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PROPOSAL SUPPORTING AGROBIOTECHNOLOGY INDUSTRY ON ITS PATH TOWARDS A SUSTAINABLE BUSINESS CONCEPT

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EXECUTIVE SUMMARY

The Executive Summary consists of three chapters. In the first, the *research project* is described. In the second, *key findings of the project,* comprising results – along with their discussion, are presented. The third chapter contains the *conclusions* derived from the previous parts.

1. The Research Project

In the following, the context, relevance, research objectives and methodology of the project are described.

1.1. Context

The growing concern about Genetically Modified Organisms (GMOs) in the European Union has initiated a debate about the use of biotechnology in plant breeding and has raised questions about the implications of GMOs on a Sustainable Agriculture.

A GMO is defined as "any organism that has had a gene or genes from a different species transferred into its genetic material using accepted techniques of genetic engineering". (Nafziger, 1999)

The large-scale commercialisation of GMOs in agriculture started as late as 1996 with the so-called 'first generation' Genetically Modified (GM) crops. The major agronomic traits developed have been herbicide, insect and virus resistance.

Agrobiotechnology industry is a major player in the development and commercialisation of these plants. In Europe, it had to face severe criticism for neglecting both, the potential risks for the environment and human health, and social European values. As a consequence, this industry experienced losses in reputation and profit. This difficult situation led to the initiation of this project.

1.2. Relevance of the project

My counterpart is the independent Agency BATS (Biosafety Research and Assessment of Technology Impacts of The Swiss Priority Programme Biotechnology) in Basel. The Agency is specialised in technology assessment of GM plants. BATS seeks to address industry through tools for product assessment and a teaching module in sustainability marketing and reporting for managers. This research project shall serve as basis for these projects.

1.3. Research objectives

The project aims firstly, to point out strengths and weaknesses of the way agrobiotech industry is doing its business today. Secondly, it intends to propose new ways, opportunities and management options for the industry to contribute to a sustainable agricultural system. Finally, an outline for a sustainability assessment is conceived to support agrobiotech industry in the development of

improved agricultural products and in the evaluation of their economic, environmental and social performance.
Derived from this major goal, individual objectives of the three different parts of the research project are presented below.

1.3.1. Part I – Examination of the background of the research project and study of agrobiotech industry's environment

In the first part of the project, the Concept of Sustainable Agriculture is studied and the European legal and social environment for agrobiotech industry is analysed.

1.3.2. Part II – Evaluation of the situation of agrobiotech industry

In the second part, the agrobiotech industry is presented. Its impact on agriculture and responses to them are analysed in order to identify interactions of industry with the environment and society. Subsequently, key stakeholders, their role in the GMO debate, their interests in GMOs and Sustainable Agriculture are examined.
Furthermore, efforts of Novartis to put sustainability principles into practice are taken as an example for agrobiotech industry. Strengths and weaknesses of the chosen approach are identified in order to recognise its potential to satisfy stakeholders' needs. Based on the results of those analyses, a SWOT framework is created and new business opportunities enabled by the 'sustainability approach', together with management options, are proposed.

1.3.3. Part III – Outline of a Sustainability Assessment for agrobiotech industry

In the third part, the results of Part I and II shall be applied practically by conceiving a Sustainability Assessment for agrobiotech industry, which comprises two parts – the Product Development Support and the Product Evaluation. The tool can be used by industry to obtain economically viable, environmentally friendly and socially acceptable agricultural products and to assess their effects on human and ecosystem well being. In addition, further usage, development possibilities, strengths and weaknesses of the proposed Sustainability Assessment are discussed.

In the synthesis, results of the project are discussed, the possible advantages of the 'sustainability approach' for agrobiotech industry reviewed and potential use of the Sustainability Assessment for stakeholder engagement, product management and decision-making are shown.

1.4. Methodology

The following Techniques have been used to meet the research objectives of the project.

(1) Literature Study

A wide range of literature (e.g. Sustainable Agriculture, GMOs, novel business concepts, indicator development…) has been reviewed and used for the development of concepts.

(2) Interviews

In order to acquire inside knowledge about different points of view on GMOs and Sustainable Agriculture, interviews with representatives of an agrobiotech company (Novartis) and a NGO were organised. As interview partners, three managers of Novartis, one representative of the Institute for Applied Ecology in Austria were very cooperative. The names of interview partners can be found in the references (page 159)

(3) Informal contacts

Many informal contacts have been used to acquire background information, build up knowledge about Sustainable Agriculture, novel business concepts and sustainability indicators, to obtain 'feeling' for problems in the GMO debate and to gain an understanding of industry's and key stakeholders' motives/attitudes.
The most important informal contacts have been: Dr. Kaeppeli (Head of BATS), working colleagues of BATS, Dr. Diriwächter (Novartis), Dr. Kaelin (Winterthur Insurances) and 2 colleagues of the EAEME master course employed by Novartis.

(4) Participation on the International Forum of Gene Technology in Bern – First Symposium: Risks of Gene Technology – Phantom or Reality?

Participation on the Symposium gave me direct insight in the GMO debate and helped me to get in contact with people working in the same field. Knowledge gained from literature review has been complemented by information from lectures held on the forum and the following public debate.

2. Findings of the research project

In this section, key results of all three parts of the research project are described and discussed.

2.1. Results

2.1.1. Part I – Examination of the background of the research project and study of agrobiotech industry's environment

The major goals of Part I are – first, to define principles for a Sustainable Agriculture Framework and to study the possible role of GMOs in it and second – to examine the social and legal environment of agrobiotech industry in Europe.

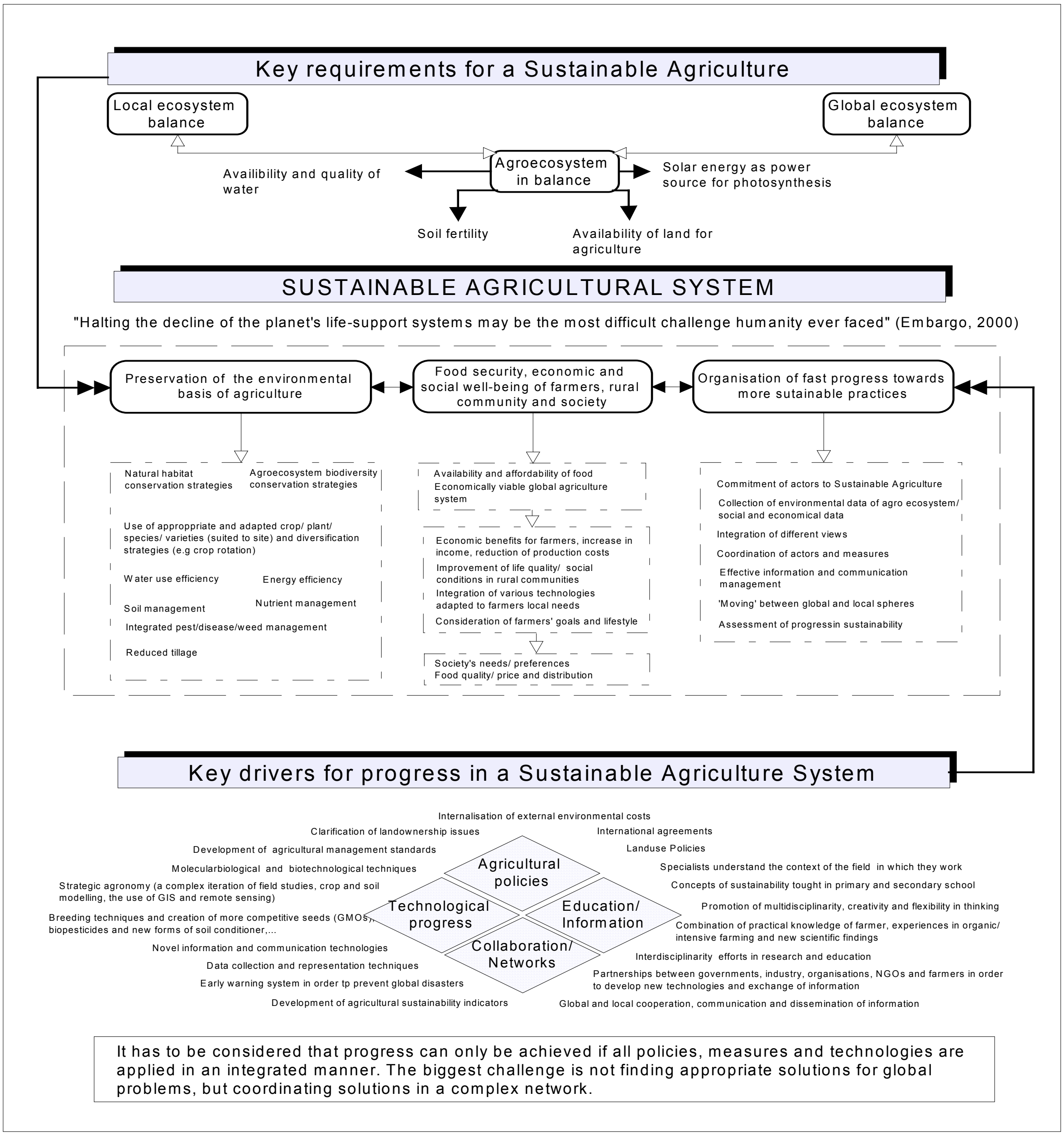
The vision of a Sustainable Agriculture is linked to the idea of Sustainable Development, which is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987)

The path towards a Sustainable Agriculture is hard to find, because economic, social and environmental goals in agriculture tend to compromise each other and actors have different views on both the importance of issues linked to Sustainable Agriculture and feasible approaches for problem solution. According to Timothy Reeves, Sustainable Agriculture is a 'moving target'. This means that sustainability is dynamic in time and space and has to be supported continually with new knowledge and technologies. (Reeves, 1998)

In general, three basic factors characterise the concept of Sustainable Agriculture – First, agriculture has to be viewed as a *multidimensional network*; second, actions take place on a *global as well as on local scale* and third, *system dynamics and evolvement of the sustainability concept* have to be considered. (Reeves, 1998), (Legg, 1999), (UC Sustainable Agriculture Research and Education, 2000)

Multidimensionality is an attempt to express in one word, the fact that agriculture has diverse roles. For instance, it has to ensure viability of many rural areas or to conserve biological diversity. Economic, social and environmental dimensions of agriculture are linked in a complex, network-like way. That means that changing one part of the agricultural system will affect associated parts. Actions of global scale may have effects on local agriculture. Modifications in the farming system at a regional level may contribute to an improvement or decrease in human and ecosystem well being on a global scale. Moreover, Sustainability (viewed as concept and in practice) is changing in time and space. This requires high flexibility and rapid transfer of information and knowledge between actors in agriculture. (Reeves, 1998), (Legg, 1999), (UC Sustainable Agriculture Research and Education, 2000), (NGO Steering Committee, 2000 (1,2))

Although the concept of Sustainable Agriculture cannot be precisely defined, key drivers for moving towards a sustainable agricultural system were identified as basis for the Sustainability Assessment.



Executive Summary - Figure 1: Sustainable Agriculture Framework (Some elements adapted from (Reeves, 1998), (Legg, 1999), (Saad, 1999) and (UC Sustainable Agriculture Research and Education, 2000))

Key requirements for a Sustainable Agriculture are factors that represent the carrying capacity of the ecosystem.

The framework shows that sustainability in agriculture is first, dependent on the preservation of the environmental basis of agriculture. Second, for the survival of the world population sufficient production and worldwide distribution of food has to be ensured. Third, to keep the whole

agricultural system in balance, farmers' life quality and income have to be ensured and the needs and preferences of the society have to be met.
A progress towards Sustainable Agricultural system has to be organised in order to solve urgent problems in agriculture fast and effectively.
As key drivers for promoting this progress, innovative technologies, agricultural policies, education/ information strategies and the creation of collaboration and networks have been identified.

What role GMOs might play in a Sustainable Agriculture is a controversial question. GMO proponents argue that plant biotechnology will bring the technological progress needed to support a viable agricultural system. Opponents point out the risks of the technology and current gaps in knowledge. (→ Find GMO pro and contra arguments on page 26)
At the moment there is little evidence that already commercialised GM crops would have negative impacts on human and ecosystem well being. But serious and controversial scientific publications confirm risks inherent in novel plant biotechnology applications.

The European Union, which focused on more environmentally and socially friendly agricultural practices in its Common Agriculture Policy reforms, has a sceptical attitude towards GM crops. On the one hand, the EU does not want to lose its stake in the gene technology and GMO market, but on the other hand it cannot ignore European public opinion which is directed against gene technological applications in the food sector. As a reaction to public pressure, inadequacy of regulatory processes, and disagreements between Member States, a de 'facto' moratorium on GMO approval processes has been implemented under the Release Directive 90/220/EEC and will probably last until the adoption of the revised Directive. (Krishnakumar, 1999), (COM, 2000 (20 final)), (CEC, 2000), (Albovias, 1999)

2.1.2. Part II – Evaluation of the situation of agrobiotech industry

Part II intends to analyse agrobiotech industry's business and its approach towards Sustainable Agriculture. The agrobiotech industry is presented, its role in agriculture defined and key stakeholders are identified. Efforts of the industry to apply sustainability principles are examined using a Novartis case study. Based on this study, a SWOT framework is conceived and business opportunities enabled by the 'sustainability approach' are proposed.

