"How Can Biotechnology Benefit the Environment?"

The report of

A European Federation of Biotechnology
Task Group on Public Perceptions of Biotechnology/
The Green Alliance Workshop

held on

Monday 13th January 1997

at the

National Museum of Science and Industry,
London GB

THE GREEN ALLIANCE

The European Federation of Biotechnology
Task Group on Public Perceptions of Biotechnology,

established in mid-1991, has some 50 members from biotechnology industry and research, communications and survey research, the media, and environmental and consumer organisations from almost all Western and Eastern European countries.

Its aims are:

- To encourage informed public debate about the development of biotechnology;
- To review our present knowledge of the relationship between biotechnology and society, to identify deficiencies and to recommend appropriate research;
- To identify target audiences, issues and messages;
- To develop and implement strategies to meet these objectives.

THE GREEN ALLIANCE

The Green Alliance works for a better environment.
We seek to ensure that the environment is a prime
consideration in all decision-making.

Our aims are:

- to focus on the processes by which decisions are made in a broad range of institutions
- to bring together relevant interest groups and individuals to debate environmental problems and explore solutions
- to complement the work of other organisations by providing interpretation and analysis from a broad perspective
- to advance the environmental agenda into new areas

Activities that fulfil these functions are diverse, but include research and publication of reports, organising high-level debates, facilitating meetings and liaison between interest groups, and providing analysis and commentary to the media.

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Introduction

The purpose of the meeting

The purpose of the meeting was to explore what might be the eventual benefits to the environment from biotechnology, as seen by a range of public interest groups, scientists and industry spokespeople. These might include the contribution of biotechnology, in particular genetic modification, to more sustainable patterns of agriculture, to more efficient food production and to biological remediation of environmental pollution.

The meeting also discussed under what conditions these benefits should be realised, in particular, ways in which public and non-governmental groups could be more productively involved in the decision-making processes for biotechnology.

The meeting was intended to progress some of the debates arising at a 1995 series of meetings, organised by The Green Alliance in collaboration with the Centre for the Study of Environmental Change, University of Lancaster, GB, on the theme *"Uncertainty, Precaution and Decision-Making – the Release of Genetically Modified Organisms into the Environment"*. The three meetings featured different interest groups: non-governmental organisations, industry, and regulators.

A key theme of the series was that current regulatory procedures in Europe take a narrow, case-by-case view of risk; they do not provide for discussion of whether the technology is needed or can be justified through the benefits it brings, or of alternatives to using genetic modification strategies. Another key theme was that in order to have an adequate debate on issues, new ways would have to be found of engaging public interest groups and the public at large. So far, NGOs had not been very much engaged with the regulatory process, a situation which risked being mistakenly interpreted as disinterest or acquiescence. Hence this event addressed the questions: in what ways biotechnology could have environmental benefits; and in what ways the public could be more involved.

The meeting was organised in collaboration with the Task Group on Public Perceptions of Biotechnology of the European Federation of Biotechnology (EFB). The EFB incorporates more than eighty national biotechnology-related scientific and technological societies throughout Europe and is the central, independent, Europe-wide organisation for biotechnology. The EFB Task Group on Public Perceptions of Biotechnology, established in mid-1991, has some 50 members from the biotechnology industry and research, survey and communications research, the media, and environmental, consumer and patients' organisations from all EU and most other European countries. The Task Group carries out a wide range of activities and has received continuing support and funding from the European Commission.

The format of the meeting

The majority of the participants at the meeting were from NGOs and scientific institutions, with some representatives from biotechnology companies and media organisations. A participants list is attached (pp21-22). In the morning session, five speakers – two from non-governmental organisations, two from companies and one from a research institute – were asked to address the questions:

- How might biotechnology (specifically genetic modification) contribute to improvement of the environment?
- How likely is it that these benefits will be realised?
- What do you think are the conditions under which these benefits should be realised?

In addition, two speakers were asked to address the specific topic:

- What are the best ways of ensuring public participation?

The abstracts of these papers, together with the briefing notes sent to the speakers, form pages 6-17 of this report.

For the afternoon session, participants split into three groups, all of which tackled the same questions:

- What additional research is needed to clarify benefits and risks to the environment?
- How can the public be more productively involved?

The 'key points of discussion' section, beginning on page 18, summarises the discussions in the workshops, as recorded by the workshop rapporteurs, and includes comments from the final discussion session. The meeting covered a very wide range of topics in a short time, so time for discussion was inevitably limited. The meeting identified the crucial issues in the current debate about acceptability of applications of biotechnology, and gave some novel pointers as to the kind of future discussions that are needed.

Briefing to Speakers

The speakers were asked to answer as many of the following questions as they could, given their particular area of expertise and interest. *We asked for specific examples and scenarios to illustrate their answers to these questions and asked that they avoid just asserting that certain things are possible in principle.* This list of questions was made available to participants.

The list of questions below was unlikely to be comprehensive, so we asked the speakers to add any issues that they thought were important.

Question 1: How might biotechnology (specifically genetic modification) contribute to improvement of the environment?

How could genetic modification contribute to more "sustainable" agriculture by contributing to:

- Lower inputs of pesticides or herbicides in the growing process
- Lower inputs of energy in the growing process (*ie* use of machinery as well as energy used to manufacture pesticides and herbicides)
- Lower inputs of chemicals used in transport and storage (*ie* anti-fungal and anti-sprouting agents)
- Less use of water for irrigation
- Lower use of additives and energy for processing food
- Lower crop loss as it goes through the distribution chain through anti-sense (slower-rotting) traits
- New types of crops with positive environmental side-effects *eg* fast-growing trees to sequester carbon and provide shelter.
- Crops that reduce the risk of soil erosion

How does genetic modification have a role in environmental clean-up?

