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Public perceptions of transgenic products: the influence of the behaviour of laboratory scientists[1]

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RESUME

This paper describes what has been learnt from over twenty years of social science research on public perceptions of risk. The case of GMOs, and in particular of Molecular Framing, is then used to illustrate an important limitation of the dominant approach used to in these studies, which assume and perpetuate the hypothesis that there is "objective", scientifically assessed risk on the one hand, and the "subjective" perceptions of the public on the other. In parallel, the classic approach assumes and perpetuates the hypothesis that Science is independent from society. A different approach to the study of public perceptions is proposed, which attempts to overcome these two false dichotomies.

[1] This paper is based on the oral presentation given by the author at the OECD Workshop on Molecular Farming held 3-6 September 2000 at La Grande Motte, France. The style and content of the paper reflects the targeted audience present at this workshop. The majority of these participants were laboratory research scientists involved in the development of molecular farming (mostly from the public sector, and mostly from molecular biology or related disciplines). Others included science policy managers from the public sector (members of the management committee of the OECD Co-operative Research Programme on Biological Resource Management for Sustainable Agricultural Systems) and from biotechnology firms (e.g. Monsanto).

1. INTRODUCTION:
SOCIAL SCIENCE STUDIES OF PUBLIC PERCEPTIONS OF RISK

The history of social science studies on risk perceptions is now over 20 years old[2] and can be traced back to the work of social-psychologist Paul Slovic and his colleagues, starting at the end of the 1970s (Marris *et al.*, 1997; Slovic, 1992). The question which motivated these studies was "why does 'the public' disagree with the 'experts' about questions of safety?". The particular issue at stake at the time in the USA was the construction of nuclear power plants, and it seemed that no amount of reassurance from scientists and engineers could reassure citizens about their safety. The implicit framing of those who commissioned these studies was that there was "objective", scientifically determined, risk on the one hand, and "subjective" public perceptions on the other, which were somehow biased by (psychological) factors. They therefore turned to psychologists to help elicit these factors and, implicitly, to help them to determine how they could we get "the public"[3] to think more like the experts. These studies therefore, in their early phases, focused on the gap between so-called "real risk" and "perceived risk". This approach was rapidly criticised by other social scientists from different disciplines, notably anthropologist Mary Douglas (Douglas, 1985) and sociologist of science Brian Wynne (1987). Others later tried to build a bridge between the Psychometric Paradigm developed by Paul Slovic *et al.* and more sociological or anthropological approaches (Marris *et al.*, 1997 and 1998).

The Psychometric Paradigm essentially demonstrated that members of the lay public, i.e. not involved in scientific research on risk or in institutional decision-making, tend to define risk differently from actors involved in the processes of risk assessment and risk management. According to these studies, the experts tend to limit their definition of risk in terms of the probability and consequences of a specific activity or technology (with consequences often reduced to mortality figures), whereas the definition of risk by the public is richer in that it incorporates a number of additional dimensions (see Table 1). This, over time and for some of the authors involved in these studies, led to a change in the framing of the original question: maybe the concerns of the public were *different* and *coherent*, rather

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[2] For a useful review of the history of this field, and of the different approaches developed by different teams of researchers, see Krimsky and Golding, 1992.

[3] I use quotation marks for the expression the public, to indicate that the very notion of who or what this consists of is in itself problematic and left largely undefined within the field of "public risk perceptions". But this will not be dealt with further in this paper.

than being *biased* and *irrational*. Furthermore, the concerns expressed by the public where not necessarily irrelevant for decision-making. Thus, the problem itself, and the search for the solution evolved. Rather than trying to develop communication strategies to "debias" public perceptions and make citizens "think more like the experts", some authors recommended that decision-makers should seek to *incorporate into decision-making* the so-called "qualitative" dimensions of risk expressed by lay people (together with the quantitative criteria derived from scientific risk assessments). In this way, risk communication became redefined within social science discourse and among some policy circles, as a two-way process between the public and the experts, rather than a top-down transmission of information.

This has been, a welcome evolution, but it has not gone far enough. Firstly, within many scientific and policy circles, these studies appear to have had no impact at all. The vision of an "irrational public" still pervades. Scientists and policy-makers still frequently express the view that the problem is simply that the public fails to understand the "objective" scientific dimension of risk, and that the solution lies in appropriate forms of (top-down) information which will somehow overcome the supposed "psychological barriers" which make people think and behaves so irrationally[4].

