, which notes the difficulty that the BBSRC Institute for Animal Health has had in recruiting and retaining staff.[172] The science union also cites Sir David King, the Chief Scientific Advisor, who blames financial and staff cuts, and the privatisation of PSREs, for declines in the numbers of experienced senior scientists available to make informed decisions about BSE and FMD:

> "The net result is that we've lost a fair amount of the science base from within the civil service, so we don't have these people bubbling up into top positions. The problem with an organisation that outsources all of its resources is that, if it does it too rigorously, it no longer knows even what questions to ask."[173]

It appears that government efforts to cut the short-term costs of public sector research and increase flexibility are eroding the human resource base it needs to conduct longer-term research in the public interest. We are gravely concerned that this approach to human resource management reflects a more general culture of 'short-termism' in public sector science. By contrast, a science policy oriented towards sustainable development objectives (Section 4.3.3) would make it a high priority to build capacity for long-term research.

4.4 Natural resources

Whereas agricultural and industrial production often require large quantities of natural resources, research processes may only involve a microscopic amount of study material. Many of the natural resources needed for research are freely available, such as air, and others, such as land, may already be incorporated into a research facility. The most notable exception to this is germplasm, the raw material for plant breeding, access to which has been tightly controlled since colonial times. Germplasm is plant matter that carries genetic information. It can be stored within live plants in botanic gardens such as Kew, as seed or as genetic material.

The ethical issues around germplasm are international in scope, rather than being confined to the UK. Historically, gene-poor rich countries have stock-piled germplasm gathered from the poor countries that contain most of the world's centres of plant genetic diversity.[174] In its places of origin, germplasm has been treated as an open access resource or as 'common heritage'. However, new plant varieties developed from that material by breeders in rich countries have not been returned to people in poor countries for free. They have been sold back to them as commodities.

Genetic engineering and plant biotechnology have seen an upsurge in the rate of 'bioprospecting'. Although some public germplasm repositories, including Kew,[175] now pride themselves on open access, plant biotechnology has in general prompted growing concern about 'biopiracy', where germplasm is taken without remunerating the communities that have stewarded its development. Some of the best-known cases of 'benefit sharing', when agreements have been made between the research organisations taking germplasm and the communities credited with its stewardship, have come under fire: sometimes the state or private 'owners' have stood in for communities, and sometimes remuneration has been inadequate.[176]

Benefit-sharing faces several persistent problems. For instance, if germplasm is used in crop breeding, how many plant generations must pass before royalties cease to be due? One of the greatest difficulties is that most bioprospecting is framed in terms of private ownership, whereas valuable germplasm has often been developed through 'bio-cooperation' in the public domain. Privatising germplasm through contractual agreements threatens that cooperative process:

> "The dilemma is whether bio-cooperation at the village level can survive in a context in which ownership and contracting dominate the exchange of seeds and farmer knowledge beyond the village… Compensation for genetic resources does not have to be cast into the mold of possessive individualism."[177]

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), which entered into force in June 2004, is one of several major initiatives intended to ensure a fairer sharing of the benefits deriving from germplasm.

Although these issues around germplasm and the efforts to address them are international, UK policy plays an important part. The UK has ratified the ITPGRFA, but it is one of a number of industrialised countries that has negotiated changes to the text to favour the demands of international seed companies ahead of the needs of poor farmers. Specifically, the UK insists that the treaty does not apply to crops derived from varieties that fall within its scope, if the form of those crops has been modified by such processes as genetic engineering. This would mean that benefits deriving from the commercialisation of those crops would not need to be shared.

We believe that this is the wrong position for the UK to take in international negotiations on germplasm. It is potentially detrimental to the interests of poor farmers and rural communities and damaging to their food security. Our view rests on the recognition that improving the wellbeing of poor communities in other countries and treating them fairly in international negotiations is essential for the UK to achieve its sustainable development objectives, which are explicitly international in scope.