- Microbes that are able digest persistent pollutants
- Crops that are able to grow on polluted land
- Strategies for treatment/disposal of farm animal wastes
- Using crops to produce chemical feedstocks that have less environmental impact than their conventionally-produced counterparts (*ie* is plastic from plants better than plastic from fossil fuels)
- Using crops to produce chemical feedstocks that have new qualities (*eg* biodegradable plastics)

Question 2: How likely is it that these benefits will be realised?

- Are they near to being marketable products at the moment, or just theoretical possibilities? If they are not near to being marketable, is this for technical, economic or political reasons?

Question 3: What do you think are the conditions under which these benefits should be realised?

Possibilities:

- Adequate risk assessment to ensure that one type of negative environmental impact (*eg* pesticide damage) is not replaced by another type of negative environmental impact (*eg* ecological disruption through invasion of natural habitats, movement of genes to wild species, damage to genetic diversity, volunteer problems in crops, bringing ecologically valuable marginal lands into agricultural production). How confident can we be of risk assessments to predict long-term impacts? Can we be sure that risk assessments will be done in any country in which GMO work is being carried out?
- Monitoring of releases after commercialisation – is it possible? Who should do it and who should pay?
- Appropriate technology – how to ensure that genetic technologies are not used in inappropriate situations, particularly in developing countries?
- Financial liability arrangements – are specific laws needed to ensure compensation for damage from GMOs (additional to current regulations)?
- Public information and participation – how to know what the public wants, and how can information and participation be productively organised?

Speakers' Biographies

Mark Cantley has since 1993 headed the Biotechnology Unit within the Directorate for Science, Technology and Industry of the Organisation for Economic Cooperation and Development (OECD). Prior to joining the OECD, Mark worked for nine years as head of the Concertation Unit for Biotechnology in Europe (CUBE) within DG XII, the Directorate-General for Science, Research and Development in the European Commission. He has held posts in the Operational Research Department of the British Iron and Steel Research Association; Lancaster University in England; the International Institute for Applied Systems Analysis; and the Forecasting and Assessment in Science and Technology team in DG XII.

Huib de Vriend has been involved in debates about genetic engineering and the consequences for consumers, farmers, environment, animal welfare and all other relevant aspects for over ten years. Since 1991, he has been working for the Consumer and Biotechnology Foundation in the Netherlands, which has played a major role in national and international debates about product safety assessment, consumer choice and labelling. The Foundation participates in a national, informal, consultation group which includes representatives of the agro-food industry, trade and consumer and environmental organisations. The main issue currently on the agenda of this group is "biotechnology and sustainable agriculture".

Jens Katzek has been the Head of the Department for International Environmental Policy at BUND-Friends of the Earth, Germany for the past two-and-a-half years. Prior to this, he has held posts as scientific adviser for the European Commission and the German Parliament.

Wally Beversdorf is Head of Research and Development at CIBA Seeds, Switzerland; and has held the same post in the United States. He is a member of the Board of Trustees of the Centro Internacional de Agricultura Tropical, a significant Institute committed to the alleviation of hunger and poverty in tropical zones in the developing world. Former posts include Professor and Chair of the Crop Science Department of the University of Guelph, Canada, where he was also Professor in Protein/Oilseed Breeding and Genetics; and Chair of the Board of Governors of the National Research Council of Canada: Plant Biotechnology Institute.

Ken Baker is a member of the Senior Management Team and Director of Government Affairs for Monsanto in Europe. He joined Monsanto in Belgium in 1973 and prior to taking up his current position, he held a large variety of business and technical management positions for Monsanto in Europe and the United States. He plays a key role in a number of organisations including the EU Committee of the American Chamber of Commerce (Vice Chair of the Agro-Food Committee); EuropaBio, a Brussels-based trade grouping; and the Public Affairs Round Table. He is also a member of the Editorial Board of the Journals Agro-Industry Hi-Tech and Bio-Separations.

Jeff Schell has been Director of the Max-Planck Institut für Züchtungsforschung since 1978, where he has concentrated his interest in gene transfer techniques for crop improvement and also as a tool to understand the control of plant growth and development. He is also Professor for Plant Molecular Biology at the Collège de France in Paris. He is an elected member of the National Academy of Sciences in the United States, former Chair of the EMBO Council and he plays an active role in organising scientific research programmes within the European Community. His prizes and distinctions include the Wolf Prize, the Australia Prize, and most recently he was awarded the Sir Hans Krebs Medal by the Federation of European Biochemical Societies in Barcelona.

René von Schomberg is Assistant Professor in Environmental Ethics at Tilburg University in the Netherlands, and Co-Director of the International Centre for Human and Public Affairs, a research Organisation which publishes in the area of technology assessment and environmental and human rights issues. Recent publications include *"Contested Technology: Ethics, Risk and Public Debate"*, *"Coping with Deliberate Release: The Limits of Risk Assessment"* and *"The Social Management of Biotechnology"*.

Lars Klüver is Director of the Danish Board of Technology, an independent organisation established by the Danish Parliament in 1986. It aims to initiate technology assessment on the positive and negative impacts of technology for society and the individual citizen. The Board has an obligation to advise Parliament and the Government, and uses participatory methods in technology assessment, such as the Consensus Conference. Former posts include a consultancy on communication and technology assessment.

Speakers' Presentations

Biotechnology and sustainable production

Presentation by

Huib de Vriend

Consumer and Biotechnology Foundation, The Netherlands

In November 1995 Consumers International organised a conference about genetic engineering*. One of the three issues that were discussed was the implications of genetic engineering for sustainable agriculture. The outcome of this part of the conference contained six important points of attention:

1 The participants of the conference agreed that modern biotechnology could offer opportunities for more sustainable agriculture – but only if the technology and its applications are **part of a holistic approach** such as by creating pest- and disease- resistant crops or by speeding up traditional breeding programs aimed at creating a larger variety of crops.