Agrobiotech companies are multinational groups which have a major stake in the biotechnology, seeds and agrochemical market. Among their characteristics are the facts that they gain billion of dollar sales each year, act internationally, have high research capabilities and increase their power by consolidation and licensing tactics.

Their products and activities promoted an intensification of agriculture, which on the one hand enhanced production capacity and farmers' profits. On the other hand, by supporting this trend, agrobiotech industry contributed to environmental damage, an overproduction tendency and a decrease of prices for agricultural products.

The Driving Force – State – Response model (see table below) shows that in order to mitigate negative effects on agriculture, agrobiotech companies have to act upon the reduction of technological forces (like agrochemical use) and economic forces (like external environmental costs). Furthermore, those companies have the possibility to reduce the impact of negative driving forces on agriculture. For instance they may develop products that enable agriculture under hostile environmental conditions or that enhance production capacity on a given surface by more environmentally friendly methods. By this means, agrobiotech industry can help decrease the impacts of negative social driving forces such as for instance population growth.

Driving forces	***State***	***Responses***
Environmental conditions ○ Physical ○ Chemical ○ Biological E.g. geographical factors (local agro-ecosystem, soil composition, pests,…), meteorological factors (climate, weather,…), potential climate change **Human activities** Economic forces E.g. economic viability of world agriculture, stable production capacity, global markets, food distribution – transport, customers' and consumers' preferences, food prices, non-integration of external environmental costs,… Social forces E.g. population explosion, urbanisation, poverty, development of rural communities, farmers' and consumers' well being, food quality and safety, policies,… Technological forces E.g. agricultural management, farming practice, use of fertilizers, pesticides, energy use, water use, … Legal forces E.g. political background, land planning, property rights, agricultural policies, trade agreements…	**Ecosystem well -being** Positive (Legg, 1999) Landscapes Flood control Sink for greenhouse gases Rural development… Negative Increased production/ increased use and degradation of natural resources (e.g. soil erosion, increased water use…) Increased transformation of virgin to arable land Loss of biodiversity (in "wild life" and crop diversity) and natural habitats General unbalances in global ecosystem (pests, natural disaster because of change of land use…) **Human well – being** Positive Increased production efficiency – due to Green Revolution Possibility to nourish world's population (at the moment) (UNEP, 1999) 'Improved food quality' (due to modern breeding techniques) Easy access to food in developed world (due to transportation and distribution networks) Negative Loss of life quality by ecosystem degradation Poverty, hunger due to natural disasters, soil erosion, non- effective distribution of food, not affordable food… Health effects because of food contamination (e.g. fertiliser/ pesticide residues/ food toxins)) Decline of family farms and disintegration of economic and social conditions in rural communities (UC Sustainable Agriculture Research and Education Program, 2000)	Economic responses E.g. Change in economic input, influence on changes in farm practice, environmentally sound practices, integration of external cost in accounting, creation of impact assessments (e.g. life cycle analysis of pesticides), creation of agri-environmental indicators, change in production processes… Social responses E.g. Societal reactions (protests, support for NGOs' actions…), consumer reactions (change in consumer preferences, boycott,…), global and local initiatives to promote Sustainable Agriculture (information, stakeholder processes and public participation in decision making,…),… Technological responses E.g. Research projects for sustainable agricultural practices, novel breeding technologies (biotechnology as means to change nutritional values/ reduce impacts on the environment and increase production efficiency,…) , information and communication technologies,… Legal responses E.g. Policies to slow down population growth, environmental regulations, environmental quality standards, research projects to promote Sustainable Development, economic incentives, rural development policies,… Environmental responses E.g. Slow adoption of species to changed environmental conditions – can be neglected

Executive Summary - Figure 2: Driving Force- State – Response model for agriculture

GM herbicide, pest and virus resistant crops are innovative products of agrobiotech industry and were an incredible financial success. Worldwide, the area planted to GM crops jumped from 2 million hectares in 1996 (the year of first commercialisation) to nearly 40 million hectares in 1999 – and had therefore an increase of 2000% within four years. (Halweil, 2000)

The problems for agrobiotech industry started only with the introduction of GMOs in European markets. Initial protests against GMOs were ignored and the opinion of the European public was not taken seriously. For this reason, the situation escalated. Food processors refused to use GMOs due to consumer boycotts and US farmers decided to grow non-GMO crops to get premium prices from retailers. Even investors protested against the previously celebrated GM crops. As a consequence, shareholder value dropped and PR strategies initiated by agrobiotech industry to calm down the European public failed completely in their goal. (Mitsch and Mitchell, 1999), (Halweil, 2000), (Washington Post, 1999)

The stakeholder analysis demonstrates that the key stakeholders of agrobiotech industry are logically shareholders and farmers, but also consumers.

The average American farmer seems to be not very interested in environmental quality, as long as no acute environmental problems emerge. They seek short-term profits and are not much concerned about the reduction of technological driving forces on the environment and the long-term conservation of the agro-ecosystem. (Anderson, 2000)

By contrast, 45.7% of Europeans are worried about the environment and establish an evident link between their health and environment. They have always taken a relatively critical view of the quality of food – even before various food scandals took place. (DG XI, 1999) The European public connects GMOs to risks to the ecosystem and to human health. Although the majority of Europeans think the various applications of biotechnology will benefit the environment, the use of biotechnology in the production of food was felt posing the greatest risk and was considered as the least useful application (together with biotechnology for transplants). (CEC, 1997b), (CEC, 2000)

In addition, Europeans are more than ever ready to express their values and concerns by consciously choosing products and putting massive pressure on governments. (CEC, 2000), (Hutton, 2000)

For Europeans, the ideal product that agrobiotech industry could produce, must be ‘clean’, ‘natural’ and ‘healthy’. (Bahrling et. al., 1999)

Societies in less developed countries have other interests. Farmers are worried about the growing power of agrobiotech industry and limitations in seed saving. Stakeholders in less developed countries want agrobiotech industry to ensure food security by cheap products and by enabling agriculture under hostile conditions by novel drought resistance GM crops. Furthermore, scientists in demand transfer of novel molecularbiological techniques. (Wambugu, 1999), (Wafula, 1999)

Agrobiotech industry is claiming that it will increase production capacity on a given surface by

more sophisticated and environmentally friendly technologies (e.g. GM crops). This strategy shall help to reduce global hunger and to conserve virgin land. (Council for Biotechnology Information, 2000), (Carta Nova Novartis, 2000)
But GMO opponents do not believe in the social motives of agrobiotech industry and even proponents of applied biotechnology are convinced that the way the industry is running its agrobiotech business will not bring the expected success in the long-term.

The case study of Novartis demonstrates that this company has a commitment to integrate sustainability principles in its business practice. The 'sustainability approach' is viewed as a moral obligation and a necessity for long-term business success.
But a framework supporting sustainability does not seem to exist in the company and the frequent consolidations are an unfavourable background for developing sustainability strategies. Already organised activities that promote sustainability are often not recognised as such by the company.

In general, sustainability is viewed from a global perspective by Novartis. Improved product traits are intended to improve farming practices worldwide. But it is not a common practice to adapt products to specific needs at a local level and sell them together with farming services. The only established service of agrobiotech industry in Europe is Integrated Pest Management which supports farmers in using chemicals in a targeted way. (Interview, Dr.Driwächter)

Moreover, an amazing lack of knowledge about interests and reasons for mistrust of the public was observed. (Interviews, Dr. Brassel, Dr. Einsele and Dr. Diriwächter)
For instance, Novartis has a longstanding-tradition in stakeholder processes with Applied Ecology Institutes or 'technology baskets' created on a case study basis and adapted to specific local economic, social and environmental problems in less developed countries. These issues are not reported to a broader public. Instead, short PR stories and defensive GMO statements can be found in the company's reports and on its Homepage.

The major problem of the current approach towards sustainability of agrobiotech industry is that social and environmental goals are often split off from financial affairs and treated independently. This means social and environmental issues are not viewed as core business and are not considered in every day decisions.

The SWOT analysis shows that many business opportunities and threats for agrobiotech industry are caused by the globalisation trend, population growth, values' awareness of society, environmental problems in agriculture, information and communication management and research capabilities of industry. (→ *Find SWOT analysis on page 82)*

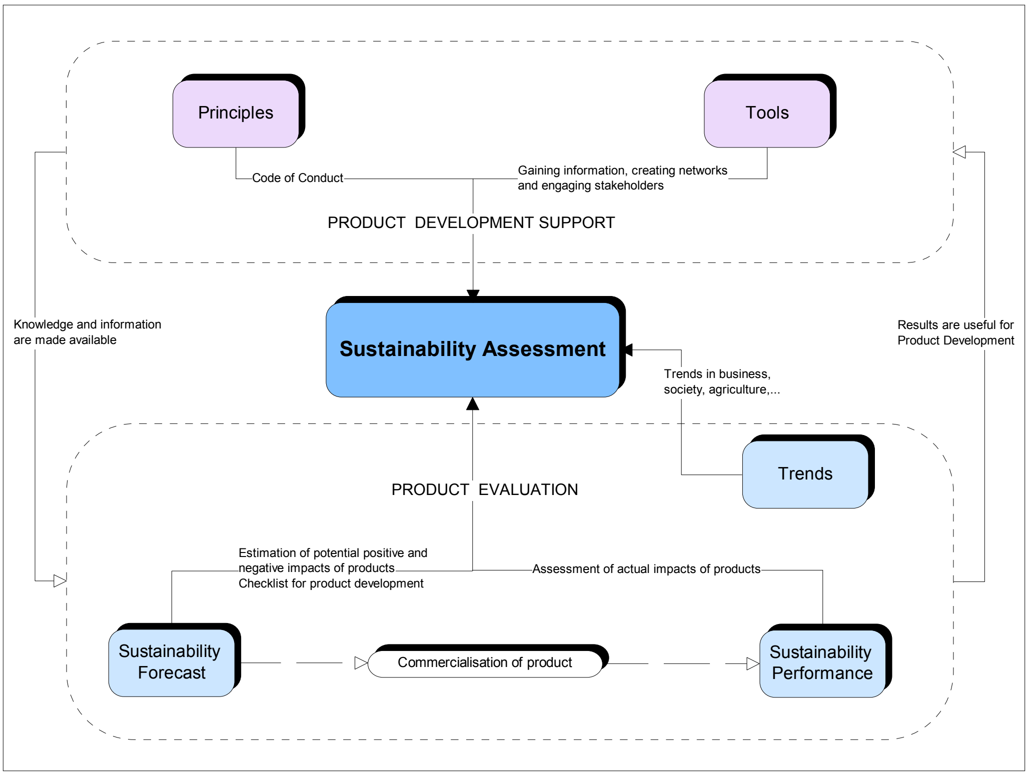
In conclusion, results demonstrate that the agrobiotech industry does not use its enormous potential to improve its financial performance, to benefit the environment and to increase worldwide quality of life.

2.1.3. Part III – Outline of a Sustainability Assessment for agrobiotech industry

In Part III, the knowledge gained from Part I and II is applied practically by conceiving a Sustainability Assessment (SA) for the development and evaluation of agrobiotech industry's products.

The goal of the proposed Sustainability Assessment (SA) is to support industry to design products, which support a Sustainable Agricultural System (see Paragraph 1.4 page 21) and meet the economic, social and environmental demands of industry's stakeholders as well as agrobiotech industry's own needs. The Assessment is designed especially for the evaluation of GM crops, but can also be used for every product created for use in agriculture.

As illustrated in the scheme below, the SA consists of two parts: the Product Development Support and the Product Evaluation.



Executive Summary - Figure 3: Sustainability Assessment Framework

The Product Development Support (PDS) comprises Principles and Tools.
The 'Sustainability Principles' are regarded as a sort of Code of Conduct for product developers and decision-makers.
The proposed tools, an information system and a cooperation strategy shall ensure the dynamism of the SA. First, they shall provide knowledge and information for measuring the indicators determined in the Product Evaluation. Second, they may help to understand stakeholders' views and to exchange knowledge. Third, the tools will help to realise novel aspects of Sustainable Development and integrate them in the SA. (→ *Find tables about the information system and proposed cooperation/ networks on page 98 and 99)*

The Product Evaluation (PE) is the assessment aspect and consists basically of an indicator system. The PE criteria shall consider the multiple dimensions of Sustainable Agriculture. Economic, social and environmental goals and corresponding indicators have been chosen to view products from different perspectives. (→ *Find sustainability goals and targets of the PE on page 96)*
The indicator system contains the following elements: Forecast, Performance and Trend Indicators.