Secondly, even where these studies have had some impact, such that it is accepted that the public has legitimate concerns about risk, these are considered to be entirely separate, and of a entirely different nature, than the scientific evaluation of risk. Thus, the authors of the Psychometric Paradigm define these as "qualitative" attributes, in order to distinguish them from the quantitative criteria used by the experts. In this way, these social scientists and the policy-makers who have taken their work into account imply that there are *scientific* concerns on the one hand, and entirely separate *social* concerns on the other. But this approach fails to understand and explicit the *institutional* dimensions of risk perceptions. "Risks" are not objects or events which somehow appear out of nowhere: they are created, assessed and managed by institutions, and this influences not only the way in which they are perceived, but also *their very nature*. Thus, the perception of risks - and more broadly all public responses to risks - has more to do with the way in which they are created, assessed, and managed than with any scientific measure of the probabilities and consequences associated with them. This argument could indeed be supported by the results of the psychometric studies of Slovic *et al.*, because if one looks at the "qualitative attributes" listed in Table 1, one can see that they often

[4] This observation is derived from extensive participant-observation research. See box.

relate more to the way in which people become exposed to a risk, rather than to any inherent attributes of a risk-object[5].

Behind the reductionist vision of risk as a reified object lies a vision of Science as entirely separate from Society, and an associated linear model of research and development (R&D) processes (Figure 1)[6]. These beliefs about the nature of science are strongly held and shared among scientists and decision-makers, even though they have been extensively challenged by a group of diverse social scientists who broadly recognise themselves within the field of "science and technology studies" (STS)[7]. There is no space in this paper to go into the details of what has emerged from the field of STS. But the main conclusion of relevance here is that scientists are *people*, and operate within *institutions* - just like everybody else in society. These institutions are subject to social, economic, and historical influences just like any other institution. Scientists, just like everybody else, exist and operate within a particular culture, i.e. they have shared values and beliefs, and their behaviour and institutions contribute to defining and consolidating this shared culture. Furthermore this culture can be and has been studied by STS researchers in the same way as national or "tribal" cultures have been analysed in other fields.

The overall conclusion, which often shocks scientists - precisely because it goes against a key premise of their shared culture - is that scientific facts are *socially constructed*. Thus, Science and Society cannot be neatly separated, but the idea that they *are* inherently and naturally separate is at the core of the vision of science shared by scientists. Scientists and their institutions devote a lot of time and energy to defend this hypothetical boundary between scientific facts and society[8]. This is where we can see the parallel with the risk field. Scientists, risk managers and their institutions devote much of their time and energy to defend

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[5] It was this observation which led the author to try to build a bridge between the Psychometric Paradigm and the more anthropological Cultural Theory approach developed by Mary Douglas (Marris *et al.* 1997 and 1998).

[6] Inherent in this model is also a supposed separation between *public*-sector research, which supposedly conducts "fundamental" research, the *private* sector, which supposedly conducts only "applied" research. STS studies have demonstrated that real world practice is much more complex, and that innovations often emerge from the private sector and/or from people working in so-called "applied" fields. Furthermore, particularly in the field of biotechnology, mixed financial arrangements and close interactions between public and private sector institutions are extremely and increasingly common, with the result that the distinction between the two sectors in particularly blurred.

[7] Sociology of science is a key discipline in this field, but it is complemented by other disciplines such as anthropology, history, economics of innovation... For an overview of this field, see Biagioli (1999) or Jasanoff *et al.* (1995).

[8] For an excellent article on this kind of "boundary work" in the risk field, see Jasanoff (1995).

the view that "objective risk" - based on science - is entirely separate from "perceived risk" - which is seen as a societal problem. STS researchers have accumulated an impressive body of research which challenges this vision, but this has to date had very little impact on scientific and risk regulatory institutions.

If the insights from the STS field were understood and accepted within scientific and risk regulation circles, the problem of "public risk perception" would be radically transformed. We have seen above that two misconceptions were already thoroughly challenged by the psychometric studies of Slovic et al.[9], at least in some circles: (i) the idea that the public is simply irrational and somehow intellectually or psychologically deficient; and (ii) the idea that what is needed is better (scientific) communication about risks from institutions to the public. The most enlightened conclusion derived from these insights is that the public should be allowed to participate in decision-making about risk issues. But the limit of this approach is that it still assumes that the public (or societal) input only applies to a *finished and well defined technological product*, issued from a linear R&D process which occurs within the *separate* world of science (Figure 1). Drawing from the insights from STS, a different approach to the study of public perceptions of risk can be developed (see section 3), which demonstrates that *people do no respond simply to technological products*. They respond instead to institutional behaviour and discourses in which these products are embedded. Public sector research laboratories are one of the key institutions involved, and this paper focuses on them because the participants of this workshop were mostly members of this community[10].

The next section uses the case of molecular farming to illustrate how scientists involved in laboratory research hold and express views about the social world which become incorporated into their research activities (and therefore the products of that research) *while at the same time defending the paradoxical hypothesis that science and society are independent from each other*. This observation helps to explain the limitations the classic approach to public perceptions of risk, which fail to take into account the social and cultural context in which risky events, activities or products are embedded. Bearing this in mind, section 3

[9] For the sake of simplicity, this paper focuses on the seminal work of Slovic et al., but this psychometric research has been supplemented over the last 20 years by other social science researchers (see Krimsky and Golding, 1992). However, with a few exceptions (Douglas, Rayner, Wynne…), these have all, to my mind, failed to take into account the social and cultural processes through which risks are constructed.