2 The participants of the conference also agreed that there should be a **check-list of criteria** to evaluate whether specific applications of modern biotechnology could be considered sustainable...

3 ... and a system for **weighing** these **against an agreed definition** of sustainable agriculture.

4 Trans-national corporations that carry out field trials in developing countries should **meet agreed international, scientifically-based, standards** and be subject to a system of prior informed consent.

5 Consumer organisations should **inform consumers** about modern biotechnology...

6 ... and encourage industry to realise a **broader assessment in product development.**

In this paper I will go a little deeper into points 1, 2, 3 and 5.

Holistic approach

The present applications of genetic engineering have been developed mainly for two reasons: the bio-molecular engineers were looking for applications through which they could demonstrate their technological abilities and industries were looking for more competitive production methods. Now that the technology is ready for the market it has to be sold, for which the industries need arguments. The (potential) contribution to (more) sustainable production methods is such an argument.

True or not, from CI's point of view this kind of product-selling is the wrong way around. The consumer organisations do not preclude the possibility that present applications of genetic engineering can contribute to more sustainable production in the short run. However, the effects in the long run are questionable if the necessary change in production methods are not included in the research and development trajectory for new products.

Check-list of criteria

A check-list could include the following elements:

- the application should lead to lower harmful emissions
- the application should lead to long-term reduction of inputs
- the application should lead to improvement of soil quality
- crop diversity should be maintained and increased (not only more genes in the same crops or the same gene in many crops)
- the application should lead to enhanced quality of products from a consumer perspective (nutritional value, taste *etc*)
- the application should address consumer needs
- the application should lead to long-term improvement of water quality
- the application should lead to lower price (but not necessarily)
- negative socio-economic effects should be avoided (or repaired – H d V)
- ethical concerns and the well-being of animals should be taken into account

Definition of sustainable agriculture/production

The oncoming market introduction of the *Roundup Ready* soybeans and many other transgenic, herbicide-

* Consumers International Programme for Developed Countries, *"Food for the Future: the Risks and Realities of Biotechnology"*, 16 – 17 November 1995, the Netherlands.

resistant crops led to a debate about this type of application of genetic engineering in the Dutch Informal Consultation Group on Biotechnology (ICGB). In the ICGB the industry (seed, feed and food), retail and consumer and environmental organisations are represented. Soon the central issue in this debate was defined: "do herbicide resistant crops contribute to sustainable agriculture or not?". The ICGB decided to discuss this issue in a broader sense, not only related to herbicide resistance. The final outcomes of this debate will be published. One of the questions that had to be answered was how do we define "sustainable agriculture". The main elements of the definition that was agreed upon were:

- using natural resources without putting any damage to them
- contribution to a healthy environment
- sufficient production to feed all people in a healthy way

Consumer Information

Talking about sustainable production, we sometimes tend to forget that the products should also be sold to consumers. In our market economies consumer demand is probably the most powerful instrument to realise changes in production methods. Therefore, in targeting genetic engineering at sustainable applications, consumer attitudes, moral considerations, *ie* the cultural context has to be part of a strategy towards "sustainable biotechnology". This implies a well organised communication with consumers. Two-way communication means:

- informing consumers about genetic engineering, the applications and the products and the consequences for food supply, human health, animal health and welfare and the environment
- asking consumers about their habits and attitudes towards food, agriculture and the environment and adapt R&D programmes to the outcomes.

Consumer and environmental organisations are best positioned to provide and collect this information.

Ideas for further action

We can and should not wait until all the conditions I mentioned are fulfilled. Concrete action is necessary and possible. What could be done:

- set up a dialogue with all interested parties (industry, trade, government organisations, NGOs *etc*)
- reach agreement about relevant criteria
- set up a public debate about genetic engineering and sustainable development
- set up an R&D programme for applications that meet with the criteria

Presentation by

Jens Katzek

Head of Department for International Environmental Affairs of BUND-FoE Germany

Because the debate within BUND-FoE Germany on the topic discussed is under development the following comments present the personal opinion of the author and do not necessarily reflect the position of BUND-FoE Germany.

BUND-FoE Germany rejects the application of genetic engineering. To very briefly summarise the reasons:

- ecological concerns,
- concerns related to human health,
- socioeconomic concerns, and
- because we at BUND think that most of the time alternatives exist with less potential risks.

Up to now there has been only one exception. In some cases the application of genetic engineering to produce pharmaceuticals is accepted if there are clear benefits in comparison to the potential risks and if no alternatives exist.

There is a discussion going on within some environmental groups and political parties whether the advantages of genetic engineering for the environment are, in some limited cases, so overwhelming that the concerns could be put aside. Up to now, however, the arguments have not been very convincing, and BUND at least, maintains its position of rejection.

But let us assume that environmental organisations will change their position as they have done with the production of pharmaceuticals under specific circumstances. What would be the criteria for such a change of position?

Let's make it simple. Let us assume that the same criteria as in the pharmaceutical sector will apply, *ie*

- no clear alternatives
- clear benefits in comparison to the potential risks
- potential positive application of genetic engineering for the environment.