The purpose of the ITPGRFA is not simply to share the benefits of plant genetic resources deemed the common heritage of humankind, but also to promote agricultural biodiversity. This is a domestic concern for the UK as well as an international issue. At a global scale, maintaining agricultural biodiversity is crucial to ensuring the continued success of plant and animal breeding and it contributes to food security. Within the UK, agricultural biodiversity is important to safeguard the health and cultural value of farming environments. Farming communities and civil society organisations have undertaken numerous projects to promote agricultural biodiversity. Examples range from seed fairs in Kenya and community seed banks in Brazil, to seed exchanges and rare breed organisations in the UK (Box 4.2). DEFRA and the Department for International Development should substantially increase their support for *in situ* agricultural biodiversity conservation, in the UK and in low and middle-income countries.

Box 4.2

On site agricultural biodiversity conservation: examples from the UK and low and middle-income countries.

Community seed banks, Brazil [a]
Local organisations have worked with farmers in Paraíba, Brazil, to create over 220 community seed banks. In this drought-prone region, agricultural biodiversity is crucial factor in food security. The seed banks are thought to benefit around 7,000 families.

Seed fairs, Kenya [b]
In Tharaka, Kenya, community seed fairs have been held annually since 1996. In 2001, farmers displayed 206 varieties. The reasons participants give for taking part in the fair include that is an opporunity to obtain rare seeds, to exchange knowledge with other farmers, and to meet with extension staff and development agents.

Heritage Seed Library, UK [c]
The Henry Doubleday Research Association established the Heritage Seed Library in 1975, in order to combat the erosion of agricultural biodiversity by commercial pressures for uniformity and by the high cost of registering seeds for sale. The library now contains over 800 traditional vegetable varieties which are distributed to its 10,000 members.

Rare Breeds Survival Trust, UK [d]
Between 1900 and 1973 more than 20 breeds of British farm animals became extinct. The Rare Breeds Survival Trust is a charity established in the 1970s, which works to preserve over 70 rare breeds. Amongst other activities the trust conducts surveys, plans breeding programmes and promotes rare breed husbandry.

4.5 Intellectual resources

Two previous reports from the Food Ethics Council have discussed ethical issues around the intellectual resources for research. These reports have focused on intellectual property (IP) protection, the legal means by which knowledge is turned into a commodity that can be bought and sold, and which grant a temporary monopoly on the use of knowledge to the people who successfully claim to be its originators (Box 4.3). The logic of IP protection is that the economic incentive it creates for making new knowledge outweighs the restrictions placed on the use of that knowledge.[178] IP strikes a utilitarian bargain between inventors and the rest of society. As the government's Commission on Intellectual Property Rights notes, whether the social benefits of IP protection exceed their costs in general remains an open question.[179]

The first of our two previous reports on this topic provides a detailed overview of IP as it relates to food and farming.[180] The second focuses on GM crops in low-income countries and re-examines the case of Golden Rice, modified to provide vitamin A, which highlights many of the difficulties associated with IP protection in agriculture.[181]

The international scope of our two previous reports on IP reflects our belief that the most serious challenges associated with IP in food and agriculture concern poor farming and indigenous communities

[a] **Mulvany, P.** (2001) *Knowing agricultural biodiversity: managing agricultural resources for biodiversity conservation (draft).* ELCI, Nairobi, September.

[b] **Mulvany, P.** (2001), see note a

[c] For information visit: *http://www.hdra.org.uk/support_us/adopt.htm.*

[d] For information visit: http://www.rare-breeds.com.

Box 4.3
Intellectual property.

Intellectual property is the term used to refer to a range of legal devices that allow creators and inventors to prevent other people from using their work or invention without permission. They include:

- Patents, which apply to the knowledge behind non-obvious, novel and industrially applicable inventions.
- Plant variety protection (PVP), including plant breeders' rights (PBR).
- Geographical indications, such as those associated with speciality wines or cheeses from a particular region.
- Copyright, which applies to creative works such as writing, music or pictures.
- Trademarks, such as those associated with branded goods.