By using the Sustainability Forecast (SF), a new product is assessed before, during and shortly after the development process.
SF criteria can be used as checklist for:

- first, determining the necessary specifications of a product,
- second, deciding if scientific discoveries (basic research) are worth to be further developed for commercial use
- third, controlling during development process if requirements are met
- and finally, evaluating the product before commercialisation.

Sustainability Performance (SP) should be checked after commercialisation of a product. Previously specified SF criteria have as counterparts SP indicators in order to assess both, the actual impact of a product in practice (SP) and the validity of the predicted impacts of the product respectively (SF). The time span for checking impacts of products after commercialisation is dependent on the degree of novelty and performance results of the product.

To make this clear an example for SF criteria and SP indicators is presented in the table below.

Indicator class	Sustainability Forecast Criteria (SF)	Scale	Sustainability Performance Indicator (SP)
<u>Sub-target</u>: Promoting global and local economic rural development while considering social structures			
	Product reduces the use of chemical substances (e.g. pesticides) and promotes use of less toxic substances	Global and local	Amount of pesticide applied per ha Consideration of quantity and toxicity of applied pesticide Toxicity of pesticide - type applied (profiling, positive list, weighting factor) (Savio, 1999)
<u>Sub-target</u>: Improving environmental farm management and ensuring environmental safety of GM and non GM crops			
	Potential decrease of labour hours by product use ☺ ☹	Global and Local	Labour hours/ year in agriculture in country x Women's labour hours/ year in agriculture in developing countries Manual weeding hours/ harvest Employment level in local communities → Jobs/ha (Savio, 1999)

Table 2.1: Example for Sustainability Forecast Criteria and Sustainability Performance Indicators

Six classes of indicators have been assigned. Operation/ impact (hammer symbol), condition (globe symbol), management, product trait, legislation and success indicators are presented as well as the scale on which the indicator should be evaluated. (→ Find indicator tables of the PE and further explications on indicator classes on page 104)

Trend indicators (TI) are sustainability indicators, which do not determine the performance of a product. They rather describe the actual state of agriculture. These indicators should be measured because they reflect social, business and environmental trends.

The proposed Sustainability Assessment has to be viewed as theoretical basic framework.
The way ahead would be to further develop the Sustainability Assessment and apply it on a case study basis. A stakeholder-based approach should be chosen to select indicators, weighing, aggregation and evaluation procedures. (→ Find proposals for further developping the SA on page 125)

2.2. Discussion

The challenge of the 21st century is to combine economic, social and environmental goals, accept them as the heart of the business and realise novel solutions, which were unthinkable a few years ago.
Agrobiotech industry's two biggest challenges are to reorient its business focus on integrated farming solutions and to build up trust to its stakeholders.

Agriculture is not regarded as a whole by industry. Only single problems are treated without considering the complexity of environmental interactions in the system. For instance, pest problems are fought by crop protection solutions. Agrobiotech industry makes an effort to reduce eco-toxicity of these products and promotes targeted use of them. The newest development is pest-resistant

crops, which do not need pesticide applications. But the basis of these applications is a one-sided end-of-pipe approach like 'We have a pest problem, we have to fight it'.
The alternative would be to follow a two-fold approach. On the one hand, agrobiotech industry has to continue selling crop protection chemicals and further reduce the application of pesticides after all in less developed countries. On the other hand, a goal for the future should be to correct causes, not consequences. Causes for the rapid spread and frequent pest infests are for instance monocultures and low crop diversity.
Moreover, agrobiotech industry has to consider that environmental conditions for agriculture as well as the social and economic environment are variable in time and space. Industry's "one product for every location" approach is highly unsuitable for complex regional problems in agriculture. Products and seeds could be viewed as building blocks combinable according to specific local needs of agriculture. What products and also services to use for improving farming practice could be a consulting task of industry. In the long term, agrobiotech companies should transform from an agrochemical and seed producer to a farm service provider.

Agrobiotech industry also follows outdated approaches in stakeholder engagement. It does not seem to realise that specific GM seeds are not the heart of all problems, but the very low level of public trust. To tell people the thousands of advantages of GMOs and enlist a million scientific arguments for the safety of GM crops does not make sense if nobody is going to believe them. In the case of GM crops, agrobiotech companies themselves increased the protests and undermined their credibility by first not admitting mistakes and then by making promises they could not kept. Helplessness in addressing the public and fears of loosing a key technology paralyse agrobiotech companies. They do not report their efforts and difficulties, but try to defend themselves by any means.

To meet these challenges and transform them to opportunities, the agrobiotech industry has to clarify what sustainability means for them and integrate the concept in its business activities. Clear goals have to be set, existing and new activities have to be coordinated and progress towards sustainability has to be measured and communicated continually.
On this basis, stakeholders have to be engaged to recognise their wishes and needs. New ways of communication have to be developed. The agrobiotech industry has to learn not only to listen to stakeholders, but also to react to their demands. Jakob Nüsch, the former president of the Federal Institute of Technology in Switzerland, hit the nail squarely on the head by stating at the Novartis Roundtable in February 1998 that " you [Novartis] create a project and try to sell it to others – this

you call dialogue. You should ask different people – even outside of Novartis – to participate even before you create a project". (Novartis Report, 1998)

The proposed Sustainability Assessment offers possibilities to find new ways for stakeholder engagement. Key stakeholders and experts could provide help to further develop the theoretical framework and to adapt it to their and the company's needs. By this mutual approach, hollow phrases could be replaced by concrete criteria for determining the sustainability of products.

3. Conclusion

European consumer protests against GMOs demonstrate that agrobiotech industry has reached a turning point. Problems, misunderstood by industry as sole concerns about biosafety, reflect the mistrust and dissatisfaction of society with current business practice.
It is now up to the agrobiotech companies to decide if they want to continue to do business as usual or to tread new paths. If they do not manage to gain the endusers' confidence, it is not likely that pure product improvements will be sufficient to meet the demands of farmers, of the society and the companies' themselves.
The 'sustainability approach' offers a way to escape this deadlock. It helps enterprises to build up stakeholders' confidence and after a short period of competitive disadvantage contributes to a new, brilliant era of more health, life quality and prosperity.

Introduction

The growing concern about Genetically Modified Organisms (GMOs) in the European Union has initiated a debate about the use of biotechnology in plant breeding and has raised questions about the implications of GMOs on a Sustainable Agriculture. Agrobiotechnology industry is a major player in the development and commercialisation of Genetically Modified (GM) crops. It had to face severe criticism in Europe for neglecting both potential environmental and human health risks of GMOs as well as social European values. As a consequence, this industry experienced losses in reputation and profit. These difficulties led to the initiation of this project.

The goals of this research project are to show new ways for agrobiotech industry to contribute to a sustainable agricultural system and to create a tool for determining the sustainability of their products.

In the *first part* of the project, the industry's environment is studied. A framework for Sustainable Agriculture is defined and the role of GMOs within the framework specified. Furthermore, European legislation and public opinion on GMOs is examined.

In the *second part*, a business analysis of agrobiotech industry is carried out. The agrobiotech industry is presented and its role in agriculture defined. Key stakeholders are identified and efforts to apply sustainability principles examined.
Based on the analysis, business opportunities and threats are analysed and proposals are made how challenges linked to the ‘sustainability approach’ may be transformed to opportunities.

In the *third part*, deduced from the results of part two, an outline for a Sustainability Assessment is proposed for supporting agrobiotech industry in both, the development of sustainable products and the evaluation of their economic, social and environmental performance.

In the *synthesis*, results of the project are discussed, the possible advantages of the ‘sustainability approach’ for agrobiotech industry are reviewed and potential use of the Sustainability Assessment for stakeholder engagement, product management and decision-making are discussed.

In the *annex*, the bibliography, indexes of tables and figures as well as a glossary and abbreviations are provided.

PART I – EXAMINATION OF THE BACKGROUND OF THE RESEARCH PROJECT AND STUDY OF AGROBIOTECH INDUSTRY'S ENVIRONMENT

In the first part of the project, the Concept of Sustainable Agriculture is studied and the European legal and social environment for agrobiotech industry is analysed.

1. Sustainable Agriculture

In this section, the concept of Sustainable Agriculture is studied. Key elements are identified and a Framework for a Sustainable Agriculture system is created. Moreover, the role of GMOs within this system is discussed.

1.1. Definition of Sustainable Development

The vision for a Sustainable Agriculture is linked to the idea of Sustainable Development. Sustainable Agriculture can be seen as part or even as a prerequisite for Sustainable Development.

Although there exist many definitions for Sustainable Development, the globally most accepted one has been published in 1987 in the report of the World Commission on Environment and Development (Brundtland Commission). In this report Sustainable Development is defined as a "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs".* (World Commission on Environment and Development, 1987)
This definition of the concept of Sustainable Agriculture served as basis for the Agenda 21 and the signed protocols of the Earth Summit in Rio de Janeiro in 1992. (Agenda 21, 1992)

The definition of Sustainable Development has been complemented by the International Union for the Conservation of Nature (IUCN), the United Nations Environment Programme (UNEP) and the Worldwide Fund for Nature (WWF), who laid a focus on the environment's capacity to support development. By them, Sustainable Development is defined a "development that meets the needs of the present without compromising the ability of future generations to meet their own needs *by improving the quality of human life within the carrying capacity of supporting ecosystems*". (Holdren et al., 1995)

'Strong Sustainable Development' is defined as conservation and improvement of the actual state; neither environmental nor economic or social capital can be diminished. In contrast, the concept of 'Weak Sustainable Development' is based on economic values. According to this concept, trade-offs between the sustainability dimensions are allowed, only the total value of the capitals must not decrease. (Schulte and Kaeppeli, 2000) In the 'weak sustainability' approach, it is assumed that for instance economic development can compensate for environmental damage or social development.

It is essential that the three dimensions of Sustainable Development are integrated in a way, that sustainability goals of one dimension do not compromise the goals of another one. There must be a critical limit for each dimension beyond which trade-offs are not allowed.

1.2. Definition of Sustainable Agriculture

"Much has been said about the need for a Sustainable Agriculture during the last ten or twenty years and hardly a paper is written or a speech is hold which does not contain the word 'sustainable'". (Reeves, 1998) But what does it mean in practical terms?

Wilfried Legg, Head of Policies and Environment Division of OECD, defined Sustainable Agriculture as "a process in which the demands for its outputs - food, fibre and other services - are met from farming practices that are economicly efficient, environmentally friendly, and socially acceptable". (Legg, 1999)

According to Egger, three basic conditions have to be fulfilled in order to achieve a Sustainable Agriculture:

(a) To produce sufficient food for an increasing world population
(b) To produce it in an environmentally friendly way
(c) To ensure that it is accessible to all people and affordable for the poor

(Egger, 1998)

Reeves describes 'sustainability in agriculture' as a "moving target". Agriculture is based on dynamic biological, physical and chemical systems and farmers live in a constantly changing economic, social and political environment, thus what is sustainable at a certain place to a certain time will only remain 'sustainable' for a limited period. For this reason, a sustainable agricultural system must be continually supported with new knowledge, practices and technologies. (Reeves, 1998)

1.3. Agriculture today

Agriculture faces enormous global challenges today and in the future. Increasing population and incomes raise the demand for agricultural products and the land and water resources have to meet that demand. At the same time, agriculture needs to decrease environmental damage from farming activities and contribute to rural development. But there will also be enhanced competition for land and water resources to meet the needs for housing, industry and transport infrastructure.

These pressures on agriculture are evolving against a background of rapid developments in technology such a biotechnology, structural change in the food sector, globalisation and trade liberalisation. (Legg, 1999)

In the last three decades, productivity increases for the major cereals, rice, wheat and maize, has been a result of the incorporation of scientific developments in plant breeding. By the 1970s, novel seeds accompanied by chemical fertilizers and, for the most part, irrigation has replaced the traditional farming practices of millions of farmers in less developed countries. (Rosset et al., 2000) This trend has been called the “Green Revolution”.
In India for instance, yield per unit of farmland improved by more than 30 per cent between 1947 and 1979 when the Green Revolution was considered to have delivered its goods. But the main promise of the Green Revolution - to end world hunger - did not come true. Today an estimated 786 million people are suffering under malnutrition (Ganguly, 2000) and population is growing at a rapid pace.

In order to meet the demands of the world population and the environment at the same time, radical changes in agricultural practice are needed. At the moment agriculture is far from being sustainable. Issues of great concerns are increased land use, degradation of the soil resource and the effects of irrigation on ground water, surface water and related ecosystems.