Let us look at the potential applications of genetic engineering and whether these applications fit the

criteria described above. Genetic engineering can be applied to:

a create herbicide resistant plants;

b create virus resistant plants;

c manipulate micro-organisms to clean up polluted soil;

d substitute toxins in chemical processes;

e and reduce energy consumption and raw materials in chemical processes.

a Herbicide-Resistant Plants

The placing on the market of herbicide-resistant plants will lead – in the long-term – to the application of more herbicides or at least to a stabilisation of the herbicide market. This is, understandably, in the interest of the companies producing the herbicide but not in the interest of those who would like to see another form of agriculture, one that does not burden the environment as it has in the past. Herbicide resistant plants will support the wrong agricultural strategy. Also, alternatives exist with ecological farming. This example would therefore not fit under the criteria described above.

b Virus Resistant Plants

The experiences with the placing on the market of Bt-cotton by Monsanto in the US in 1996 indicated that the protection is not as perfect as previously expected. Under such conditions, however, the development of Bt-resistant insects will be very likely – with the result that a well-established biological pesticide, used especially in ecological farming, will soon be worthless. This example would therefore not fit under the criteria described above.

c Soil Pollution

A study of the German Agency for the Environment (Umweltbundesamt) shows – quite surprisingly for a lot of people – that the application of natural soil micro-organisms for the cleaning up of soil contaminated with toxins is much more effective than the use of genetically modified organisms. So why take the risks related to the unpredictable behaviour of GMOs when natural alternatives exist?

d/e Toxin Substitution and Less Use of Energy and Raw Materials

It is known that enzymes – isolated from natural occurring microorganisms or from GMOs – are able to substitute toxins in the paper and leather industry. This area – which is a contained use application rather than a deliberate release – might be the only one where the application of genetic engineering could under some conditions be beneficial for the environment.

Sustainability versus benefit for the environment

Talking about environmental benefits, I would like to congratulate the organisers of the conference that they carefully avoided the phrase sustainability when choosing the title for this conference. I was invited in mid-December to a workshop organised by the German Ministry for the Environment entitled *"Possible Impact of Biotechnology for Sustainable Development"*. You have avoided – at least in the title – the impression that a potential benefit for the environment does automatically correlate with sustainable development.

Since Mr Baker from Monsanto is giving a presentation here today, I assume, however, that he will present us data which support the headings in Monsanto's advertisement that *"herbicide resistant soy beans will support a sustainable agriculture"*. I therefore will briefly clarify why the application of herbicide-resistant plants does not, in our view, correlate with a sustainable agriculture.

Firstly "sustainable development" is more than "benefits for the environment". Sustainable development includes an economic and social dimension. In the public debate – and the workshop today is part of it – we have clearly to differentiate between supporting sustainable development and benefits for the environment.

Beside the simple reduction goals, defined by scientific parameters, and the focus on consumption patterns, in our opinion it is important to include also social aspects (*eg* the equity of environmental space) when analysing the most effective approach towards a sustainable society. We have to take into consideration also why societies have developed in such a way that quality of life is so closely related to the amount of consumption. The radical reduction of consumption, as is necessary following the environmental space concept, is, however, not possible just by achieving a higher technological efficiency.

Secondly, even if one agrees with the assumption that less of the herbicide is used (studies imply that this will not be the case) herbicides are toxins – and they will always be! Even "environmentally friendly" herbicides such as glyphosate have been found in ground water in a concentration higher than the limit value of 0,1 mg, and in California glyphosate products were the third leading cause of both acute pesticide poisoning and skin and eye illnesses among California farm workers between 1984 and 1991.

The debate on "benefits for the environment" and public acceptance

Debates in society – and this workshop is, as already mentioned, part of such a debate – cannot be seen in isolation from other developments going on in parallel. The debate today is of course also influenced by the attempt to deregulate existing EU regulations on the contained use and on the deliberate release of genetically modified organisms. And because my own Government is actually quite active in this field I should also mention that the British Government unfortunately is also very much in favour of such a deregulation.

If whole classes of organisms are deleted out of the scope of the contained use regulation, if public participation is further limited and if the physical containment measures are lowered, no-one should be astonished if people think that a debate such as the one today is only used to increase public acceptance towards genetic engineering and is aiming at less public concern and resistance on the deregulation efforts. If this is not the goal of the organisers and the participants from industry – I would like to invite them to join us in convincing the European Commission and the Member States that such a deregulation is not appropriate.

Thank you very much.

Biotechnology: Agri-food and Environmental Considerations

Presentation by

Wally Beversdorf

CIBA Seeds, Switzerland

While much has been written since the publication of *"Our Common Future"* (the summary of the findings of the World Commission on Environment and Development) in 1987, the basic situation remains unchanged. Increasing per capita consumption (food, energy *etc*) by an increasing human population are placing pressure on the planet's environment, diminishing both the quantity and quality of essential (non-renewable) and the aesthetic (quality of life) components.

Biotechnology provides only one of many opportunities that can contribute to balancing the demands of our population with the finite carrying capacity of our environment. Biotechnology alone cannot solve the environmental dilemma nor can any other technologies, but it can contribute. How?

Improved technologies are indirectly one of the "causes" and potentially one of the "cures" for many of the planet's environmental problems. Biotechnologies have contributed to environmental degradation by contributing to population growth (life expectancy has doubled in much of the world during this century, in large part due to improved nutrition, childhood vaccinations and antibiotics). Biotechnologies may contribute to the "cures" by improving the utilisation efficiency of non-renewable resources (agricultural and forest lands, fossil fuels *etc*) and through environmental remediation (resource recovery).

How might biotechnology (specifically genetic modification) contribute to improvement of the environment?

In the near-term, genetically modified organisms will contribute to preservation of some non-renewable resources consumed by the world food production systems. How?