[10] See footnote 1.

describes a different approach to the study of public perceptions of risk and outlines some of the insights which can be drawn to explain the emergence of public controversies on new technologies such as GMOs.

PARTICIPANT OBSERVATION AND ACTION RESEARCH

I position my work at this interface between STS and risk perception studies. I conduct research on public perceptions of risk, and also on views about the public held by scientists, regulators and decision-makers (e.g. Joly et al., 1999; Marris, 1999; PABE, 2000). One of my objectives is to try to share the insights from these bodies of social science research with the scientists and regulators who have been the subjects of these studies. In order to do this, I engage in participant-observation. This means that I participate frequently in meetings with scientists, regulators and policy makers (and also with environmental, consumer or anti-GMO groups). At these meetings, I play the role asked of me by the organisers (e.g. speaker or member of the audience), but at the same time I am also constantly observing and recording what is said about the public, and about public perceptions of risk.

The nature of these meetings varies widely: conferences, seminars, public meetings, press conferences. Moreover, my observations and interactions occur both during the formal parts of these meetings and the informal "corridor" discussions which take place with the participants. In addition, since I often conduct contract research (e.g. for ministries and other public bodies), I also have the opportunity to discuss with my clients their view of public perceptions of risk, and of the role that social science can or should play in this field. Over the last 2 years, I have participated in over 50 such meetings (for a list, see Marris, 2000).

My participation at this OECD Workshop on Molecular Farming was a classic example of such "participant-observation". It was also a particularly good occasion for me to give immediate feedback to the other participants about what I had observed. The round-table on "public perceptions of transgenic products" was scheduled for the last afternoon of this 3-day meeting. I was therefore able to utilise in my presentation things I had heard during the previous sessions, and to place them in the context of insights from my work on public perceptions of risk, and in particular of genetically modified organisms (GMOs). This is discussed in the following session.

2. HOW SCIENTISTS INFLUENCE PUBLIC PERCEPTIONS: IMPLICIT FRAMINGS OF LABORATORY RESEARCH

As mentioned above, scientists tend to defend the view that their work is conducted in a context which is independent from social influences. According to this model, scientific discoveries are made within the laboratory, and it is only when these discoveries leave the laboratory world that they are subject to societal processes. Thus, it is at the time when the discovery exits from the laboratory - and only at this point - that the social trajectory of the discovery is determined. Furthermore, still according to this vision, the societal processes which determine which discoveries are used, and for which objectives, is entirely out of the control of scientists. Yet STS studies have shown how the work of scientists, even when they are working in public sector laboratories on so-called "fundamental" or "blue-sky" research, is framed by particular visions about society. These framings tend to be implicit, i.e. not subject to explicit discussion among colleagues or with communities outside the laboratories.

This section of the paper uses the case of the OECD Workshop on Molecular Farming to illustrate how scientists[11] are able to hold this linear vision of "science-separate-from-society", while at the same time expressing clear assumptions about society, and about how the world should be. Thus, even without taking into account financial pressures[12], the work of scientists inevitably helps to shape the social world in a way which is compatible with these implicit framings.

Reading through the abstracts for this OECD Workshop, and listening to the oral presentations, an overall common pattern emerged. The researchers all tended to begin and/or end their presentations with universal declarations about the benefits of their work for society. These declarations were framed by implicit definitions of what the problem was, yet the research presented did nothing to examine whether this definition of the problem was appropriate, or whether the solution proposed by their research was the only possible one, and indeed the best one. Such declarations were accepted as given by other participants of the

[11] Throughout this section, I refer to "scientists" in an undefined way. What I have in mind in particular are molecular biologists, who represented the majority of the participants at the OECD Workshop, and which represent a particularly classic example of the attitudes described here. For an interesting discussion of the nature of this discipline and the way in which boundaries have been constructed between the laboratory world of molecular biologists and the world outside the laboratory, even the relatively close world of plant breeding, see Webster (1989).

[12] See footnote 6.

workshop, and therefore represent elements of a shared culture among this community of researchers. Table 2 lists some examples of these unqualified universal declarations of benefits.

These declarations of benefits can be qualified as "universal" in the sense that they tended to exclude any idea that the benefits (and risks) associated with an innovation will only be realised under certain conditions. Some of these contingencies are technical, in the sense that they can to some extent by tested within the laboratory. Thus, for example, the details of the research presented revealed how the success of the innovation (i.e. whether the GMO behaved in the desired fashion) was dependent on complex and still not well understood gene expression processes (the influence of position effects, tissue- or developmental- specific gene expression, co-regulation of different genes…). But gene regulation and the resulting phenotype is also influenced by the - social and ecological - environment in which these GMOs will be cultivated in the real world. For example, climate and cultivation practices will play a role. Thus, when grown in the field, GMOs do not always perform as expected from laboratory studies. Furthermore, they do not necessarily have the beneficial social consequences assumed by the scientists in their universal declarations.