Some examples for negative environmental effects of current agricultural practice are:

- Irrigation has increased 60% since 1960. (Business Week, 1999)
- 75% percent of Australia’s land and water resources are used in agricultural production, which has had an enormous impact on the environment and landscape. (SoE, 1995)
- In Germany, 54,7% of the surface is used for agriculture in comparison to 0,7% of land use by industry (Data 1997). (Maxeiner and Miersch, 2000)
- By 1990, poor agricultural practices had contributed to the degradation of 562 million hectares, about 38 percent of the about 1.5 billion hectares in cropland worldwide. (World Resource Institute, 2000) 40% of global farmland is washed out. Scientists of the International Food Policy Research Institute and the World Resource Institute found out that the most effected region is Central America, where 75% of the farmland eroded. In Africa 20%, in Asia 11% of farmland are concerned by soil erosion (Der Standard, 2000)
- About 70% of decrease in species in Central Europe is due to direct or indirect effects of modern agriculture. (Maxeiner and Miersch, 2000)

In order to face problems of to date agriculture, products, technologies and services must be developed to enhance production capacity while protecting and restoring natural resources. But the focus cannot only be put on production efficiency, also the distribution of agricultural goods and the development of a viable agricultural sector is of similar importance. Global and local co-operations have to ensure that changes in agriculture will occur in a fast and well co-ordinated manner. Furthermore, an early warning system should be created to announce alarming environmental changes.

1.4. Framework for a Sustainable Agriculture

The framework has been developed to identify ideas and practices that constitute the concept of Sustainable Agriculture.
A sustainable agricultural system is based on three basic factors.

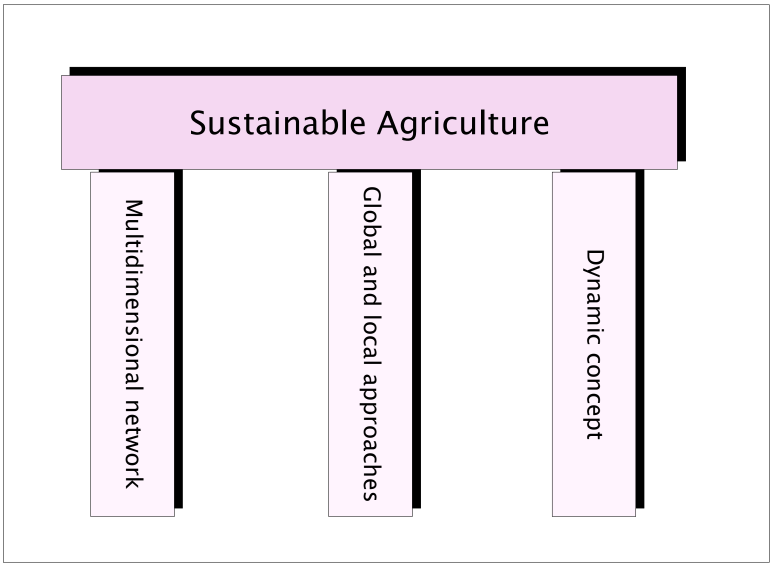


Figure 1.1: The three sustainability pillars

First, agriculture has to be viewed as a *multidimensional network*, second actions have to take place on a *global as well as on local scale* and third *system dynamics and evolvement of the sustainability concept* have to be considered. (Reeves, 1998), (Legg, 1999), (UC Sustainable Agriculture Research and Education, 2000)

Agriculture viewed as a multidimensional network recognises its diverse roles and the interconnections between them. For instance, agriculture has to ensure the economic viability of many rural areas and it has to conserve biological diversity. Consequently, changing one part of the agricultural system will affect connected parts. Actions of global scale may have effects on local agriculture. Modifications in the farming system at a regional level may contribute to an improvement or decrease in human and ecosystem well being on a global scale. Moreover, sustainability (viewed as concept and in practice) changes in time and space. That requires high flexibility and rapid transfer of information and knowledge between actors in agriculture. (Reeves, 1998), (Legg, 1999), (UC Sustainable Agriculture Research and Education, 2000), (NGO Steering Committee, 2000 (1,2))

The problems to move towards a more sustainable farming system are that there is neither a common definition for a Sustainable Agriculture, nor universally valid values. Issues connected with sustainability are seen by actors in agriculture in completely different ways. Actors' views are dependent on perception of life quality and perspectives for a 'better' world.

However, basic elements for a sustainable agricultural system, presented in the scheme below, have been identified. The framework has been developed as basis for further analysis in Part II and the

Sustainability Assessment in Part III.

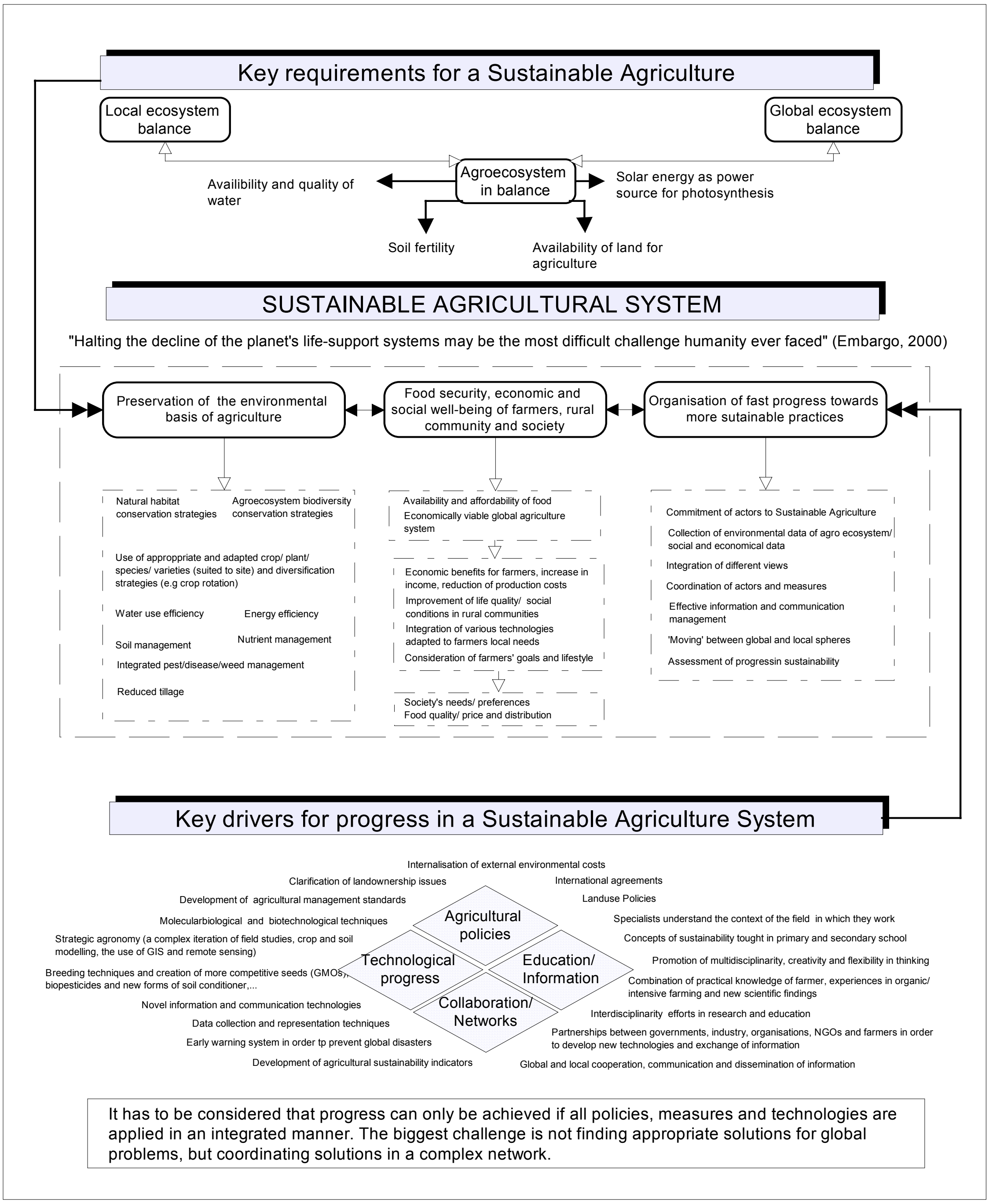


Figure 1.2: Sustainable Agriculture Framework (Some elements adapted from (Reeves, 1998), (Legg, 1999), (Saad, 1999) and (UC Sustainable Agriculture Research and Education, 2000))

Key requirements for a Sustainable Agriculture is the carrying capacity of the ecosystem and factors enabling the growth and prosper of plants.

Three key factors and further sub-factors ensure the *sustainability of an agricultural system*.
The framework shows that sustainability in agriculture is first, dependent on the preservation of the environmental basis of agriculture. Second, for the survival of the world population sufficient

production and well-balanced distribution of food has to be ensured. Third, to keep the whole agricultural system in balance, farmers' life quality and income have to be guaranteed and the needs and preferences of the society have to be met. Progress towards sustainable agricultural system has to be organised in order to solve fast and effectively urgent problems in agriculture.

As *key drivers for promoting this progress*, novel technologies, agricultural policies, education/ information strategies and the creation of collaboration and networks have been identified.

1.5. Can Genetically Modified Organisms (GMOs) contribute to a Sustainable Agriculture?

Genetic engineering, also called biotechnology, is a new technique to improve plant-breeding methods. It allows the integration of foreign genes of all sources in host organisms. The term Genetically Modified Organism (GMO) refers to the newly created organism. Biotechnology applied on crops/ plants, leads to the expression Genetically Modified (GM) or transgenic plant. The term is defined as "any genetic plant type that has had a gene or genes from a different species transferred into its genetic material using accepted techniques of genetic engineering". (Nafziger, 1999)

The ability to engineer GMOs enhances enormously the possibilities to create improved agro-species. Furthermore, it could contribute to the technological progress needed for reaching a more sustainable agricultural system. But this novel technological application also raises ethical concerns and could threaten human and ecosystem well being.

The first field trials 'under closed conditions' of transgenic plants were conducted on tobacco crops in the US in 1982. In 1990, GM crops were first tested out in the fields. However, it was not until 1996, when the first generation of GM crops became commercially available. (Krishnakumar, 1999)

The major agronomic traits developed in these first generation crops have been herbicide, insect and virus resistance. Furthermore, to a lesser extent, composition has been modified to increase nutrition value or shelf life. These initial developments were addressed to the food production in the developed world. Promised modification of crops for growth in the difficult conditions in the developing countries (e.g. saline resistant and drought resistant crops) are not at the marketing stage today. (Bahrling et al., 1999)

During 1998, nearly 12 million hectares were planted wit transgenic crops with most of the area covered by GM soybean, maize, cotton and canola. Nearly 75% of the area under GMOs was in the United States. (Parida, 1999) The only other countries with a substantial transgenic harvest were

Argentinia and Canada. These three nations accounted for 99% of global transgenic crop area. (Halweil, 1999)

Although transgenic plants had/ have to fulfil safety requirements before commercialisation, critics insist on their potential risks and want to reach a GMO ban.
They raise concerns regarding food safety, environment, intellectual property rights and less developed countries' economics. Opponents also criticise involved industry for too much emphasis on corporate profits and for neglect of risks of GMOs. (Thelen, 2000)

GMO proponents argue the opposite. They emphasise that transgenic crops will help protecting the environment, improving food quality and contributing to solve problems in less developed countries. (Thelen, 2000) GM crop supporters are convinced that the so-called 'Green Gene Technology' will improve agricultural practice. By cultivation of improved genetically modified crop varieties, it would be possible first, to apply fewer chemicals in a more targeted way, second, to anticipate harvest losses by pest resistant crops and third to enhance nutrition value of vitamin or mineral poor plants. (Maeschli, 1998)

If GMOs have the potential to make current agricultural practice more sustainable is a controversial issue, because not much data about environmental impacts of large scale commercial planting are available. Argumentation is generally based on risk estimations, modelling or merely assumptions.

In the tables below, pro and contra arguments in the GMO debate are presented.

Note:
The column 'argument specific to GMOs?' in the tables 1.1 – 1.6 has been introduced because the current discussion about GM crops often suffers from a failure to differentiate between risks inherent in gene technology and those, which transcend it. This means that many critical issues discussed in the GMO debate does also concern conventionally bred crops or to date agricultural practices; thus solely prohibiting plant biotechnology for food production would not solve most of the mentioned concerns.