Patents are a more restrictive form of IP than PVP or PBR. They allow the patent owner to charge royalties to other people who use their technical knowledge and to exclude others from using that knowledge. Since the 1980s, some countries have allowed patents on biological 'inventions'. By this route, patenting has come to affect the use of plants and animals in agriculture.

in low and middle-income countries. We are concerned that international IP agreements are detrimental to the interests of these communities and the processes by which those rules were negotiated have been unjustly weighted against them. The UK government is involved in these international processes. It has a moral obligation to act fairly and to uphold the human rights of people who are not UK citizens, as well those who are.

This report focuses on the UK. Accordingly, we concentrate on issues that are directly relevant to food and farming research in the UK. We identify four flaws in the utilitarian bargain underpinning IP. This raises a question: if current forms of IP are not the right ways to stimulate and finance knowledge creation, then what are?

- The first problem is that IP protection is premised on an individualistic model of invention and creativity.[182] This is inconsistent with the complex and realistic understandings of innovation favoured elsewhere in government policy (Section 2.1). Whereas innovation is usually a collective process, IP protection is designed to reward a small number of individual 'inventors'. In practice, because IP law is complicated and protection is expensive to obtain, it is likely to reward the individuals or companies with the best lawyers, rather than those that are most innovative. The mismatch between the practicalities of innovation and the model presupposed in IP rules has given rise to numerous legal battles between rival companies. IP protection creates an incentive to invest in lawyers as much as in R&D. To alleviate this problem, incentives for knowledge creation should reward collective creativity.

- Our second concern is specific to patents. In certain fields of biological science, including pharmaceutical research and plant breeding, a proliferation of expansive bio-patents threatens to gridlock research.[183] The Royal Society and other science organisations have argued that "broad intellectual property claims, or claims on DNA sequences without a true invention being made, should not be granted because they stifle research and development".[184] Their concern is that public sector research may be compromised because the 'upstream' knowledge it depends upon has too many owners. The exclusive nature of patents, unlike some other forms of IP protection, means that companies can buy them in order to block their competitors from developing new products, even if they do not intend to use the knowledge themselves.[185] In order to address this difficulty, incentives for biological research should not grant any individual or company exclusive control over the use of new knowledge.

- Third, IP creates a market for knowledge, on the assumption that the market is a good approximation for many public needs and aspirations, and that the state will fill in any serious gaps. This view acknowledges that there are certain kinds of knowledge and technology that the market is unlikely to satisfy, including innovations that meet the needs of marginal groups with little purchasing power and 'basic' knowledge that has no immediate commercial application. Public research expenditure is often justified on the grounds that it addresses such cases of 'market failure'.[186]

Yet market forces, IP and patenting are not confined to the private sector. They have an increasing bearing on the direction of publicly financed research. Universities and public sector research organisations now routinely patent knowledge, if only to protect it from commercial appropriation and to act as a bargaining chip when negotiating IP with companies. The growing reliance of these institutions upon companies for income also exposes their research to market forces.[187]

The effect of this trend is that the commercial value of research has become very important to public sector research organisations. It affects the kind of research they do, directly impinging upon their capacity to generate freely available public goods.[188] Food and farming research across the public-private continuum is under heavy commercial pressure to produce products that can be sold. Although this development is regarded with caution by some of the government bodies involved, such as DEFRA, it is actively promoted by others, such as HM Treasury and the House of Commons Public Accounts Committee.[189] We endorse the proposition made by the Royal Society that the "UK Government should carry out a study to establish the extent to which the present drive to acquire [IP rights] affects the directions of publicly financed research."[190]

The challenge here is either to alter IP rules in order to reduce their influence on public sector research, or to counterbalance those commercial pressures by strengthening the rewards for non-commercial science and innovation that already exist. The most obvious of these are government funding and procurement, but they could also include competitive prizes for certain kinds of public good research.