The declarations were also universal in nature in the sense that they assumed that there was only one possible way to define and resolve the problem at stake. The most common example relates to the idea that there is an evident need to increase global food production in order to feed a growing world population. Yet this assumption (that the solution to current or future lack of food for some portions of the world population resides in increasing food production) is hotly debated. There is, for example, evidence to show that the current food supply, on a global scale, is more than sufficient to feed the world population adequately - and yet many people still go hungry today. Bearing this in mind, some argue that increasing food production, in itself, will not resolve the problem of under-nutrition and that more attention should be paid instead to the social, economic and political processes which prevent the current world population from being fed adequately. Such arguments are neither taken into account nor refuted in the "universal declarations" of researchers: they are simply ignored. In this way, a particular framing of the problem is implicitly accepted. Furthermore, this means that relevant contingencies which would be relevant to determine the kind of laboratory research which is needed are also ignored, for example about which kind of crop varieties and

characteristics might be most appropriate to alleviate poverty and famine in developing countries, especially among small-scale farmers (Marris, 1992).

Another way in which particular assumptions about the world was being constructed by the researchers present at the workshop was through the shared assumption that it was natural to use animals (and plants) as "bioreactors" for the production of pharmaceuticals or other industrial products. This is, after all, the very basis of molecular farming (and the associated concept of the "cell-factory"). Yet this assumption is based on a particular vision of the relationship between humans and other living organisms, which is not necessarily shared by other members of our societies. Again, this was not presented as a topic for discussion: the idea of using plants and animals as bioreactors was simply assumed to be the appropriate solution to solve a number of economic and health problems. Furthermore, the problems addressed were themselves not subject to discussion (as in the case of "feeding the world" above). For example: Are vaccines always the best solution to human health problems, in contrast, for example to increasing incomes, women's education or access to basic hygiene and clean water? Does the development of veterinary pharmaceutical products facilitate breeding practices which some people believe to be inhumane?

Table 2 lists a number of examples to demonstrate these kinds of implicit framings. They illustrate two different strategies utilised by scientists to defend their work - both of which have negative effects on public perceptions of innovations, and of scientists. The first is *denial*, i.e. a reluctance to acknowledge or understand that their scientific research inevitably influences society. This can be stereotyped as follows: "we just do science, it is society which will decide - at a later stage, and outside of the laboratory - what to do with the product of our work". In this way, scientists deny that they play any significant role in the trajectory of innovations.

The second strategy is expressed as a kind of arrogance, or hubris. Thus scientists claim, as discussed above, to be able to provide solutions for serious global societal problems, without giving much thought to the way in which these problems have been constructed, and even more importantly, without giving much thought to the possible negative consequences which might be caused by the very solutions that they propose.

These two strategies are largely contradictory, but are often expressed simultaneously by the same scientists or scientific institutions. Moreover, they are *noticed* by the lay public.

Thus, even people with no advanced scientific education[13] notice the inconsistency and dishonesty reflected by such attitudes, because they are well aware, through common sense and their personal experience[14], that:

(i) scientific research in laboratories does influence what is or becomes possible or not within our societies[15];

(ii) benefits - and risks - associated with innovations are contingent on a great many complex and/or local social and environmental factors;

(iii) there are still many important unresolved domains of uncertainty or ignorance in scientific knowledge about genetics;

(iv) the solution proposed is not necessarily the only or best one for the problem at stake; and furthermore the choice of particular solutions is not derived through a democratic decision process.

Given this lay knowledge, they find the behaviour and discourse of scientists, scientific institutions, and regulatory bodies which rely upon them worrying since, as shown in Table 2 and discussed above, it:

(i) refuses to acknowledge that laboratory research does influence society;

(ii) refuses to acknowledge and incorporate contingencies;

(iii) refuses to acknowledge uncertainties and domains of ignorance[16];

(iv) frames complex, multidimensional and contested "problems" is an oversimplified way.

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[13] Or indeed precisely *because* of this lack of scientific education, during which scientists are "formed" and learn their shared culture…

[14] These points emerged from the PABE research discussed at more length in section 3.

[15] They are also increasingly aware - especially with respect to biotechnology - of the links between the private and public research sectors, but this is not the focus of this paper.

[16] STS studies have shown how scientists are happy to explicitly discuss uncertainties when talking to their peers, and in relation to details of the research process. In contrast, when they present their work to the "outside world", and when they talk of general benefits or risks, they tend to avoid any discussion of uncertainties. This was again apparent during this workshop, which was conducted among peers: the discussion focused at great length on domains of ignorance, complexities and uncertainties - but only when talking about the details of the research results. These dimensions were entirely pushed aside as soon as the researchers talked about the "universal benefits" (and the lack of risks) which could be expected from their research.