Arguments pro GMOs	**Arguments contra GMOs**	**Argument specific to GMOs?**
	General arguments	
Until 1997, globally 70 transgenic plants in more than 3600 field trials on 15000 locations have taken place and nothing has happened. (Maxeiner und Miersch, 2000, 2))	The time frame is too short in order to measure long term environmental and health damage. No legislative framework for long term monitoring is in place until now.	Specific to GMO
Risk/ Benefits analysis There is a significant risk not to develop and commercialise GMOs.	Risk/ Benefits analysis Risks are not calculable/ are generally too high. There is no need for GMOs. The Precautionary Principle shall be applied.	Specific to GMO
Transgenic crops are <u>not significantly</u> different from conventionally bred crops. GMOs are thoroughly assessed crops and genetic techniques are only an extension of a historical process of continued manipulation and ancient breeding techniques. The use of gene technology in plant breeding is a more precise, efficient and controllable technology than conventional breeding methods, which produce a high degree of unwanted and unfocused mutations. For conventionally bred crops there is in general no legal obligations for ensuring food safety or environmental testing although proteins and regulatory functions are modified by the enhancement of mutation rate (mutation breeding).	Transgenic crops are <u>totally</u> different from conventionally bred crops. Risks due to gene technology: - Risks due to vector (regulatory elements, selection marker) - Transgressing species limits on large scale basis - Persistence of DNA in the ecosystem - Effects due to genome organisation and expression patterns - Risks of gene technology are not calculable/ generally too high - should not be applied. - The technology is not ethically correct because DNA is transferred over species barriers. - Limited possibilities of gene transfer over species barriers in conventional breeding	Concerns also should be raised for conventionally bred plants, testing should be regulated for both conventionally bred and GM crops
Gene flow is a process which is also happening naturally, cross pollination is also happening between conventionally bred plants and wild relatives.	Vertical (crosspollination) and horizontal gene flow (to soil, to gut bacteria) might happen. - Inserted transgenes could incorporate into other species or directly or indirectly affect other species and human health. - Antibiotic resistance gene could be transferred to soil or gut bacteria.	Gene flow is a common phenomenon. Gene flow of transgene is GMO specific (antibiotic resistance gene could be avoided)

Table 1.1: General Arguments pro and contra GMOs

Arguments pro GMOs	Arguments contra GMOs	Argument specific to GMOs
	Environmental arguments	
There is nothing natural in today's agriculture. Agriculture had for a long time a negative impact on the environment. GMOs would improve agricultural practices.	Alteration of agronomic practice due to GMOs has a negative influence on the environment. A new form of pollution could arise – 'genetic pollution'.	Not specific to GMOs
Productivity increases in favourable areas alleviates pressure to use more marginal and fragile environments for agriculture.	Other measures than increase of productivity can improve production and at the same time ecosystem quality (e.g. improvement of transportation structure)	One means to increase productivity might be might gene technology. But also by conventional breeding methods yield-intensive varieties can be produced.
Protection of the ecosystem and conservation of natural resources by GMOs Future development possibilities: Drought and saline resistant crops, increased nitrogen efficiency,…	Useful applications have to be assessed on a case by case basis in the future. Until now, no useful products are in the marketing stage.	Such crops can be produced by conventional breeding, but cheaper and faster by gene technology.
Pest resistance GM crops improve energy efficiency and million tons of pesticides were saved.	Pest resistances (first generation herbicide, pesticide and virus resistant crops) did not improve significantly environmental quality and promote pest resistance.	Continuing expression of pest resistance genes can promote resistance development, although development of pest resistance is a common phenomenon when pesticides are applied.
Virus resistance crops enable new possibilities of plant protection.	Virus resistance GM crops can lead by recombination processes to new forms of more virulent viruses	Virus recombination events are possible, which would not be possible with conventionally bred crops
Pedigree diversity in crops	Loss in crop diversity	Crop diversity is generally low in modern agriculture
-----------	Impact on non-target species or unwanted impact on target species by pest resistance GM crops	If the crop is produced by conventional breeding or gene technology does not matter - not the technique has to be evaluated but the impacts of the product.

Table 1.2: Environmental Arguments pro and contra GMOs

Arguments pro GMOs	Arguments contra GMOs	Argument specific to GMOs ?
	Health arguments	
Crops with higher nutritional value, improved traits or pharmacological value (e.g. Vitamin A rice) can be produced. See Nutraceuticals p.30	Reduction of nutrition value in the case of herbicide resistant soy beans - contained less isoflavon. (Altieri and Rossett, 1999)	Reduction in nutrition quality/ value can also happen by conventional breeding method
No food safety concerns have been scientifically proven.	Controversial scientific papers (e.g. Pusztai, Lectin potatoes experiments) see *Lancet* 1999 Oct 16;354(9187):1353-4	Specific to GMOs
Allergens and toxins can also be produced by conventional breeding e.g. mutation breeding and GMOs.All crops should be assessed for toxins and allergens.	Production of toxins and allergens by gene technology	Possibility to transfer genes over species barriers allows the introduction of proteins in the food chain which never have been there before (Bt toxin in insect resistant crops)
GM food is eaten by billion people for several years and no food concerns did arise.	If serious health problems due to GMO consumption arise, it will be extremely difficult to trace them to their source and it may take a long time.	Specific to GMOs
Labelling is not necessary because GM food is not substantially different from non GM food	Labelling of GM crops is necessary The consumer has the right to know the content of food	-----------

Table 1.3: Health arguments pro and contra GMOs

Arguments pro GMOs	Arguments contra GMOs	Argument specific to GMOs?
	Social/ ethical arguments (also see stakeholder section page 53)	
Need for GMOs to feed a growing world population.	No need for GMOs to feed world population Most innovations in agricultural biotechnology have been profit driven and not need driven.	It is not clear if specifically GMOs are needed to feed a growing population in the future. But fast technological progress is for sure needed. Debate should not circle only around GMOs, but seek for combined solutions like e.g. improved transport of food and farm management techniques.
Poverty alleviation, employment opportunities	Poverty is due to mostly other factors than food production. It has to do with wars, social injustice, high food prices,…	Not specific to GMOs
GM products are likely to be less expensive.	First generation products show a lack of consumer benefits and potential risks of technology will increase prices.	---------
----------	Monopoly or oligopoly of few companies in GMO business. Industry has only commercial motives for the promotion of GMOs.	Argument partly specific to GMOs, but agrobiotech industry will dominate business in agricultural sector with or without GMOs.
Improvement of food security in less developed countries	Exploitation of poor people by agro biotech industry. Increased inequality of income and wealth between developed and less developed countries.	Argument partly due to GMOs
Gene flow is the basis for evolution.	Ethical concerns that gene technology could be against the rules of nature.	Specific to gene technology

Table 1.4: Social and ethical arguments pro and contra GMOs

Arguments pro GMOs	Arguments contra GMOs	Argument specific to GMOs?
	Farmers (also see stakeholder section page 50)	
GMOs promote an increase in farmer's income	In the best case only an increased short-term profit can be achieved by farmers.	Argument specific to GMOs
Crops with better agronomic performance could be produced.	Conventional breeding can also produce them.	--------
---------	Crosspollination from GM to non GM crops leads to problems for the certification process of non-GM crops. Segregation is difficult.	GMO specific argument
---------	Creation of dependency relations between industry and farmers. (e.g. by grower agreements)	Not specific to GMOs, but the use of gene technology fosters this development.

Table 1.5: Positive and negative effects of GMOs on farmers' well being

Arguments pro GMOs	Arguments contra GMOs	Argument specific to GMOs?
	Intellectual property rights (also see stakeholder section page 50, page 53)	
---------	Patents on GMOs - "seeds contracts" Growing expansion of proprietary science is on the expense of small and resource poor farming families - seed saving is prohibited. Agrobiotech industry conflicts with the old rights of farmers to reproduce, share or store seeds and attempts to control germplam from seed to sale.	GM crops are the first crops where seed saving is not allowed by contract (and could be stopped by technological means like the terminator technology, which is theoretically abandoned at the moment)
---------	'Ecopiracy' – seeking for species indigenous in less developed countries for getting new DNA sequences or compounds in order to produce superior varieties and sell them back to less developed countries	Partly specific to biotechnology

Table 1.6. Property Right Issues linked to GMOs

As some arguments demonstrate, it is not evident why no safety assessment is demanded for most of the‘conventionally bred crops’. For example, no safety assessment and labelling is required for plants produced by mutation breeding which is a very common method in plant breeding today. In mutation breeding, plants are bombarded with nuclear or UV radiation or/ and chemical mutagens such as mustard gas. This method creates artificially an enhanced number of mutations and produces gene variations, which do not exist in nature. As a consequence, also by this method, allergens and toxins can be generated and also these crops can have adverse effects on the ecosystem.

Technological progress has been identified as key driver for fast and effective progress towards a sustainable agricultural system. For this reason, it is questionable if a ban for GMOs, promoted from some GMO opponents, is the right way to react to novel technologies.
Weighing all the above mentioned risks and benefits, it seems to be ridiculous to claim that Sustainable Agriculture is only feasible with or without transgenic plants and attribute to GMOs all possible (and impossible) positive and negative properties. In reality, nobody can predict what role GMOs might play on the path towards sustainability.
Facing the problems, which exist in agriculture today, possibilities to reduce them should not dismissed carelessly. On the other hand, risks should be taken more seriously as they have taken after the first commercial releases. There is urgent need for a clear regulatory framework for the release of any cultivated plant (genetically modified or not). Additional tests and large scale long term monitoring is required for GM crops in order to demonstrate their beneficial or adverse effects. More basic research is needed in order to gather more data and to understand complex relationships and interactions of the agro-ecosystem. Action has to be guided by the Precautionary Principle, which says that "when an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically." (Sehn, 1998)

The best way to support Sustainable Agriculture would be to avoid conflicts between 'modern' and 'organic' farming supporters. All resources available should be exploited and used. If GM crops meet the expectations (improvement of environmental quality and/or food quality) and risks linked to biotechnology are negligible, it should not be hesitated to use improved varieties in organic agriculture.

The current aim of agrobiotech industry is to develop a second generation of GM crops. First generation pest, herbicide and virus resistant GM crops are normally based on the introduction of one resistance gene. This is a quite limited approach, because rapid resistance development is probable. For this reason, progress in plant biotechnology like the introduction of more genes in one plant or the interaction in more complex regulatory protein functions is desired.

Klaus Ammann, professor of geobotanic of the University of Bern, has a vision how GMOs could contribute to a Sustainable Agriculture. He thinks that "some kind of precision biotechnology" would allow reducing the use of monocultures in agriculture. "Precision biotechnology" would mean for him a combination of resistance genes, each one mixed with others in a rich variety of different seeds on the same field, so that pests will have a much lower chance for adaptation. This would create a situation, which is similar to the 'natural' one, where hundreds of species and thousands of different resistance genes are encountered within a square mile. (Ammann, 2000)

Other products, which are still in the research pipeline like drought or saline resistance could be a possibility to grow crops in hostile environments and could become a necessity in the era of global warming. Unfortunately, most of these traits are based on interactions of several genes and mechanisms are not well understood until now. Other desirable traits, which could improve environmental quality, would be crops with enhanced nitrogen or phosphorus efficiency, improved photosynthesis ability or changes in ripening process.

Another product category, nutraceuticals, could improve quality and nutrition value of food. Nutraceuticals are crops designed to produce medicines or food supplements within the plant, e.g. canola oil with a high beta-carotene content or rice with enhanced vitamin A content.

The ability to stack genes – including more than one specialised biotech trait in a single variety – is another technology which will likely lead to improvement of input traits (agronomic performance e.g. pest resistance) and output traits (food quality e.g. enhanced vitamin content) at the same time.

It is to emphasise that gene technology applications in the agricultural sector are still in its infancy and that it can be expected that solutions with a higher potential to contribute to a Sustainable Agriculture will be found.

2. European background

After having studied GMOs in the wider context of Sustainable Agriculture, the EU’s position concerning these two issues is analysed.

2.1. Sustainable Agriculture in the European Union

Sustainability is the key concept of the 5th Environmental Action Programme, which refers to Sustainable Development as “development, which meets the needs of the present without compromising the ability of future generations to meet their own needs”. (COM, 2000 (20 final))

The fundamental basis of the European model for Sustainable Agriculture lies in recognition of the multifunctionality of agriculture. (COM, 2000 (20 final)) The concept of multifunctionality is not new. It has already been recognised at the UN Conference on Environment and Development in Rio in 1992.. Multifunctionality is an attempt to encapsulate in one word that agriculture has many roles. It highlights the fact that farming has other functions besides producing goods. For instance, agriculture is the basis for food security, food quality and the viability of many rural areas. Furthermore, it has environmental obligations like to conserve biological diversity and natural resources like soil and water. (NGO Steering Committee, 2000 (1,2))

The complexity of the relationship between agriculture and the environment like connection of socially beneficial and environmentally harmful processes or the diversity of local environments and production systems has conditioned the approach of integrating environmental and social issues in the European Common Agricultural Policy. (COM, 2000 (20 final))

2.1.1. Common Agricultural Policy (CAP)

Since its creation in 1962, the CAP has played a key role in the EU’s development. The main goal of the CAP has been to ensure implementation of common market organisations and structural policies in agriculture. But also the social role of agriculture in the EU, regional and national diversity and the need to take account of consumers’ preferences and environmental concerns are (or should have been – according to critical voices) considered by the CAP. (Agriculture Directorate-General, 2000)

The common policy mainly contributed to technological development and promoted commercial considerations to maximise returns and minimise costs in EU agriculture. These developments have given rise to an intensification of agriculture in the last 40 years. A high level of price support favoured this intensification trend and lead to an increased use of pesticides and fertilisers. This resulted in pollution of soil and water and in damage to European ecosystems. (COM, 1999 (22 final))

2.1.2. Agenda 2000

New CAP reforms, undertaken as part of the Agenda 2000 package, shall represent a significant step forward for putting the ‘sustainability approach’ into practice. (COM, 2000 (20 final)) Agenda 2000 is an action programme whose main objectives are to strengthen Community policies and to give the European Union a new financial framework for the period 2000-2006. Agenda 2000 shall ensure the continuation of the agricultural reform, stimulate European competitiveness while “taking great account of environmental considerations, ensuring fair income of farmers, simplifying legislation and decentralising the application of legislation”. (European Commission, 2000) Furthermore, Agenda 2000 recognises the diverse nature of farmed environment across Europe. (COM, 2000 (20 final))

Three courses of action are included in the new Regulation: first, compulsory restrictions have to be applied. Second, Member States have to implement cross-compliance, by attaching specific environmental conditions to the granting of direct CAP payments. Third, Member States are encouraged to use agri-environment programmes to protect or enhance the environment beyond good farming practice. (COM, 2000 (20 final))

2.2. Genetically Modified Organisms in the European Union

GMOs are neither included nor mentioned in the Agenda 2000. Besides, no official EU publications were found discussing the future role that GMOs might play in a Sustainable European Agriculture.