- Finally, IP selectively affords protection and rewards to the kinds of formalised knowledge associated with industrial R&D. It provides no safeguards for 'informal' knowledge, developed *in situ*, shared free of charge and often communicated orally. This is usually thought to be a problem for rural communities in low and middle-income countries, because there have been many cases where informal knowledge has been appropriated by private companies for commercial gain and the actual originators have received little or no compensation.[191] However, it is also an issue for rural and urban communities in the UK. Many of the farming and food-related innovations that might be useful for achieving sustainable development have been developed informally. These range from plant breeds and land management techniques to community food programmes.

  We believe that the current IP environment can create a parasitic relationship where 'big science', involving expensive facilities, highly-qualified scientists and scarce study materials, feeds off informal knowledge systems. This counteracts UK policies to achieve sustainable development. The task is to strengthen the informal knowledge system by promoting the rights to share knowledge and adapt technologies informally. Farmers' rights and livestock keepers' rights already provide such protection in some countries. Non-farming communities fall outside the scope of existing forms of protection.

We do not know how to resolve these four flaws in the bargain that IP strikes between inventors and society, whilst also maintaining adequate regulatory incentives for knowledge creation. **We recommend that the Office of Science and Technology undertakes an international review of such incentives in order to inform UK policy.** Intellectual resource policy should aim to reward collective creativity, combat the use of patents to block R&D, alleviate commercial pressures on public research and strengthen informal knowledge systems.

5.Conclusion: towards a just research system

Science is more than 'just knowledge'. Science and technology have an ethical dimension. The previous chapters have illustrated this, focusing on food and farming research. We have tried to show why this ethical dimension matters and how it relates to research priorities and spending, to the kinds of products that are marketed and to the way our food is produced. We have argued that science and technology would be more robust if their inbuilt values and assumptions were more explicit and more open to challenge.

Our point of entry to this issue was public engagement, the central theme of current policies on science and society. Whilst we agree that greater public involvement in research and research policy is a crucial feature of a more robust research system, we believe it is only part of the answer. Based on the preceding chapters, we believe research and research policy must meet four additional criteria in order to earn public trust. The governance of science and technology must be consistent, sustainable, accountable and fair.

a) Consistent

R&D policy is inconsistent: on the one hand, the government champions public engagement; on the other, it maintains one set of rules for a minority of non-scientists who have a powerful influence on research decision-making, and another set for the vast majority who do not. This looks like a double standard.

The government needs to join-up its policies on science and technology. Its enthusiasm for public engagement cannot credibly be confined to 'science and society' programmes. The government's aim to rebuild the relationship between science and citizens must be made integral to all its science-related activities. It must carry over into:

- **Science education – now that ethical and social objectives feature in science curricula, we recommend that science teachers in schools and universities are given the support, training and resources they need to achieve them (Section 2.2.3).**
- **Technology regulation – we recommend that a clear and cross-sectoral responsibility for participatory technology assessment is established by government (Section 2.3.3).**
- **International trade – we recommend the UK government to press in international trade negotiations for amendments to any clauses that are perceived to rule ethical or social considerations out of regulatory assessment for new products (Section 2.3.3).**
- **Innovation policy – not only should public engagement play a greater part in the government's own science procurement and funding, but it should also be integrated into flagship policy initiatives to support business R&D (Section 3.2.3).**

b) Sustainable

If there is one theme that currently does link together research and research policy across government, from the research councils and the OST to DEFRA, then it is a narrowly conceived notion of 'wealth creation'. We have argued that this is too limited an objective for public R&D. In particular, we are concerned that the government aims to increase the ratio of private to public research, and the blurring between them, in pursuit of this aim. There is a risk that this would compromise public and environmental health.