3. PUBLIC PERCEPTIONS OF GENETICALLY MODIFIED ORGANISMS

Over the last few years (broadly since 1996), as the controversy over the use of GMOs in food and agriculture intensified in Europe, one increasingly heard within scientific, regulatory and biotechnology industry circles an argument along the following lines:

> *Consumers do not accept transgenic products in food because they do no see any direct benefits, but they do (or will) accept the used of GMOs for medical purposes*[17].

Thus, so the argument goes, pharmaceutical products produced using genetic engineering technologies will not be faced with the same kind of public opposition as that seen (at least within Western Europe[18]) with regard to GM food products. A subsidiary argument is that once consumers perceive direct benefits from GM-food products, resistance will evaporate. Recent research conducted in five European countries does not support this assertion.

In this section, results from qualitative sociological research on public perceptions of GMOs[19] is presented to illustrate the way in which lay citizens notice and react to the kind of implicit framings and assumptions about the social world described in section 2. Indeed, they notice the way in which views about the world are used by the people and institutions that create GMOs and that assess the risks (and benefits) associated with them. Thus, instead of reacting simply to risks as reified objects, their perception of GMO products is rooted in their perception of the institutions involved in the creation and regulation of GMOs. Furthermore, this perception is shaped by their previous and repeated experience of these institutions with regard to other risk-related issues. These kinds of insights cannot emerge from classic social science research on public perceptions which assume a separation between "objective" and "subjective" risks, and between "science" on the one hand and "society" on the other. In

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[17] This statement emerges from extensive participant-observation research with actors in the field including scientists, regulators and industry managers (see box). At the end of the PABE project, a group of these actors was invited to participate at a workshop. This statement, along with a dozen other similar "myths" which circulate in expert circles about public attitudes to GMOs and which had been collected by the PABE research team were presented and contrasted with the results from the focus groups with lay citizens. Overall, the actors present at these workshops (one in each of the five countries participating in the PABE project) willingly recognised the existence and pervasiveness of these "myths" (for further details, see MARRIS, 2000 and PABE, 2000).

[18] For a discussion of the public debate on GM foods in the USA, see Joly *et al*. (2000).

[19] This section is based on the results of the PABE project, see PABE (2000).

particular, it is necessary to enable the "public" being studied to describe in their own way their perception of the embedded nature of GMOs, rather than asking them to respond to GMOs as a reified object, as is usually the case in quantitative surveys. The research described here used and developed qualitative methods in order to address this problem.

Focus groups were used to elicit the views of members of the lay public. A focus group consists of a group discussion among (in our case) 5 to 10 participants, facilitated by a researcher. The aim is to encourage, a far as possible, the free expression of the participants, while at the same time focusing on broad issues of interest to the researchers. These two objectives are necessarily conflicting, and a compromise has to be reached through the method chosen to prompt and direct the discussion. For the PABE project, 14 group discussions of 2 hours each were conducted in each of the five participating countries, between September 1998 and October 1999 (for more details, see PABE, 2000).

The results from the PABE project reveal that public attitudes were indeed broadly more positive for the use of GMOs to produce pharmaceuticals than for their use in agriculture and food, but this was not only, or even mostly, because of perceptions of individual benefits. The participants in the focus groups discussed a number of positive factors for pharmaceuticals, including:

(i) The feeling that they had adequate access to information, both on the leaflets distributed with medicines, and through consultation with a doctor. An important aspect was that this information was seen to take into account potential harmful side effects, the uncertainties and contingencies possible associated with the product. Thus, the doctor could place the information in the context of the particular patient concerned.

(ii) Associated with this access to information was the issue of the free choice by a patient to take the treatment or not, regardless of the advice given by the doctor.

(iii) The understanding that there was well-established regulatory system which included lengthy step-by-step testing procedures, and monitoring of products after their release on the market, thereby allowing for the removal of a product if and when unexpected harmful effects are identified[20].

[20] Note that examples where a pharmaceutical product was removed from the market was always brought up as *positive* examples to demonstrate the efficacy of the system, rather than to complain that unsafe products had

(iv) The fact that pharmaceuticals (and other medical treatments such as gene therapy) were *targeted* to a small proportion of the population, and that it was the *same* population which would receive the benefits and suffer from any potential risk. Medicines were also seen to be targeted in time, in that they would be taken only during short periods of illness.

In contrast, none of these conditions were felt to apply to GM foods:

The participants felt that they had been given next to no information about the use of GMOs in food and agriculture. Moreover, the information they had received failed to take into account inherent uncertainties, the complexity of ecological and social systems, and the contingent nature of risks and benefits. Given this lack of information, and the fact that "no one had ask them for their opinion", they felt that they had no choice about whether or not GM crops would be grown in their country, and whether or not to eat GM-food. Furthermore, they thought that no serious long-term safety testing had been conducted, that once on the market it would be difficult if not impossible to identify chronic health effects, and that harmful effects on the environment would be irreversible. They also insisted that food, unlike medicines, is something that we all consume everyday, three times a day, for the whole of our lives. GM-food products were therefore not targeted to people who would particularly benefit from them, and could indeed end up being consumed by particularly vulnerable sub-populations, such as the old, the very young and people with allergies. Quite to the contrary, the main beneficiaries were perceived to be the firms which produced and sold them (and perhaps farmers), whereas the risks would be borne by entirely separate communities: the general population, including future generations, who would not receive any benefits.