Although the introduction of GMOs into European agriculture moved from experimental field trials to the approval of commercial planting of GM crops, only a minimum area in the EU were grown with those plants (0,03% of worldwide-planted area in 1999). While an increasing number of farmers in major crop exporting countries (USA, Argentina and Canada) adopting GM crops, concerns on the demand side are intensifying, especially in crop importing countries like the EU. Consequently, these countries also have adopted a more restrictive stance on GMOs. (DG Agriculture, 2000)

In general, the strategy of the EU policymakers for the future is to focus on a "European way using GMOs" which would allow balancing public concerns with the economic development benefits associated with plant biotechnology on the scene of European agricultural policy. (Joly and Lemarié, 1998)

2.2.1. Current EU legislation

Community biotechnology legislation has been in place since the beginning of the 1990s and throughout the decade. The EU introduced "specific legislation designed to protect its citizens' health and the environment while simultaneously creating a unified market for biotechnology". (DG Health and Consumer Protection, 2000)

Current EU legislation on GMOs can be divided in horizontal and vertical legislation. Horizontal legislation is a *process oriented* approach meaning that special attention is paid to the process of genetic manipulation. Horizontal EU legislation is Directive 90/220/EEC on the Deliberate Release into the Environment of genetically modified organisms (currently in revision) and the, at the same time, adopted Directive 90/219/EEC on the contained use of genetically modified microorganisms (for research and industrial use). In addition to these two Directives, the EU has adopted a number of vertical Directives and Regulations, which are *product-oriented*. An example for vertical legislation is the Directive 258/97 on novel foods and food stuff. (Douma and Matthee, 1999)

But the main instrument for giving consent to experimental releases and for placing on the market of genetically modified organisms (GMOs) in the Community is Directive 90/220/EEC. (DG Health and Consumer Protection, 2000)

Directive 90/220/EEC on the Deliberate Release into the Environment of Genetically Modified Organisms

In response to the starting risk debate on genetically modified organisms (in the end of the 1980's), the European Community enacted the uncertainty-based Directive 90/220/EEC on the Deliberate Release into the Environment of Genetically Modified Organisms.
The Directive was designed to control both the experimental and the market release of GMOs throughout the 15 Member States. Directive 90/220 is precautionary, by virtue of preventing harm not yet documented by GMOs. (Levidow et al., 1996) It has to be implemented in national legislation and requires from Member States environmental evaluation and 'step by step' approval for the dissemination of GMOs. (Albovias, 1999) The EU has currently approved 9 GMO products for commercial release under this Directive. (Mitsch and Mitchell, 1999)

As well as preventing harm to the environment, the Directive was intended to "harmonise the legislation governing deliberate release in the environment." (Directive 90/220/EEC, 1990) In practice, Member States have given different interpretations to key terms in the Directive like 'risk', 'adverse effect' and 'the step by step' principle. This leads to substantial differences between methodologies among Member States in risk assessment and release criteria. (Levidow et al., 1996)

Since public pressure grew stronger in the mid 90's and authorization procedure under Directive 90/220 has essentially come to standstill, the European Commission started to work on a proposal to revise the Directive in 1997. (Jessen, 2000)
Its first proposal was finally made public in early 1998 (COM(98) 85 final).(FOE, 2000)

A recent draft revision of the Directive, proposed by the EU Environment Council in June 1999, includes a 10-year limit on approvals, additional requirements for risk assessment, long time monitoring, mandatory public consultations, labelling and tracking biotech products throughout the commercial stream and stricter use of the "precautionary principle". (AIT, 2000), (TransGen, 1999)
The revised Directive will probably be adopted in 2002. (TransGen, 1999)

However, on October 12, 1998, The European Parliament's Environment Committee adopted a moratorium "until further notice" on all GMO releases. (Krishnakumar, 1999) Since the "de facto" had been implemented, no new authorizations have been granted and there are about 14 applications pending. (Jessen, 2000)
In March 2000, the European Union announced that it would keep its 'de facto moratorium' on the approval of genetically modified crops in place at least for a further six months. An EU committee had been due to decide whether to approve marketing and sale of three new genetically modified crops in the European Union, but instead postponed a decision until the summer. (Reuters, 2000)

Food labelling Directive

A major instrument for making informed choice has always been considered the labelling of food products. The basis of the European regulation of GM food is that only food that is no longer equivalent to non GM food should be labelled, as laid down in EC regulations: 258/97 and 1139/98. (Barling et al., 1999)

Directive 1139/98 adopted in May 1998 clarified the "equivalency" standard triggering the mandatory labeling requirement for food and food ingredients produced from two specific biotech varieties (Round Up Ready soybeans and the first genetically engineered corn approved in the EU) that were approved prior to the novel foods regulation. The EU stated in the Directive that foods or food products derived from these two genetically engineered varieties are "not equivalent" to their conventional counterparts if they display the presence of DNA or protein resulting from genetic modification. (AIT, 2000)
However, the entry of GMOs into the food chain and the massive commingling of GM crops with non-GM crops has clouded the efficacy of labelling the final product. Furthermore, some ingredients in processed food are not detectable and contamination with GMOs cannot be avoided

in industrial processes and trading systems, thus labelling does not prove to be informative or transparent. (Barling et al., 1999)

2.2.2. Risk perception and attitude of the European society towards GMOs

66% of Europeans are worried about health problems (second rang after violence) and 45.7% about the environment (sixth rang). Europeans establish an evident link between their health and the environment and they take a relatively critical view on the quality of food products – even before various European food scandals. (DG XI, 1999)

GMOs are connected for the European public to risks to the ecosystem and to human health. Although the majority of Europeans think the various applications of biotechnology will benefit the environment, the use of biotechnology in the production of food was felt posing the greatest risk and was considered as the least useful application (together with biotechnology for transplants) in 1996 as well as in 1999. (CEC, 1997b), (CEC, 2000)

Perceived risks of GM crops are:

- Decline in crop diversity – 'supercrops' will dominate the food production
- Overproduction will threat the environment and ecosystems
- Harm to the environment and to human health could be irreversible

(Bahrling et al., 1999)

Support for transgenic plants has declined since 1996. Taking genes from plant species and transferring them into crop plants to make them more resistant was morally acceptable for 62% of Europeans in 1996, but for only 47% in 1999. Furthermore, there was most support for the ethical statement "even if GM food has advantages, it is basically against nature". (CEC, 2000)

Europeans are willing to express their preferences for non-GM food in their consuming behaviour. Two thirds are not willing to buy genetically modified fruits even if they taste better. Only 22% would be willing to buy cooking oil containing a bit genetically modified soya, 62% of European consumers are rejecting this possibility. Over one half of the respondents claim they would pay more for non-GM food. (CEC, 2000)
These results correspond to projections of Deutsche Bank's report Ag Biotech: Thanks, But No Thanks? – "although we [Deutsche Bank] are willing to believe that GMO crops are safe and may provide a benefit for the environment, the perception wars are being lost by industry".(Mitsch and Mitchell, 1999)

Europeans have deeply rooted concerns about risks of biotechnology application in the food sector. Although biotechnology is viewed as a technology, which can be beneficial to society for instance in the area of pharmaceuticals and genetic testing, it is not accepted in food production.

In order to make a choice between GM and non-GM products, the majority of the Europeans (74%) favour labelling of genetically modified food. Perceived risks may become more acceptable when there is transparency and in food production processes and the consumer has the freedom of choice. (Bahrling et al., 1999)

A further important issue is the perception of trust. Overall, the findings suggest a relative lack in trust in both, the effectiveness of the EU and the national regulator. (Bahrling et al., 1999) This is confirmed by the fact that despite the creation of more than 60 EU Directives to regulate GMOs, public opinion is not satisfied. (Albovias, 1999) Furthermore, industry is not trusted at all by the Europeans (with a percentage of trust towards 0%). (CEC, 2000) In consequence, even if regulatory controls and risk analysis are properly concluded, they might not be believed by society. (Bahrling et al., 1999)

However, findings from the fourth Eurobarometer survey show a significant decrease in public trust towards all sources of biotechnology information. In particular, trust in environmental protection organisations and universities has declined by 10% since 1996. Consumer organisation (26%) followed by the medical profession (24%) were seen as the most trustworthy sources. (CEC, 2000)

In general, Europeans wish to know more about advantages and disadvantages about biotechnology and they feel not to be enough informed about biotechnological issues. The feeling of the Europeans was confirmed by the survey. The understanding of some of the very basic issues is surprisingly limited. In addition, respondents' awareness and the degree to which they discuss the subject does not appear to have increased since 1996. (CEC, 2000)

To speak generally about Europeans' opinion is misleading. There are major differences between countries. For instance, Spanish have a positive attitude towards biotechnology, whereas Greeks hold the opposite view. (CEC, 2000)

Another example, in Italy, biotechnology is hardly considered as controversial, and the 'public' debate is confined to small circles of scientists and industrials while the Catholic Church is involved as far as human applications are concerned. In Germany on the other hand, environmental groups, consumer organisations, religious groups and farmers' organisations actively participate in an intense public debate on biotechnology, especially regarding biosafety. German groups also have a considerable influence in the debates at the European level. (Commandeur et al., 1996)

Furthermore it should be noted that there are significant differences in sociodemographic variables as age, gender, income and degree of education.
(CEC, 1997b), (CEC, 2000)

The study demonstrates that the legal and social climate is unfavourable for agrobiotech industry. The attitude towards GMOs is generally negative and there is no sign for change of spirit of the public and the EU legislator.

PART II - EVALUATION OF THE SITUATION OF AGROBIOTECH INDUSTRY

In the second part, the agrobiotech industry is presented. Its impact on agriculture and responses to them are analysed in order to identify interactions of industry with the environment and society. Subsequently, key stakeholders, their role in the GMO debate, their interests in GMOs and Sustainable Agriculture are examined.

Furthermore, efforts of Novartis to put sustainability principles into practice are taken as an example for agrobiotech industry. Strengths and weaknesses of the chosen approach are identified in order to recognise its potential to satisfy stakeholders' needs. Based on the results of those analyses, a SWOT framework is created and new business opportunities enabled by the 'sustainability approach', together with management options, are proposed.

3. Presentation of agrobiotech industry

In this chapter, the agrobiotech industry is introduced and its characteristics are described. Furthermore, the development of the GM crop business is analysed.

3.1. Characteristics

The term 'agrobiotech industry' comprises big multinational companies controlling the seeds and agrochemical market by products like crop protection chemicals, seeds and plant care products.

Characteristics of these companies are that they gain billion of dollar sales each year, act internationally, have high research capabilities and increase their power by consolidation and licensing tactics.

For instance, Novartis was created by the largest merger in history – by Ciba and Sandoz. It is a leading company in the pharmaceutical business but also in the agro sector. Group sales were CHF 32.5 billion in 1999. Novartis has its headquarter in Basel (Switzerland), employs 85,000 people and it is operating in 140 countries. The agro sector of Novartis (Crop Protection and Seeds) will be split off and fused with AstraZeneca to a new company called Syngenta. (Novartis About us, 2000), (Stiftung Risiko-Dialog, 2000)
Novartis has patents on the insect toxin Bt (as does Agrevo) and cereal transformation. (Nuffield Council on Bioethics, 1999)

Agrobiotech companies operating in Europe are:

- Monsanto/ Calgene / Delkalb / Agracetus / PBI / Hybritech / Delta and Pine Lane Co (now Pharmacia)
- Novartis (future Syngenta – together with Zeneca)
- Du Pont/ Pioneer
- Aventis (Rhone-Poulenc and AgrEvo - Hoechst)
- Zeneca/ Mogen/ Avanta
- ELM/ DNAP/ Asgrow/ Seminis

(Nuffield Council on Bioethics, 1999)

Rapid consolidation of agrobiotech companies raise fears that the commercial exploitation of GM crops' research and development will only promote the profitability of a small group of large companies rather than smaller private companies and public research.