We recommend that the government develops a more joined-up approach to research and innovation around the theme of sustainable development (Section 3.3.3). A concept of sustainable development is already prominent in UK policy, particularly in DEFRA, and is currently being further refined. Sustainable development encompasses economic objectives, including a fuller notion of wealth creation, but it places equal emphasis on social and environmental aims. It recognises the need for international co-operation as well as competition – we cannot develop sustainably without meeting the needs of the poorest people in society, within the UK and internationally. A sustainable science policy would presuppose precautionary product regulation. Given that precautionary decision-making entails a comparison between alternative options, we have suggested that a sustainable science policy might aim to promote a diversity of technologies and products, rather than 'picking the winners'.

c) Accountable

A robust research system must be publicly accountable. Policy advice should be transparent, independent and should open up the possibilities available to decision-makers. Independence appears to be compromised in some fields of product regulation, where regulators compete internationally for industry licence applications. **As a matter of priority we recommend that DEFRA restructures its regulatory agencies so as to ensure their financial independence from industry (Section 4.2.2).** We believe that R&D decisions should be made more accountable in private companies as well as in the public sector, and that government regulation could help to achieve this.

At the very least, informed and accountable decision-making requires that data on public and private R&D spending should be gathered and presented in a way that makes useful comparisons possible. Official data categories currently defy comparisons between different departments and between the public and private sectors. **We recommend that the Office of Science and Technology develops data categories which facilitate cross-departmental and public-private comparisons of research spending (Section 4.2.1).**

We have argued that public engagement should be seen as a complement to traditional systems for politically accountable decision-making, not as a substitute. It is crucial that public engagement processes are adequately resourced and that, in the public sector at least, decision-makers are obliged to explain publicly why they accept some pieces of advice and reject others.[192] However, public engagement need not be on a colossal scale: seen as a source social intelligence, public engagement becomes a realistic option for most research organisations in the public and private sectors.

d) Fair

Public accountability is not guaranteed simply by putting in place better information, rules and procedures. The intended beneficiaries may lack the power or resources to make the most of such mechanisms. We see this when 'open' meetings and consultation processes, dominated by professional stakeholders, are dressed up as public engagement. A similar scene plays out on the global stage, where the UK and other powerful governments out-gun representatives from poorer countries in negotiations on genetic resources and intellectual property.

At present, for all the rhetoric of 'level playing fields' and partnerships, research and research policy are systematically unjust. The privatisation of public sector research is concentrating decision-making power and research resources in the hands of corporate stakeholders, at the expense of other citizens, science workers and farming communities. A serious restructuring of decision-making and a radical redistribution of resources are both preconditions of a just research system.

We are particularly concerned that intellectual property rules, which govern the exploitation of knowledge, are currently contrary to the public interest. However, we recognise the value of regulatory incentives for knowledge creation. **We recommend that the Office of Science and Technology undertakes an international review of such incentives in order to inform UK policy (Section 4.5).** Policies governing the exploitation of intellectual resources should aim to reward collective creativity, combat the use of patents to block R&D, alleviate commercial pressures on public research and strengthen informal knowledge systems.

We believe it is possible to meet these challenges. This government has both the components required: the 2004 *Spending review* demonstrated its clear commitment to research and innovation; at the same time, it has ratcheted up its policies on science and society. The time has come for the government to combine the two, to the take lead in promoting ethically robust science and technology, in the UK and internationally.

Review Panel comments

In order to help open debate around the issues covered in this report, we invited the members of the report's external Review Panel to write individual comments. Four out of the five members were able to submit comments. With their permission, these are reproduced here.

Dr Jofey Craig (Parliamentary Office of Science and Technology)
The report's analysis of current food and farming research and its development raises important questions for debate as well as suggesting ways research and development can be more socially and ethically robust. Public engagement is identified as the key method and is of interest to Parliament. For instance, in 2000 the House of Lords Select Committee on Science and Technology published a report titled Science and Society and concluded that, to address what is referred to as "the crisis of confidence in science", a cultural change within institutions handling science- and technology-related issues was necessary. A key component of this was to broaden the use of public consultation and dialogue processes in engaging citizens in debates and decision-making.