The issue of benefits was therefore important when these focus groups participants made a distinction between the use of GMOs in the ag-food and pharmaceutical sectors, but this distinction could not be reduced to a simplistic and individualist risk-benefit equation. Even when they spoke of benefits, this was framed in a societal way, as benefits for sick people, and not as a personal dimension. Moreover, as described above, the issue of the balance between risks and benefits was embedded within the whole institutional and social

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been authorised. This observation goes against a common (but unsupported) vision that citizens demand a "zero risk" level from regulatory agencies, and are outraged if any product on the market is shown to have unexpected adverse effects. Indeed these examples were brought up to demonstrate also that even when the best precautions had been taken, unexpected harmful effects could always occur.

context through which these products emerge onto the market, including information, control, choice, regulation, monitoring…

These institutional dimensions were broadly judged as more favourable in the context of GM-pharmaceuticals than for GM-foods, but this research did reveal serious concerns and questions about the medical sector also, including:

(i) They felt that if pharmaceuticals were to be produced in GM crops or farm animals, it would be important to keep these GM organisms separate from the human food chain, but did not feel confident that this could be ensured.

(ii) Similarly, how could we ensure that these crops would be kept separate from surrounding crops and their environment?

(iii) Genetic manipulation of animals made people feel uneasy, especially in cases where human genes would be introduced.

On the basis of these concerns, the participants often expressed the view that if the product could be produced using other techniques which did not involve genetic manipulation, this would be preferable. Furthermore, they stated that before using GM products, non-GM alternatives should be thoroughly investigated, and that GM products should only be considered for serious life-or-death situations.

4. CONCLUSIONS

The perceptions of GMOs elicited through the PABE research were clearly shaped by the participants' previous experiences with regard to other issues, which, in their minds, were very similar. BSE was the most frequently stated example. It has become common place to say that the GMO controversy in Europe has been influenced by the "BSE affair". However, the links made between these two issues have perhaps not been fully understood by policy-makers and experts, who tend to focus only on the idea that regulatory institutions are no longer trusted because they made so many mistakes on this particular topic. Many also feel that the public reaction to the BSE affair demonstrates consumer demands for the application of a "zero risk" level by regulatory agencies. This is not supported by results from the PABE project, which instead demonstrates that the way in which the BSE story has been treated by

scientific, regulatory and commercial institutions was not perceived as *exceptional*. Quite to the contrary, it is portrayed as an *archetypal* example of the kind of institutional behaviour they feel they are exposed to regularly. Furthermore, the story is used by the focus group participants to illustrate that unanticipated harmful effects *can* occur, especially in the long term, even when precautions are taken. Thus they conclude that it is indeed impossible to anticipate all risks, and this is not seen as a problem in itself. Rather, they complain that the potential but uncertain occurrence of harmful effects is not *acknowledged* in communication about risks, and is not *taken into account* in decision-making about new products and technologies, nor in measures put in place to reduce and/or monitor risks once the product or technology is put on the market. These are "lessons" people have learnt about the behaviour of institutions through their experience in many different sectors (other examples cited included asbestos, pesticides, HIV contaminated blood…), and BSE was simply portrayed as a particular poignant example (see Table 3)[21].

It was these kinds of lessons and experiences about the link between scientific innovation, regulation, commercial pressures and the complexities of social and ecological systems that our focus group participants used to construct their opinion about GMOs. The participants knew and accepted that all choices necessitate counter-balancing risks with benefits, but felt that they, as ordinary citizens, were not told how this judgement has been made, or enabled to participate in that decision. As a result, there was a tendency to suspect that economic interests override health and environmental considerations in the regulation and management of risks. These results therefore suggest that, in the context of public controversies about science and technology issues, it would be useful to:

(i) Help to make implicit framings about the social world utilised by scientists, regulators and others involved in the innovation process more explicit, and therefore more easily subject to discussion with all sections of society.

(ii) Acknowledge, where relevant, uncertainty when communicating about risks and innovation processes.

[21] It was interesting to note the striking similarity between these "lessons" drawn from the PABE project and the "hazard sequences" described by Glynis Breakwell in her presentation at this OECD Workshop, and which were developed using different methods and a different disciplinary approach.

(iii) Make decision processes more transparent, such that the way in which a judgement has been made about the balance between risks and benefits is traceable, explicit, and can be subject to discussion with all those who will be affected by the decision.

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TABLE 1: QUALITATIVE RISK CHARACTERISTICS[22]

FACTOR 1[23]

Voluntariness of risk
Do people face this risk voluntarily?

Control over risk
If you are exposed to the risk, to what extent can you, by personal skill or diligence, avoid death?