According to one estimate, 10 companies controlled 40% of commercial seed sale world wide in 1997. (Murphy, 1999)

Regulatory constraints and procedural difficulties have led to delays to bring GMOs on the market and thus made it more difficult for small companies to introduce transgenic plants by an independent strategy. The six above mentioned industrial groups control independently and in between them most of the technologies which give freedom to undertake commercial R&D in the area of GM plants. (Nuffield Council on Bioethics, 1999) For instance, of the 56 transgenic products approved for commercial planting in 1998, 33 belonged to just four corporations, Monsanto, Aventis, Novartis and DuPont. (Halweil, 1999)

3.2. Trends

Agrobiotech industry projects that the worth of multinational groups involved in GM crop business will be growing in the next two decades. Zeneca estimated the global Agrobiotech industry could be worth around $75 billion by 2020 compared with 33$ today. But this is modest compared with DuPont's estimates of $500 billion a year by 2020, followed by Monsanto's forecast of $100 billion by 2015. (Reuters, 1999)

Europe biggest bank, the Deutsche Bank, presents another picture of the agrobiotechnology industry's future. "We continue to believe that the growing negative sentiment toward GMOs creates problems for Pioneer, Monsanto, Delta & Pineland, Novartis and to a smaller extent Dow. (Mitsch and Mitchell, 1999)

A closer look at Monsanto's development in the last two years seems to confirm projections of the Deutsche Bank.

Monsanto always deeply believed in its value and potential profitability. The company pursued an aggressive strategy by buying up seed companies, pioneering in R&D of GM crops and dismissing concerns of the public and NGOs. But now, no company is suffering more in terms of finances, stock price and reputation, from the international debate about the safety of GM seeds. Monsanto's stock lost more than a third of its stock value between October 1998 and November 1999. (Washington Post, 1999)

Deutsche Bank notes that “Monsanto has spent more than $1.5 millions to persuade English consumers of the rectitude of their position, but alas, to no avail”. (Guardian, 1999)

In February 2000, according to calculations by analyst James Wilbur, investors have valued Monsanto's profitable agricultural business unit at less than a zero dollars. (Fortune, 2000) Battered first by a massive backlash in Europe and growing controversy in the U.S. and second by debts, Monsanto was compelled to merge with Pharmacia&Upjohn in March 2000. The combined company, Pharmacia Corp., seems to be not very interested in the controversial agribusiness and plans to sell up to 20% of it as Monsanto Co., to the public later this summer. Analysts anticipate it would sell the rest in the next two years. (Business Week, 2000)

Concerns about uninsured liabilities for farmers and agribusiness companies further complicate the financial picture. In December 1999, a group of lawyers filed a class-action lawsuit against Monsanto, on behalf of American soy farmers, claiming that the company had not conducted adequate safety testing of engineered crops prior to release and that the company had tried to monopolise the American seed industry. (Halweil, 2000)

Experts, leading companies to adoption and implementation of sustainability principles, think that Monsanto has provoked financial and image losses by denying social and environmental values. According to Hawken, businessman and founder of the Natural Step, Monsanto would pretend to have a strong commitment to sustainability, but it would be trying to introduce products aggressively into the market place without consulting a broader stakeholder community about effects, values, science and other potential concerns. (Montague, 1999)
John Elkington, leader of SustainAbility, argues that Monsanto would discuss issues with the “outside world”, but would be unable to listen to the feedback. (Fortune, 2000)

The question is if despite current difficulties, GMOs will continually contribute to business success of agrobiotech industry in the future.
Market analysts are very cautious with projections of agrobiotech industry's future. Most of them are sceptical about near time prospects (about five years). But some believe in expanded markets for GMO crops in the long term. (Multinational Monitor, 2000)

4. Identification of industry's impacts on agriculture and possible responses

The Driving Force – State – Response model is used in this analysis to comprehend the relationship between stress generating activities, the state of human and ecosystem's well being and adequate responses in order to mitigate impacts.
The aim of the analysis is to determine the influence of agrobiotech industry on the agricultural system, to analyse potential interactions with it and to identify adequate responses.

4.1. Driving Force – State – Response (DSR) model for agriculture

The Driving Force-State-Response model (DSR) is a stress-response model adopted by the UN Commission on Sustainable Development (CSD) on the basis of the Pressure-State-Response (PSR) model (OECD, 1993) in order to develop a list of sustainability indicators in collaboration with governmental and non-governmental organisations.

The DSR Framework for agriculture can be defined as:

- *Driving Force*: Those elements which cause changes in the state of the environment such as natural environmental processes, biophysical inputs and economic at farm level and societal driving forces.

- *State:* refers to the changes as a result of the 'driving forces' such as use of natural resources, effect on the ecosystem, state of human health and welfare.

- *Response:* refer to the reaction of society to the changes in the 'state' of the environment such as farmer behaviour, consumer reactions, technological changes and government actions. (OECD 1997)

Model for Agriculture

Driving forces	State	Responses
<u>Environmental conditions</u> - Physical - Chemical - Biological E.g. Geographical factors (local agro- ecosystem, soil composition, pests,…), meteorological factors (climate, weather,…), potential climate change <u>Human activities</u> - Economic forces E.g. Economic viability of world agriculture, stable production capacity, global markets, food distribution – transport, customers' and consumers' preferences, food prices, non-integration of external environmental costs,… - Social forces E.g. Population explosion, urbanisation, poverty, development of rural communities, farmers' and consumers' well being, food quality and safety, policies,… - Technological forces E.g. Farming practice, use of fertilisers, pesticides, energy use, water use, … - Legal forces E.g. Political background, land planning, property rights, agricultural policies, trade agreements…	<u>Ecosystem well -being</u> Positive (Legg, 1999) - Landscapes - Flood control - Sink for greenhouse gases - Rural development… Negative - Increased production/ increased use and degradation of natural resources (e.g. soil erosion, increased water use…) - Increased transformation of virgin to arable land - Loss of biodiversity (wild life and crop) and natural habitats - General unbalances in global ecosystem (pests, natural disaster because of change of land use…) <u>Human well – being</u> Positive - Increased production efficiency – due to Green Revolution (Rosset et al., 2000) - Possibility to nourish world's population (at the moment) (UNEP, 1999) - 'Improved food quality' (due to modern breeding techniques) - Easy access to food in developed world (due to transportation and distribution networks) Negative - Loss of life quality by ecosystem degradation - Poverty, hunger due to natural disasters, soil erosion, non- effective distribution of food, not affordable food… - Health effects because of food contamination (e.g. fertiliser and pesticide residues/ food toxins) - Decline of family farms and disintegration of economic and social conditions in rural communities (UC Sustainable Agriculture Research and Education Program, 2000)	- Economic responses E.g. Change in economic input, influence on changes in farm practice, environmentally sound practices, integration of external cost in accounting, creation of impact assessments (e.g. life cycle analysis of pesticides), creation of agri-environmental standards and indicators, change in production processes… - Social responses E.g. Societal reactions (protests, support for NGOs' actions…), consumer reactions (change in consumer preferences, boycotts,…), global and local initiatives to promote Sustainable Agriculture (information, stakeholder processes and public participation in decision making,…),… - Technological responses E.g. Research projects for sustainable agricultural practices, novel breeding technologies (biotechnology as means to change nutritional values/ reduce impacts on the environment and increase production efficiency,…), information and communication technologies,… - Legal responses E.g. Policies to slow down population growth, environmental regulations, environmental quality standards, economic incentives, rural development policies,… - Environmental responses E.g. Slow adoption of species to changed environmental conditions – can be neglected

Table 4.1: Driving Force – State – Response Model for Agriculture

4.2. Discussion of impacts and responses

Agrobiotech companies' positive effects on agriculture are mainly due to improvements in agricultural production methods and a rise in agricultural productivity achieved by economic and technological means. Negative impacts of industry's products are environmental degradation and changes in farm practice leading to economic and social changes in rural communities.

Negative technological forces caused by industry are for instance the production of agrochemicals (toxic for some species and persistent in the environment) and the stimulation of non-sustainable agricultural practices e.g. high energy and water use. But the increase in technological and economic forces also delivered its social and economic goods like a rise in production capacity and life quality in less developed countries. In developed countries, technological progress contributed to a more efficient way of production and higher farming income on the one hand. On the other hand, the increase of productivity has started a trend of food overproduction, which lead to a drop in food prices, destruction of harvests, higher unemployment rate in the agricultural sector and as a consequence cultural changes in rural communities.

The future demand for agricultural products is uncertain, but the main underlying forces suggest that agricultural production would need to double by 2030. This will be the case if population rises from 6 billion today to around 11 billions between 2030 and 2050. (Legg, 1999) This fact demands from agrobiotech industry to contribute to food security on a global and local scale and at the same time to reduce harmful effects on the environment.

Impacts of technological and economic forces on human and ecosystem health can be mitigated by technological responses like environmentally sound farming products/ services or economic responses like the introduction of environmental management standards.
Technological progress, economic measures and social responses can reduce impacts of given negative driving forces like population growth and hostile environmental conditions.
In order to influence the agricultural system in a holistic way, agrobiotech industry could cooperate on the one hand with actors in agriculture to develop strategies for a joint-acting on global problems. On the other hand, the creation of global science networks would accelerate technologal progress. Social responses of the industry would be transparency in information and openness in communication of critical issues.

Agrobiotech industry claims that already developed herbicide, pesticide and virus resistant crops are its technological response, firstly, to react to social forces like population growth, secondly, to

ensure farmers' well being, thirdly, to reduce impacts of environmental factors like pests and finally, to mitigate effects of current chemical use.
In contrast, GMO opponents argue that transgenic plants are not the right (or only) means to react to population growth. They have doubts about the potential of first generation GM crops to improve ecosystem quality and they are convinced that risks of this technology are inestimable. Furthermore, opponents argue that development and commercialisation of GMOs is only driven by the commercial arguments of agrobiotech companies.
At the moment, there is little evidence that already commercialised GM crops would have negative impacts on human and ecosystem well being. But serious and controversial scientific publications confirm risks inherent in novel plant biotechnology applications.
In fact, little is known about beneficial and adverse effects of already grown crops on the state of human and ecosystem well being. This is due to the complexity of agro-ecosystem as well as the human metabolism, the lack of scientific data and the short usage time of transgenic plants.
It has to be taken into account that large scale commercial growing only started a few years ago, thus long-term effects cannot be assessed at the moment. In principle, short term risk assessment and modelling are the only means to estimate impacts of GMOs. These methods are hardly accepted by some stakeholders of industry who do not see the usefulness of first generation GM crops and as a consequence are not ready to accept any risk.

In conclusion, agrobiotech industry's products and activities promoted an intensification of agriculture, which enhanced on the one hand production capacity and farmers' profits. On the other hand, by supporting this trend, industry contributed to environmental damage, an overproduction tendency in developed countries and a decrease of prices for agricultural products.
For this reason, it has to act upon the reduction of driving forces like technological and in on economic forces and it also has to respond to social forces and environmental pressure. The study of the actual state of human and ecosystem well being will contribute to find adequate responses.
Responses of agrobiotech industry should be focused on finding win-win scenarios meaning for instance increasing industry's profits by reducing environmental impacts.
Controversies on GM crops demonstrate that industry has to find approaches, which are viewed as adequate responses to economic, social and environmental problems by their stakeholders.

In the scheme below, industry's implication on driving forces and appropriate responses are summarised.