Both Houses of Parliament have endorsed the Committee's suggestion that the Parliamentary Office of Science and Technology (POST) should keep a "watching brief on the development of public consultation and dialogue on science-related issues, and to keep members of both Houses of Parliament informed". Since then POST has published two reports looking at the methods and use of public dialogue in science technology. Public dialogue activities are increasingly widespread but the objectives and methods are varied, and new processes are developing continually. Underpinning questions include how this experience can be widely shared, identification of good and bad practice, and dialogue founded on sound evidence. The Food Ethics Council report suggests additional approaches besides public engagement. The challenge to the research, industry and policy communities will be which methods to use and when, and how to integrate the outcomes into decision-making. Though an iterative approach throughout the R&D chain is needed, particularly at this early stage, the question of where best to concentrate resources needs to be addressed.

There is no doubt that public engagement and ethical analysis need to play a greater part in decisions about the use of science. The report recommends that the UK should have the capacity to undertake participatory technology assessment (TA) along the lines of other European TA organisations. POST, as a member of the European Parliamentary Technology Assessment (EPTA) network, has close links with these organisations and is well positioned to co-ordinate the UK's efforts in this direction. It has already assisted the organisation of two UK national "consensus conferences" (on GM foods and on radioactive waste) and has been widely consulted by domestic and overseas organisations interested in developing consultative techniques.

Professor Sir John Marsh (University of Reading)
1. There are practical problems in introducing explicit ethical considerations into decision-making processes. Decisions come in a bundle that includes ethics but this does not determine how they should be taken into account. Several models are possible:

a) Decision takers must find an ethical gateway that will prevent an action being rejected by consumers or citizens.

b) Decision takers must apply an ethical position that represents the view of their society. However, no society has a single ethical position. One common escape route is to present specific positions as 'public concerns'. However, it is far from clear who are the public:

i. An elite of the informed and articulate.
ii. Pressure groups.
iii. Public opinion polls .
iv. Newspaper comment.
v. Shoppers.

In practical terms each of these may be the public that matters but the decisions taken are likely to be radically different.

c) Decision takers may have a defined ethical position; their duty is to enforce this. Their task is to examine the actions involved in and consequences of the research to be undertaken and to reach a decision by reference to a set of rules.

d) Decision takers should allow all citizens to influence outcomes. They must weigh the ethical significance of views expressed by:

i. The informed versus the illiterate.
ii. Those who are materially affected and those for whom the decision has no material consequence.
iii. Views that may be a statement:
 - about right and wrong.
 - of a social or ideological position.
 - of self interest.

If conflicting views are expressed they must determine how far to take each into consideration.

2. Ethical positions often imply political action and political activists often seek to capture ethical high ground. This makes the concept of an ethical agenda very slippery. Again several approaches could be considered.

a) We can have an ethical checklist. This simply pushes the difficult issues into a different debate. Devising a set of ‘ethical indicators’ elevates the particular ethical position of the designers.

b) We may rely on process, for example a committee of experts or/and lay people. The outcome will depend on whom we include in this committee.

c) The demand for ethical indicators is a claim that a wider set of considerations should be taken into account when research decisions are made. This is persuasive but difficult. For example, a key to whether research is or is not wealth creating is the extent to which the benefits that result enable losers to be compensated. But:

i. We do not know the outcome of research before it is complete.
ii. We cannot fully imagine all the technological uses to which research may be put. We therefore cannot compile a list of losers and gainers.
iii. It is relatively easy to estimate material gains and losses but almost impossible to measure those that are non-material.

And:
Decisions have to be made within a limited time frame.

John Turner (Farm)
The first public meeting of the AEBC in November of 2001 was a step into the unknown. It was a crucible into which poured the frustrations of those who had encountered a regulatory process that was intended to oversee the responsible introduction of new technologies such as GM, but was clearly just not equipped to deal with the wider ethical and cultural aspects that were inextricably linked.

At the meeting, representatives of the Church and of Parish Councils stood alongside those from within the scientific community and environmental pressure groups. Each had a very different perspective of the impact that the government's farm scale evaluation (FSE) trials of GM crops was having; ranging from those who held that GM was nothing more than an extension of plant breeding techniques practised over thousands of years to those who felt the technology challenged the integrity of nature itself.