- By reducing losses ultimately attributable to those pests (weeds, insects, and disease organisms) that have adapted themselves to exploit the world's food and food production, storage, and distribution systems, through genetic modifications that resist pests and spoilage. (Such losses vary by region and food/feed type, but collectively represent a significant portion of the total resources utilised to feed the human population and its domesticated animals. Specifically, land, fossil fuel, irrigation water, high grade fertilisers *etc*, could be preserved if such losses were significantly reduced or eliminated).
- By reducing soil erosion and water pollution associated with extensive soil tillage (required for mechanical weed control or pre-plant-incorporated herbicide activation) and insecticide applications.
- By reducing the applications of fungicides and insecticides on our agricultural lands and forests.
- By conversion of waste by-products of our agricultural system to energy and substitute feeds or foods.
- By exploitation of heterosis (hybrid vigour) in several food and feed crops for which hybrids are not currently feasible, which will compound resource utilisation efficiency.

In the longer term by means that have not yet been identified.

How likely is it that these benefits will be realised?

The environmental benefits of biotechnology are limited by three somewhat interrelated factors: the understanding and acceptance by society of the potential benefits of specific products/processes of biotechnology, by the ambitions and motivations of our governments in addressing technological/societal issues, and by our own individual creativity. Human society is quite homogeneous in its desire to protect the environment, but this apparent homogeneity is disrupted when political and business realities, or individual personal well-being are brought into consideration.

What do you think are the conditions under which these benefits should be realised?

The benefits of biotechnology will be realised when the diverse views of our society regarding environmental protection, the demands of our society regarding bio-safety, human development and the understanding of our society regarding the risks and benefits of *status quo* versus new technologies are resolved.

- Environmental and bio-safety risk-benefit analyses are fundamental to the responsible release of modified plants into the environment and their use in the agri-food system. Zero risk-based assessments are meaningless since *status quo* maintains significant risks to both the environment and the sustainability of our society.
- We can be confident but not complacent in assessments. Societies have the right and the responsibility to protect both themselves and their environment. Through responsible governmental processes, many of our societies exercise those rights. Inter-governmental associations (UN, OECD, WTO, WPO *etc*) work to mediate these rights and responsibilities, through continually evolving international principles, agreements and laws.
- We believe monitoring is as essential for societal purposes as it is for commercial purposes. Monitoring is possible. The beneficiaries of the technologies normally pay (either directly or indirectly).
- Financial liability arrangements for irresponsible or illegal behaviour are the business of government. Our purpose should be improvement of our social condition and our environment, not the quest for litigation (lawyers are creative and will find means to extract value from society on these issues as they have on most other issues).
- Consumer information and education are essential if the benefits of any technology are to be fully realised. To that end, biotechnology-oriented enterprises, along with educational institutions, consumer and other associations must share responsibility. Unfortunately, the rate of technological advance often exceeds temporarily, the interest or ability of the public (including scientists) to fully understand the technology and its implications. When such dis-equilibrium occurs, activist groups are usually effective in bringing technological evolution back into synchrony with society's interest and understanding.

Thanks to all of you for fulfilling your special roles so responsibly today.

Presentation by

Ken Baker

Monsanto Services Europe, Belgium

How might biotechnology contribute to improvement of the environment? What are the conditions under which these benefits can be realised?

- The first issue is how to define the environment. For the purposes of this seminar and my discussion, I will define the environment as the broad surroundings and earth on which we as people live.
- Having defined the "environment", the next question is *"what effects are we as a global population having on the environment?"* and *"what needs improving and why?"*.
- As human beings, we live in a world where all the individual components are connected and interrelated. This is rather like Newton's first law of physics in play: *"To every force there is an equal and opposite force"*.

- Given that the environment is a complex entity to which apply the laws of science and physics, the only way to minimise the impact we, as human beings, have is to minimise the "equal and opposite force" which in turn means minimising the original impact in the first place.

- A key element in this process is to focus on making our actions sustainable, but at the same time, history tells us that technology is a progressive thing – it evolves and so, therefore, do the benefits. This implies that the effect of technology and therefore biotechnology will be incremental rather than sudden.

- The benefits from the application of biotechnology will also be evolutionary rather than with a "big bang".

So what therefore are some of the major issues facing our environment where the application of biotechnology can lead to a more sustainable environment?

In the field of agriculture:

The immediate and measurable benefits of a number of new crops can be demonstrated through the limited number of examples for which data is available. Most of the experience has been generated in the United States.

1 NewLeaf® Potatoes: These potatoes are modified to defend themselves against the destructive Colorado beetle and are already in use on farms. Use of the product substantially reduces the manufacture, transportation, distribution and aerial application of substantial amounts of chemical insecticides. Over a short six week period in summer in Canada, these potatoes were also sold as branded products in a Canadian grocery chain where they achieved an outstanding success in outselling all other potatoes.

2 NuCOTN®: Insect protected cotton which incorporates the gene expressing the Bt protein, a naturally occurring insecticide found in soil microorganisms which protects the plant against bollworms and budworms. The planting of NUCOTN has allowed the spraying of insecticides to be reduced from up to 7 times in a growing season to a maximum of one or two and many growers needed no spraying at all to effectively control budworms and bollworms.

   At the same time there is a consequent reduction in the use of farm machinery and energy for spraying.

3 Roundup Ready(TM) Soybeans: Soybeans which have been modified to tolerate the application of Roundup herbicide. The 1996 sowing of this crop in the United States has allowed more effective use of and substantial savings to be attained in the way herbicides are used. Data is still coming in and many find it difficult to imagine how such increases in efficiency can be achieved. But when it is considered at what level herbicides are used prior to planting in order to eradicate the possibility that weeds may germinate and grow with the new soybeans, and that applications of herbicides can be made in line with the weed problem and using more environmentally friendly products, it is clear that substantial efficiencies can be attained.

   None of the ongoing benefits will accrue without either the correct prior evaluation of the benefit or the encouragement of the use of the technology.