Chronic-catastrophic
Is this a risk that kills people one at a time (chronic risk) or a risk that kills large numbers of people at once (catastrophic risk)?

Global catastrophic
To what extent does pursuit of this activity, substance, or technology have the potential to cause catastrophic death and destruction across the whole world?

Severity of consequences
When the risk from the activity is realized in the form of mishap or illness, how likely is it that the consequence will be fatal?

Equity
To what extent are those who are exposed to the risks the same people as those who receive the benefits?

Future generations
To what extent does present pursuit of this activity or technology pose risks to future generations?

Change in risk
Are the risks from this activity, substance, or technology increasing or decreasing?

Ease of reduction
How easily can risks for this activity or technology be reduced?

Dread
Is this a risk that people have learnt to live with and can think about reasonably calmly, or is one that people have great dread for - on the level of a gut reaction?

FACTOR 2

Knowledge - to those exposed
To what extent are the risks known precisely by the persons who a exposed to the risk?

Knowledge - to science
To what extent are the risks known to science?

Immediacy of effect
To what extent is the risk of death immediate - or is death likely to occur at some later time?

Observability
When something bad is in the process of happening because of this activity, substance, or technology, to what extent is the damage observable?

Newness/Familiarity
Is this risk new and novel or old and familiar?

FACTOR 3

Personal exposure
To what extent do you believe that you are personally at risk from this activity, substance or technology?

Exposure
How many people are exposed to this risk in the United States?

[22] Source: Slovic, Fischhoff and Lichtenstein (1985).

[23] Using factor analysis, the authors resolved the "characteristics" into 3 groups which were closely related.

TABLE 2: IMPLICIT FRAMINGS FOR MOLECULAR FARMING RESEARCH[24]

"As the world population continues to grow exponentially, it is clear that if fish are to maintain their current status as an essential food resource, production must be dramatically improved."
But:
Who decides that increase of production is the desired solution? And how?
Might it be possible to find other solutions? Or to pose the problem differently?

"Even though […] consumer perception of GMOs as food source is far from benevolent, this should not refrain research is this field. Transgenesis allows to explore new niches and provides a wide range of modification in livestock that can provide the livestock we need to cope with future food demands at a reasonable price."
But:
Who decides "need"? How? What is "a reasonable price"? Does such a price include only financial considerations? Why should we dismiss negative "consumer perceptions" without trying to understand them better?

"Novel approaches to modify disease resistance or susceptibility in livestock are justified by economical and animal welfare reasons"
But:
What are these "economic and animal welfare reasons"? Who are we, participants at this workshop, to decide that these are reasonable justifications? Do we have any data (or even ongoing research) to investigate whether these benefits exist, and under what conditions they can be realised? What about the link between livestock breeding conditions and susceptibility to disease?

"Infectious diseases, particularly viral diseases, continue to be a major cause of human morbidity and mortality in the tropics and sub-tropics"
But:
Why is this only true "in the tropics"...? (Is it true in Queensland, where the researchers are based?)

"Cow milk is not always optimal" and "it is necessary to improve to nutritional quality of wheat grain"
But:
Under which criteria is milk or wheat considered to be "not optimal"? (The unstated assumption is that these agricultural products are sub-optimal for use in industrial food production processes, or with respect to particular assumptions about how people do or should feed themselves).
"Don't worry, I only work on animal models; there are no related products on the market"
But:
Products will one day be developed (otherwise this research would not attract funding), and work is being done (including by this researcher) on pigs, sheep, goats, chicken…

Strict regulations will be established to ensure that the specialised GM products will not enter the general agricultural-food chain.
But:
Past experience (e.g. from BSE) reveals that regulations are not always followed[25]*. Furthermore, some potential applications (e.g. lean meat) are being developed for the general food market.*