The FSE trials were to be one of the final (and originally unplanned) stages in a process involving scientists, commercial companies and the Government. Scientists had recognised the potential benefits offered by the technology, biotechnology companies the potential for commercial exploitation and the Government supported what it saw as a means of ensuring the UK was able to place itself at the forefront of scientific and technological development. It wasn't until this final stage, where commercialisation was poised to take place, that the views of those having to deal with the practical realities and consequences of their introduction were sought. Even then, the AEBC was only born as a response to the growing tide of adverse opinion, rather than forming an integral part of the planning process.

So many cultural and ethical aspects of food and farming are not empirical values that can be measured in scientific terms, but that does not diminish their value. To dismiss such views when they potentially threaten the pace of scientific progress by labelling those who hold them as "luddite", "illogical" or "unscientific" clearly achieves little other than further polarising firmly held views.

In the time that has elapsed since that first public meeting of the AEBC, the regulatory system has continued to rest on the same few advisory committees, which themselves acknowledge have a very limited remit. Battle lines are thus drawn over the few pieces of legislation that stand between the laboratory and commercial plantings and a trench warfare of attrition has characterised a debate in which few can really claim a satisfactory outcome.

It is against the backdrop of this uneasy interface between science and the application of technology that this report can potentially contribute some useful ideas about how ethical issues can be embodied effectively within the process of science, research and development.

The Government has made a forthright commitment to promoting the UK's lead in science and innovation. With that commitment comes an equal challenge of ensuring that science and culture do not become irrevocably separated and that technological advances and public aspirations all work towards common objectives.

Dr James Wilsdon (Demos)
As the science and society agenda matures, processes of research, development and priority-setting are coming under increased scrutiny. One of the most glaring lessons to be drawn from the GM debate is the need to involve the public in addressing ethical, social and environmental questions at an early stage, before positions are entrenched and when it is still possible influence the direction of R&D.

Yet despite the growing consensus about the need to move public engagement 'upstream', there is still little guidance on how this should work in practice. How can social and ethical intelligence be knitted into the policy and practice of science? How do we build greater reflective capacity amongst scientists themselves? At what stage can the public become involved, and how can they meaningfully engage with and influence R&D priorities?

Just knowledge? is an important and timely contribution to these debates. Its comprehensive analysis of existing patterns of food and farming research provides an invaluable guide to how, where and why social and ethical questions can be addressed. And its vision of a 'just research system' offers a compelling template against which we can measure progress.

I greatly welcome the report, and hope that it sparks a vibrant debate, not only within the food and farming sector, but across the science community as a whole.

Abbreviations

ACR	FSA Advisory Committee on Research
AEBC	Biotechnology Commission (formerly Agriculture and Environment Biotechnology Commission)
AFRC	Agricultural and Food Research Council
ARC	Agricultural Research Council
AUT	Association of University Teachers
BBSRC	Biotechnology and Biological Sciences Research Council
BSE	Bovine Spongiform Encephalopathy
CAP	Common Agricultural Policy
CCFRA	Campden and Chorleywood Food Research Association
DfES	Department for Education and Skills
DEFRA	Department for Environmental, Food and Rural Affairs
DH	Department of Health
DTI	Department of Trade and Industry
EPTA	European Parliamentary Technology Assessment
ESRC	Economic and Social Research Council
FAO	Food and Agriculture Organisation of the United Nations
FMD	Foot and Mouth Disease
FP	Framework Programme
FSA	Food Standards Agency
FSE	Farm Scale Evaluation
GM	Genetically Modified
HMT	HM Treasury
IP	Intellectual Property
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
LFI	Leatherhead Food International
MAFF	Ministry of Agriculture, Fisheries and Food
NERC	Natural Environment Research Council
NICE	National Institute of Clinical Excellence
OFR	Operating and Financial Review
OST	Office of Science and Technology
PBR	Plant Breeders’ Rights
POST	Parliamentary Office of Science and Technology
PPP	Public-Private Partnership
PSD	Pesticides Safety Directorate
PSRE	Public Sector Research Enterprise
PVP	Plant Variety Protection
RCUK	Research Councils United Kingdom
RPG	DEFRA Sustainable Food and Farming Research Priorities Group
RSA	Royal Society of Arts
TA	Technology Assessment
TSB	Technology Strategy Board
UK	United Kingdom
USA	United States of America
VMD	Veterinary Medicines Directorate
WTO	World Trade Organisation

Notes

[1] **Blair, T.** (2002) *Science matters.* London, April 10, added emphasis.