- Generally – and in contrast to many other developments in agricultural technology – even with "naturally evolved" plant varieties, those developed through the application are evaluated under risk assessment-based regulatory processes.

- In the case of commercial crops, the major desire for responsible companies is to avoid potential long-term liability. Thus risk assessment is considered an essential element of modified crop use, and crop performance is monitored continuously. Any loss of effectiveness by whatever means implies a loss of a commercial opportunity, and commercial enterprises will thus pay extra attention to this aspect.

- The ultimate test of effectiveness of a crop is whether a farmer or other user is both willing to pay for the crop in the first place in the expectation that there will be a financial benefit and at the time of harvesting, concrete evidence that the expected benefit has been attained. In both of the crops mentioned above (cotton and soybeans), the substantial savings mentioned have been seen by the farmer, thus confirming the benefits. No crop will be successful commercially unless such first order benefits can be obtained by the farmer.

- As with the introduction of most new technology, initially the benefits to the "man in the street" are difficult to quantify. Ultimately, however, the application of biotechnology in agriculture will provide sufficient food to help feed a hungry and growing world population by more environmentally sustainable means while further reducing the overall relative cost of producing food.

Presentation by

Jeff Schell

Max Planck Institute and AMICA, Germany

1 How might biotechnology contribute to the improvement of the environment ?

Probably the most important consideration is that presently the development of plant biotechnology (which is the topic I am most familiar with and from which I shall derive examples and conclusions) is driven mainly by commercial considerations. If environmentally concerned organisations would use their influence and resources to promote research in plant biotechnology aimed at using this technology to improve the environment, there is no doubt that this goal could be achieved. This can be illustrated by the fact that even in the first wave of commercial products (the commercial aspects of which are aimed at satisfying at least part of the needs for plant protection through plant breeding) one can identify several products that should improve the environmental impact of agriculture by providing an alternative to the use of herbicides (in favour of biodegradable herbicides), insecticides, fungicides, and hopefully in the future, nematocides, thereby improving agricultural productivity at significantly reduced costs to the environment. In view of the vastly increased capacity for knowledge accumulation which is made possible by the use of molecular techniques, the goal of a "knowledge driven" agriculture and in particular plant breeding can be realised provided sufficient support is given to plant sciences. Thus indeed genetic modifications of plants could contribute to a more sustainable agriculture by:

- making it possible to increase agricultural productivity without increasing dependency on environmentally damaging agrochemicals;
- reducing the inputs of energy in the growing process (mostly saving on the energy needed to manufacture agrochemicals);
- achieving increases in yield by making use of increased knowledge about plant development (by *eg* controlling photoperiodicity, changing morphogenesis, increasing biomass *etc*);
- reducing the damaging effects of climatic stresses (*eg* drought, low and high temperatures) on plant productivity;
- providing an alternative to the policy of "set-aside" of agricultural land by making "non-food" agriculture possible and economically rewarding for the production of renewable energy sources (*eg* biodiesel);
- creating commodities and raw material for industrial uses (*eg* fibres – biodegradable plastics); and
- creating high-value chemicals and pharmaceutical products (*eg* edible vaccines).

With regard to environmental cleanup or "bioremediation"

I have no doubt that specifically engineered micro-organisms have and can be further developed that will be able to break down persistent pollutants. Also, text prepared for the World Bank summarises the present efforts to select or develop crops able not only to grow on polluted land but also crops capable of "cleaning up" polluted lands.

With regard to treatment/disposal or better **prevention** of pollution by animal wastes, I refer you to engineered plants used to produce animal feeds containing the enzyme phytase (MOGEN/Gist-brocades, NL).

Since it is not possible for me at this time to evaluate the effectiveness of various schemes (policies) to recycle plastics and various polymers used to package goods, I should only point out that very serious and promising results have already been obtained indicating that the production of biodegradable plastics by plants is a feasible goal.

2 How likely is it that these benefits will be realised?

Although there can be little doubt that in the next decades the described goals can be realised, this question can only be answered positively given the realisation of a number of conditions such as:

1 Continued and increased research and development of plant sciences not only by private industry but also by public funding because not all goals of plant biotechnology are commercially rewarding although very important (*eg* biotechnology for Africa);

2 An adequate regulatory environment. Most and possibly all possible negative aspects of gene-technology can be eliminated by appropriate regulations;

3 Organisations involved in promoting the protection of the environment should participate in informing the media and the public with regard to the potential of this technology. They should use their influence to guide developments rather than opposing them.

Presentation by

Dr Ir René von Schomberg

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The question on how to democratise decision-making on complex scientific and technological developments should be answered in parallel to the question of how to mediate science and politics.

I will discuss four strategies to achieve a mediation of science and politics. The evaluation of these strategies will enable us to answer the question: what are the best ways for public participation?

These four strategies are:

1 Ethics committees

2 Consensus conferences

3 Technology assessment procedures and participatory-policy making

4 "Covenants" (voluntary agreements between NGOs, companies and the government)

1 Ethics committees

Ethics committees have been created in order to unburden political decision-making from "sensitive" ethical issues. I will briefly discuss the case of the Dutch ethical advisory committee which had to decide whether breeding with the first transgenic bull "Herman" was ethically acceptable.

In conclusion I will argue that ethics committees are not able to add ethical insights that substantially differ from the quality of actual public debate. Insofar as ethics committees are broadly-based, these committees will not be able to achieve a consensus that could legitimise political decision-making. Ethics committees also seem not to be able to answer the ethical issues in relation to the actual logic of technological developments which are not intentionally directed. Although ethics committees, in some cases, are formally said to stimulate public debate, their actual functioning has a demonstrated contrary effect: they reduce public and political deliberation and provide decision makers with a false quasi-authoritative point of view.