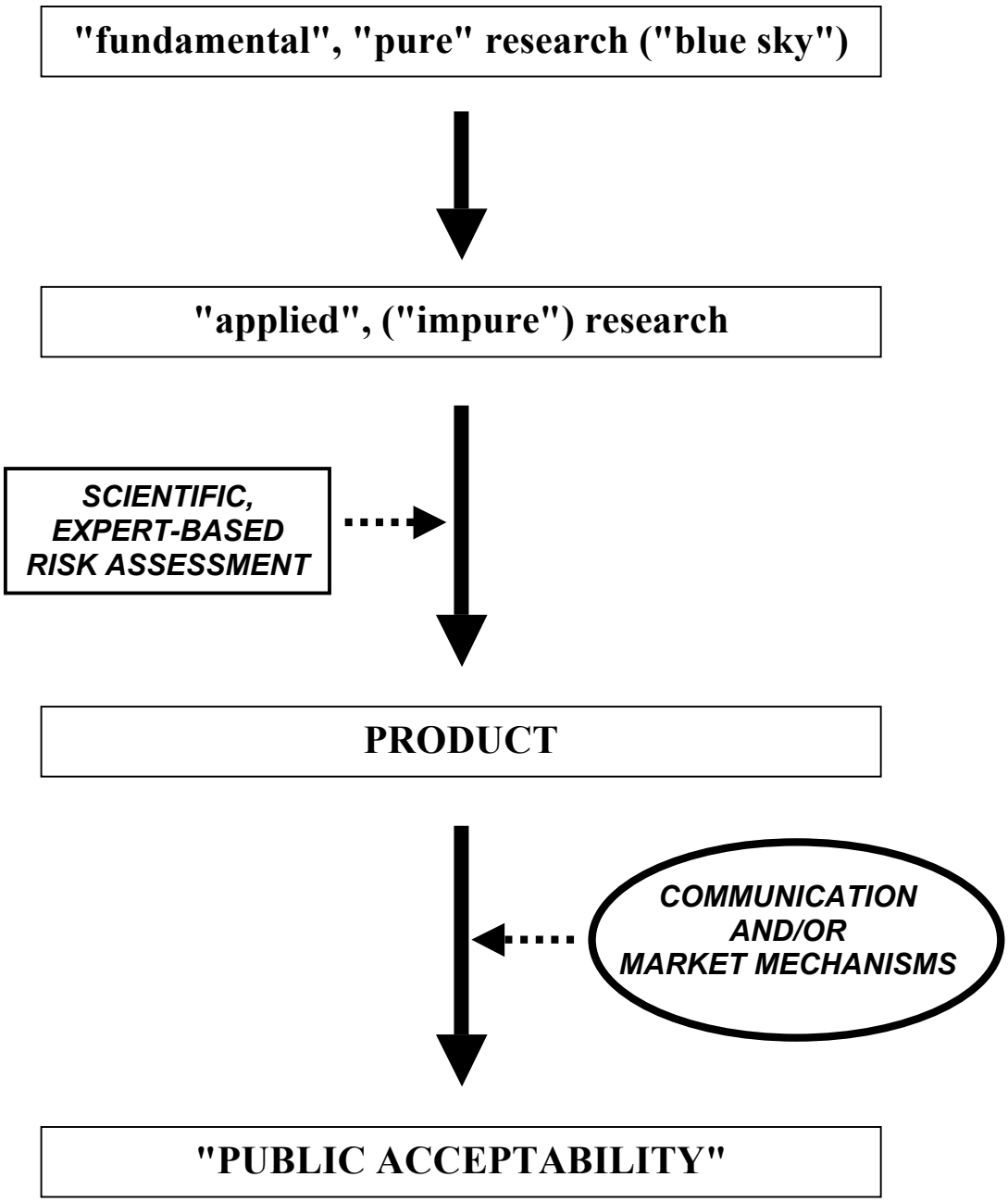
[24] These quotes were taken from the book of abstracts distributed to the participants of the workshop, or from the oral presentations. I must emphasise that this selection does not aim to identify specific participants who would be somehow "deviant". Quite to the contrary, I argue that these quotes represent "classic" examples of shared assumptions and framings. Similar quotes could have been taken from most of the presentations (except a few who did not address the reasons behind their work at all, thereby denying or assuming the relevance of their research for society in an even more radical fashion). And a similar list of quotes could have been derived from any other scientific meeting. I choose to use quotes directly from the meeting in order to "reflect back", in as direct fashion as possible, these implied framings to the participants present.

[25] Indeed scientists who insist on reassuring the public about such strict regulations often joke informally, among themselves, about how they have themselves tasted or tested the products of their own research, in total contravention of existing regulations…

TABLE 3: LESSONS FOCUS GROUP PARTICIPANTS HAD LEARNT FROM THE BSE AFFAIR, AND MANY OTHER AFFAIRS

- It is impossible to anticipate all risks - especially in the long term.
- Uncertainty is not admitted and not taken into account in the decision-making process.
- Economic interests override health and environmental considerations in the regulation and management of risks.
- Preventative action is delayed even when risks become apparent.
- There is no transparency in decision-making.
- Even when rules are established, they are not strictly adhered to.
- "Nature" is powerful and ecological systems are complex; this means that we can expect unforeseen (harmful) consequences when we interfere with these systems.
- New technologies introduced facilitate the current trajectory of agro-food system, towards more intensive agriculture and 'artificial' food; people are already unhappy about these.
- These developments in the agro-food system are closely associated with broader societal changes which people also feel uneasy about.

FIGURE 1: The inappropriate linear model of R&D[26]



[26] I emphasise that the model presented is a vision shared and constructed by scientific institutions which, as shown by numerous STS studies, has little to do with innovation processes in practice. It is presented here as a stereotype and I attempt to show within the text how: (i) this vision was pervasive in the framing of the presentations given by scientists at the OECD Workshop on Molecular Farming, (ii) how this inappropriate portrayal of R&D processes is noticed by lay people, and (iii) how this portrayal influences their perceptions of risks and of GMOs.