[2] **HM Treasury (HMT), Department for Education and Skills (DfES) and Department of Trade and Industry (DTI)** (2004) *Science and innovation investment framework 2004-2014.* HMSO, London, July: 156, added emphasis.

[3] **GM Nation** (2003) *GM Nation? Findings of the public debate.* DTI, London, September. For contrasting critiques see: **Horlick-Jones, T., Walls, J., Rowe, G., Pidgeon, N., Poortinga, W. and O'Riordan, T.** (2004) *A deliberative future? An independent evaluation of the GM Nation? public debate about the possible commercialisation of transgenic crops in Britain, 2003.* Understanding Risk Working Paper, February. **Mayer, S.** (2003) *GM Nation? Engaging people in a real debate?* GeneWatch UK, Buxton. **Radford, T.** (2003) Scientists complain GM debate was mishandled. *Guardian*, November 1.

[4] Greenpeace and Royal Society responses to **HMT, DfES and DTI** (2004), see note 2. Responses are available from scienceframework@hm-treasury.gov.uk. **Royal Society (RS) and Royal Academy of Engineering (RAE)** (2004) *Nanoscience and nanotechnologies: opportunities and uncertainties.* The Royal Society and The Royal Academy of Engineering, London, July 29.

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[6] **Nature** (2004) Going public. *Nature* 431: 883.

[7] **HMT, DfES and DTI** (2004), see note 2.

[8] **Wilsdon and Willis** (2004: front cover), see note 5.

[9] **Blair** (2002: added emphasis), see note 1.

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[16] **Gieryn, T.** (1999) *Cultural boundaries of science: credibility on the line.* University of Chicago Press, Chicago.

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[18] **Latour, B.** (2000) When things strike back: a possible contribution of 'science studies' to the social sciences. *British Journal of Sociology* 51: 107-123.

[19] **Wynne, B.** (2001) Creating public alienation: expert cultures of risk and ethics on GMOs. *Science as Culture* 10: 445-481. Also see: **Stirling, A.** (2004) Opening up or closing down? Analysis, participation and power in the social appraisal of technology. In: Leach, M., Scoones, I. and Wynne, B. (eds), *Science, citizenship and globalisation*. Zed, London: forthcoming.

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[21] **Clayton, E.** (2004) *Letter to the editor of the Economist.* International Alliance Against Hunger, Rome, August 3. The International Alliance Against Hunger includes the Food and Agriculture Organisation.

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[39] **BBSRC** (No date) *BBSRC statement on safeguarding good scientific practice*. Accessed on-line: http://www.bbsrc.ac.uk/funding/overview/good_practice.pdf: 1.

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[59] **Elliot, C.** (2001) Pharma buys a conscience. *Prospect* 12. **Turner, L.** (2004) Bioethic$ Inc. *Nature Biotechnology* 22: 947-948.

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[62] **Wynne** (2001), see note 19. A high-profile report on GM crops by the Nuffield Council on Bioethics illustrates this approach: **Nuffield Council on Bioethics** (1999) *Genetically modified crops: the ethical and social issues*. Nuffield Council on Bioethics, London, May.

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[93] **RSA** (2004: 53), see note 91.

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[135] **SDU** (2004), see note 128.

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[148] **Nowotny, H., Scott, P. and Gibbons, M.** (2001) *Re-thinking science: knowledge and the public in an age of uncertainty*. Polity Press, Oxford.

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[151] **OST** (2003) *SET statistics*. Accessed on-line: www.ost.gov.uk/setstats/index.htm, 20/02/04.

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[157] **Thirtle *et al.*** (1997), see note 73.

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