2 Consensus conferences

Consensus conferences have been held among others on the genetic modification of animals in Denmark, the Netherlands and the UK. I will conclude that these conferences are interesting strategies for mapping different policy options and these conferences could function as an input for public debate rather than they reflecting a formal closure of public debate with a consensus in order to provide policy makers with a legitimate basis for decision-making. Whereas informed public opinion always reflects dissent in pluralist Western societies, consensus conferences have set a goal which is unnatural (and thus anticipate an unlikely outcome of the debate) for public debate. The consensus conference on the genetic modification of animals in the Netherlands has shown that lay people increase their dissent on the issue during the conference rather than be persuaded to expert opinions. The unclear relation with parliamentary decision-making renders the results of the conference of low value for parliamentary decision-making.

3 Participatory policy-making and technology assessment procedures

Participatory decision-making takes place in broadly installed governmental advisory committees. I will evaluate the public participation in such committees which handle the deliberate release of genetically modified organisms (GMOs) into the environment. In conclusion, and in accordance with our recent study for the European Commission (see L Levidow *et al*, *Science and Public Policy*, special issue, 1996), I will argue that these committees would be able to cope with public participation, but have not been able to do this satisfactorily on a European level. In addition, discursive procedures for Technology Assessment (Science Centre Berlin) have been developed in order to deliberate on the risks of the release of GMOs. These procedures and the actual decision-making process in advisory committees show that reasonable consensus formation on safety issues can only be achieved if one would agree on normative standards which enable us to say something on the acceptability and definition of environmental harm. Standards which have been discussed recently are: the comparison with conventional agriculture, the comparison with the natural vegetation, biodiversity or sustainable development. In Europe, advisory committees implicitly apply these different standards and thereby cause a divergence in risk assessments across Europe. Even if one would agree on a single standard, continuous discussion is needed for the interpretation of such a standard in individual cases. These interpretations might differ substantially in short-term periods as new information feeds the debate. Since these normative standards within the boundaries of the relatively narrow disputes on safety

issues are identical with the normative standards discussed publicly on the socio-economic and environmental effects of biotechnology, public participation seems to be both appropriate and necessary to solve legitimacy problems of policy-making.

4 "Covenants"

Up till now, restricting myself to the Dutch situation, the voluntary agreements (covenants) between NGOs, companies and the government have shown to be the most effective way of public involvement. Environmental regulation in the Netherlands is covered (over 80 percent) by covenants. A convention exists in the field of biotechnology on the labelling of products containing GMOs and covenants with industry on the restricted use of genetically modified crops (soya) and the non-use of lactoferrin, a product produced by the offspring of "Herman", for applications in baby milk. Although effective, the use of covenants is dependent on the actual power-relations between industry and environmental/ consumer organisations and a sociocultural setting in which antagonist forces are open for negotiations.

What are the best ways of ensuring public participation?

Presentation by

Lars Klüver

The Danish Board of Technology

What are the best ways of ensuring public participation?

- What is public participation?
- Participation in what degree?
- Risk and gain with participation
- Public participation seen as strategic investment
- Some sort of answer
- The tools are ready

What is Public Participation?

- Process, including others than traditional decision-makers
- Based upon integral understanding of society and technology
- Integrates communication between parties, furthers balance

Participation in what degree?

Action	*Participation*	*Examples*
Feed information	Audience	Pamphlets
Get feedback	A voice	Eurobarometer
Go into dialogue	Equal human being	NOVO-NGO dialogue
Support articulation	Consultant	Consensus Conference
Give influence	Decision-maker	Direct democracy

Risk with participation

- Start processes out of your control
- Give away power
- Get responses you do not like

Gain with participation

- Kill “routine moaning”
- Get into balance with market/voters
- Confront it before it hits you
- Opens horizons
- Extend democracy

Public participation as strategic investment

1 Enterprise and Production

- Product design
- Market awareness
- Developing strategies
- Conflict resolving
- Negotiated and known conditions
- Corporate image and policy

Public Participation as strategic investment

2 Science and Research

- The concept of “relevance”
- Science’s understanding of the public
- Input to priority-setting/societal needs
- Research programme definition

Public Participation as strategic investment

3 Policy and Administration

- Input of new rationales
- Balance with the “customers”
- Supply of political options
- Make new negotiation environments
- Export responsibility for decisions
- Keep democracy alive

Some sort of answer

- Dialogue is necessary
- But action speaks louder than words
- The best ways of ensuring public participation is to establish processes that fit one’s own willingness to take consequences.

The tools are ready

- Scenario workshops
- Future labs
- Round table debates
- Consensus conferences
- Citizen juries
- Future search conferences
- ... and more can be developed

Risk & Gain – and consequences

Abraham Lincoln

> *“You can fool all the people some of the time, some of the people all the time, but you cannot fool all the people all of the time.”*

Key points of discussion

Is there any place for biotechnology?

Biotechnology, it was suggested by some of the participants, had the potential to be one of the technologies which could contribute to more environmentally-sensitive agriculture. This may be both by improving the efficiency with which non-renewable resources such as agricultural lands and fossil fuels are used and by protecting and remediating the environment, including:

- reducing food losses due to pests (diseases, insects and weeds) thus reducing wastage and spoilage and preserving land, fossil fuels, irrigation water, fertilisers, *etc*
- reducing the application of fertilisers, fungicides and insecticides while increasing agricultural productivity
- reducing energy inputs, mostly involved in the manufacture of agrochemicals
- reducing water pollution from pesticides and soil erosion associated with current methods of soil tillage for weed control
- converting agricultural waste by-products to energy and substitute foods, feeds and fertilisers
- achieving increase in yields by using increased knowledge of plant development and exploiting hybrid vigour in those food and feed crops in which hybridisation is not currently possible
- reducing the effects of climatic stresses (drought, low and high temperatures) on plant productivity
- producing renewable energy sources (eg biodiesel), commodities and raw materials for industrial uses (eg fibres, biodegradable plastics), and high-value chemicals and pharmaceuticals

However, a number of participants thought that the title of the meeting implied that biotechnology definitely could have environmental benefits, and this should not be assumed. In their view, there might not be any place for biotechnology – because they disagreed in principle with the manipulation of genes, or because of the unpredictable nature of the risks. There was concern that genetic manipulation might deflect effort from exploring alternative strategies towards better agriculture or environmental improvement.

Some participants put forward the argument that it would be hard to meet increasing global demand for food without using biotechnology. Others challenged the assumptions and data on which such a claim was based.

Ways of involving the public

A number of models were suggested. These included:

- involving interest groups or lay people in regulatory and advisory committees, including ethics committees and technology assessment procedures;
- consensus conferences;
- voluntary agreements between NGOs, companies and the government. These have been used in the Netherlands to come to agreement about the labelling of genetically modified food;
- a range of other discussion tools such as scenario workshops, future labs, round table debates, consensus conferences, citizen juries and future search conference;
- an independent body to communicate the implications of new developments to the public;
- labelling genetically modified products was a way of communicating with the public. In some participants' view this would not be enough – it needed to be supplemented by information and involvement through other routes in order to be meaningful.

It was pointed out that different techniques may be more or less successful in different cultural contexts. The important point was for governments and industry to experiment with different means of communicating with, and involving the public. In a climate where trust in many official institutions has been lost, institutional innovation is crucial. Several people spoke of the need for 'new forms of democratic control' and 'enhanced democracy'.

Scientists in particular should be made aware of the importance of public debate, about the implications of their work, and the public should be involved at an early stage in the debate.

Could biotechnology be made subject to a technology assessment process that would adequately capture the range of different views?

Much of the discussions concerned on the need to subject applications of genetic modification to a broadly-based system of technology assessment, that would take into account all possible impacts, including environmental, social and economic, and that could also weigh up risks against benefits. Such a system might also aim to judge whether an application was needed, and whether there were alternatives. To command the widespread confidence of the public, this kind of technology assessment would have to be developed with the involvement of a wide range of groups and individuals. However, the difficulties of arriving at such a system included:

- Reconciling the views of those bringing different values to their judgements about biotechnology, including whether genetic modification is right or wrong in principle. Some people feel that current regulatory systems already have embedded values, for instance as expressed by the way in which regulatory systems define 'harm' to the environment. Another embedded value may be that biotechnology is desirable and should be encouraged unless there are specific safety concerns, although regulators would probably claim that their systems are neutral.
- Access to sufficient information about both risks and benefits to make a judgement. Our ability to predict how the release of GMOs will affect the environment is very limited in some areas.
- The scope of a technology assessment. In order to explore alternatives to a use of genetic modification, its purpose has first to be clear, and then boundaries drawn around the possible range of alternatives to meet that purpose.
- The geographical scope of the assessment. Should risks and benefits be explored on a local, national, regional or global level?
- Who would bear the costs of such a technological assessment programme?

The role for industrial interests

There was considerable discussion of the role that could be played by companies wishing to develop applications of biotechnology. They should engage in early discussions with interest groups about the likely acceptability and usefulness of specific developments.

Further research needed

- **The social acceptability of the risks of biotechnology:** there is clearly a mismatch between the scientific appraisal of risk and members of the public's view of risk, and the latter needs to be better understood.

- **The role of insurers:** it was suggested that it would be useful to talk to insurance institutions about the way they would assess the risks of releasing GMOS.

- **Post-commercialisation monitoring:** Here there was a high level of consensus between the interest groups present, that some form of monitoring of the impacts of commercial use of GMOs will be necessary. At the moment the regulatory system does not make any provision for monitoring after clearance has been granted for commercial use. Research is needed into monitoring techniques, including ways of ensuring that genetically manipulated organisms are traceable once released.

- **Gene flow** and the possibilities for horizontal gene transfer were felt to be areas of considerable uncertainty.

- There was also felt to be uncertainty about **long-term effects** on human health and the environment, particularly of **large-scale** releases and of specific inserts such as antibiotic resistance. However, some participants doubted whether further research could lead to a greater degree of certainty, because such effects may be inherently unpredictable.

- The possibilities for **segregating** genetically modified and non-genetically modified commodity crops.

- The impact of biotechnology on **biodiversity**, and the **ownership** of genetic information.

- **indirect effects** of biotechnology applications in agriculture, particularly of herbicide- and pest-resistance. A complete audit is needed not just of the way the genes will behave, but of all the effects of growing the crop. This includes the effects of any alterations to the pattern of chemical use, and the possibility of pests developing resistance to the engineered crop.

Conclusions

According to some, biotechnology has the potential to contribute to providing sufficient food for the growing world population by more environmentally-sensitive means. There are a wide range of interest groups involved with, and concerned about, the development and application of genetic technologies. There is also considerable public unease about some of the possible applications, as demonstrated by the recent debates over genetically modified maize and soybeans. Whether biotechnology will ultimately have benefits that are felt to outweigh the risks, including those risks that are unpredictable in nature, is still unclear to most people.

What is important at this stage of the development of the technology is that the debate be broadened beyond the presently quite narrow confines of research and commercial organisations and regulatory systems. The debate about risks, benefits and acceptability needs to involve a wide range of groups and individuals, using innovative discussion techniques and building new and credible institutions for handling complex decision-making. This can only happen with the commitment of companies, researchers and regulators to move outside their traditional spheres of influence and accept a greater range of opinions in shaping their work.

The Green Alliance,
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