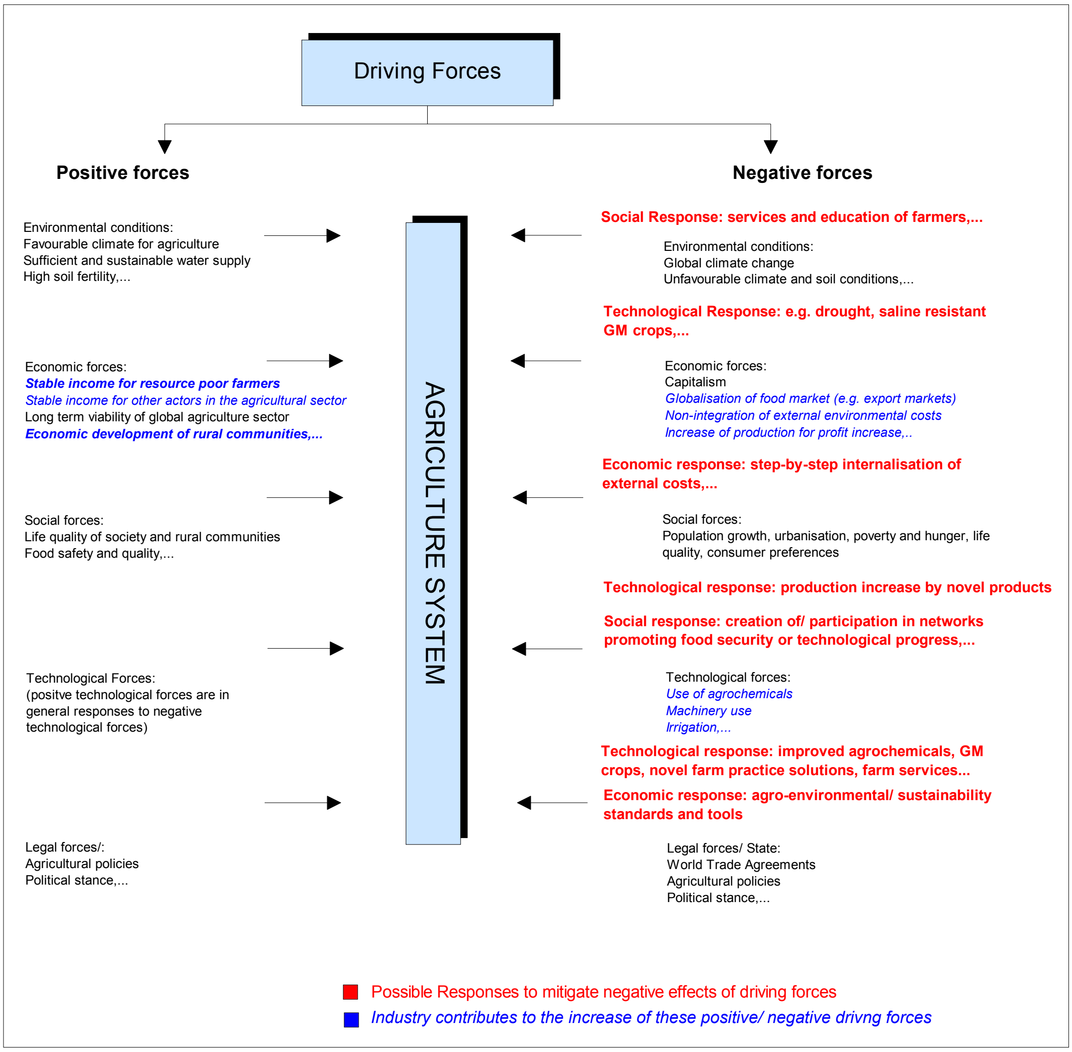


Figure 4.1: Industry's contribution to driving forces on agriculture and possible responses

5. Stakeholder analysis

The analysis intends to identify agrogiotech industry's key stakeholders. It aims to find out their interests, concerns and demands of industry in order to recognise (for them) acceptable sustainable business strategies.

5.1. Identification of agrobiotech industry's key stakeholders

Definition of a stakeholder

Stakeholders can be any individual or group of people, organised or unorganised, who share an interest or stake in a particular issue or system. (Overseas Development Administration, 1995) It can be distinguished between direct stakeholder, to whom business relations exist and indirect ones, who are affected by or interested in business' decisions and activities.

Agrobiotech industry’s stakeholder	
Economic stakeholders	Non-economic stakeholders
Shareholders/ Investors	Non Governmental Organisations (NGOs)
Farmers	Universities/ Public Research/ Scientists
Suppliers	International Organisations
Retailers/ processors/ manufacturers Competitors	EU/ Governments (Regulators)
Employees	Insurances Media
World population including different societies (as consumers and citizens)/ local rural communities/ less developed countries	

Stakeholders of agrobiotech industry (in the GMO debate)		
Category 1	Stakeholders to whom business relations exist and who have interests in the GMO debate	
Category 2	Stakeholder who are affected by business activities or have a direct or indirect influence on the business success of industry. Moreover they have interests in the GMO debate.	
Category 3	Stakeholders who are important for industry but do not have a specific interest in the GMO debate	

Table 5.1: Identification of agrobiotech industry’s stakeholders

Stakeholders of Category 1

Key stakeholders of agrobiotech industry are:

- Shareholders and investors whose main interests are profits of industry by GMOs, but they are also governed by social and ethical values
- Farmers buying products (like GM seeds) and services from industry
- Consumers, a subgroup of society, eating food that has been grown from agrobiotech industry’s seeds and that has been treated by industry's products

It can be argued that consumers are only indirect stakeholders of agrobiotech companies, because they are not directly purchasing products from them. But consumers’ preferences have a direct impact on industry's business success. In the GMO debate, European society has demonstrated impressively what an industry can loose if it does not care about endusers' needs and preferences.

Stakeholders of Category 2

- Society is also indirectly affected by agrobiotech industries' activities, products and technologies. The way agrobiotech industry conducts its business and which strategic decisions it takes (e.g. promotion of GMOs) has an influence on the way people will live in the future. For instance, the introduction of GM crops may have an impact on the social and economic development of local rural communities worldwide and may have a high potential to improve or reduce life quality in less developed countries.
- International Organisations especially the Food Agriculture Organization (FAO) and the World Health Organization (WHO) have influence on international agreements on GMOs and political power on industry
- Governments and the European Union are regulators of agrobiotech industry and have economic and political interest in GMOs as well as concerns about consumer and environment protection.
- NGOs have diverse demands to industry and should ideally represent the interests of the broad public. In the GMO debate, some NGOs are GMO proponents, but most of them are influential opponents.
- Universities and public research are competing with agrobiotech industry for patents and licenses particularly in the sector of plant biotechnology. Scientists have different views about GMOs. Some of them promote GMOs (and agrobiotech industry) uncritically, others refuse them aggressively and most scientists call for a ‘responsible’ use of GMOs.
- Retailers/ Grain processors estimate the cost advantages and the risks (consumer preferences) of products (e.g. GM crops) and make a choice.
- Major competition only exists between agrobiotech groups themselves. In promoting GMOs they follow a common strategy and do not compete with each other.

Stakeholders of Category 3

- Media are not directly concerned or really involved in the GMO debate, but they are interested in ‘good’ stories, high viewing or reading rates and (generally to a much lower extent) conservation of ethical and social values. The media are one of the most powerful stakeholders of agrobiotech industry because of their influence on public opinion.
- Insurances are not especially concerned by GMOs, but they are interested in the degree of risk that GMOs might pose in order to estimate potential costs (e.g. liability claims of farmers due to contamination of non-GM seeds with GM seeds).
- Employees of agrobiotech industry are to a lower degree concerned by GMOs.

- Suppliers are probably not concerned by GMOs as long as agrobiotech industry pays on time and is economicly viable.

5.2. Stakeholders' role in the GMO debate and their interest in GMOs and Sustainable Agriculture

In this section, stakeholders of the first and second category are characterised and their interests/concerns are identified.

5.2.1. Key stakeholder: Farmer

A survey of the Leopold Center for Sustainable Agriculture showed that 53 percent of the farmers [800 Illinois farmers] used GM crops to increase yields through improved pest control. Another 27 percent listed decreasing pesticide costs, 12 percent said increased flexibility in planting, and 3 percent listed adoption of a more environmentally friendly practice. (Duffy, 1999)

Agrobiotech industry claims that farmers will benefit from the use of GM plants. The question is whether or not the first generation of transgenic crops has delivered on promises from industry of increased farmer profitability, reduced pesticide use, increased yield, and improved environmental quality. The answers are controversial.
The Guardian reported that recent US government research demonstrated, that GM crops of maize, soya and cotton did not automatically produce greater yields or lower use of pesticides. (Guardian, 1999)
A report of the Economic Research Service of the US Department of Agriculture states that the farm level impacts of GMO crops on pesticide use, yields and net returns vary widely with the crop and technology examined. (Fernandez-Cornejo and Mc Bride, 2000)
In an Iowa State survey differences in profit of farmers that grew GMO crops and those that grew non-GMO crops were studied. It was demonstrated that the GMO soybean yields were lower and had lower costs while the GMO corn yields were higher and had higher costs. The results did not substantiate any economic reasons to grow or not grow GM crops in 1998.
The University of Georgia estimated that insecticide use decreased by 60 to 70 percent this year because of the use of GMO cotton. Cotton herbicide use and yields were about the same as for conventional cotton. (The Leasing Forum, 2000)

Although growing of some GM varieties could lead to higher profits and an improvement of environmental quality, many farmers are reconsidering planting transgenic crops because economic and political resistance closed export markets to the European Union and East Asia.

U.S. grain buyers have responded to this trend by offering premium prices at select locations for non-transgenic crops. Some grain buyers even have refused to accept the few types of transgenic corn crops introduced after the European Union moratorium on new GMOs was enacted. (Thelen, 2000)
Furthermore, organics sales reached $6 billion last year and industry organisations project further growth of 20 percent to 25 percent per year, according to the Organic Trade Association. (The Campaign, 2000) The American Corn Grower Association predicts that here will be a 20 percent to 25 percent reduction in GMO planted crops in 2000." (The Leasing Forum, 2000)

But, farmers deciding to grow non-GM crops may have some difficulties in order to guarantee that their products do not contain GMOs. Due to pollen drift, cross contamination from harvest and handling equipment, and potential seed production errors, there exists a potential for small amounts of GMO material to be found in non-GMO crops. (Thelen, 2000) Since many businesses in Germany and Japan require that products be certified to contain less than 0.1% or even 0.01% of GMOs, farmers run the risk not to get premiums for non-GM crops. (Betts, 1999)

Another reason for farmers not to grow GM crops is the growing influence of agrobiotech industry by novel biotechnological techniques and products. GM crops offer new possibilities for industry to create dependencies in form of grower 'agreements', intellectual property rights and novel seed protection technologies.
Agrobiotech industry tries to control germplasm from seed to sale. By forcing farmers to pay high prices for seed-chemical packages, companies are determined to extract most profit from their investments. (Altieri and Rossett, 1999)
Not only by use of intellectual property laws but also by technologies (e.g. Terminator Technology) agrobiotech industry tries to protect its seeds. Terminator technology allows seed companies to control the viability of progeny without harming the crop. In other words, the technology genetically alters the seed so that it will not germinate if re-planted a second time.
After violent public protests, Monsanto, the license owner, promised not to use the patent.
This technology would pose severe problems for 1.4 billion resource poor farmers in less developed countries who rely almost exclusively on seed saving. But even in industrialised countries seed saving is still common in certain areas for certain crops. (Halweil, 1999)
Although precise statistics are not available, it is estimated that 20-30% of all soybean fields in the US Midwest are typically planted with saved seeds; up to 50% of soybeans in the South are planted with farmer-saved seeds. (Wolfson, 1998)

Conclusions
Farmers’ interests in GMOs 1. Economic benefits - Lower pesticide/ herbicide use/ improved quality - Increased yields - Marketability of GM and non-GM crops 2. Flexibility in farming practice 3. Improved environmental quality
Farmers’ concerns about GMOs 1. Gain of power by industry by means of GMOs 2. Restricitons in seed saving 3. Social and economic changes in agriculture
US farmers generally want to use new GM crops as far as they can sell them for a good price. If consumers pay more for non-transgenic food and merchants will pay premiums for non GM crops, American farmers will not plant them anymore. Furthermore, the average farmer is worried about the profitability of the planted crops, consumers’ preferences and dependency on industry.
Interests in Sustainable Agriculture Generally, a trend of more conscious product choice can be observed. Most important factors for choice are price and effectiveness of products. (e-mail, Dr. Diriwächter) The average American farmer seems to be not much interested in environmental quality, as long as no acute environmental problems will emerge. In general, farmers do not protect the soil and they make extensive use of chemical fertilizers, pesticides and fossil fuels. They seek short-term profits and are not much concerned about the reduction of technological driving forces on the environment and the long-term conservation of the agro-ecosystem. (Anderson, 2000)

Table 5.2: Farmers’ interests in and concerns about GMOs and their interests in Sustainable Agriculture

5.2.2. Key stakeholder: Shareholder/Investor

Five years ago, GMOs were viewed as a great scientific and financial success for agrobiotech industry and were the celebrated ‘Wallstreet darlings’.
Bt corn was introduced in 1996 and was a incredible success. Roundup Ready soybeans hit the market at about the same time and the estimates were that close to 50% of the soybean acreage, and 40% corn acreage, would be planted to these two GMO innovations. (Mitsch and Mitchell, 1999) According to these positive developments and projections, shareholders invested in agrobiotechnology industry and they were not disappointed in the first years because stock of these companies was rising steeply.

But investors are now sceptical towards GMOs. This shows a survey about socially responsible investors by the Ethical Investment Trust. Concerns about investing in businesses carrying out GM research has gone from being a minor issue two years ago to investors' second biggest concern. In addition, Europe's biggest bank, the Deutsche Bank, gave advice to leading investors to sell their agrobiotech shares. (The Scotsman, 1999)

Deutsche Bank's first research report, entitled GMOs are dead, said: "We predict that GMO's, once perceived as a bull case for this sector, will now be perceived as s pariah". (Guardian, 1999)

In January 2000, investors' scepticism spread also to shareholders of big food companies (like McDonalds, Coca Cola, Heinz and Safeway...) who were concerned about GMO policies of these companies. The movement of shareholders is described as the biggest example of "social issue shareholder activism" since company boards were called to account for doing business with South Africa under the Apartheid regime. (Independent, 2000)

Conclusions
Shareholders/Investors' interests in GMOs 1. Short term financial success of agrobiotech industry (extreme stock rise,...) 2. Long term viability of companies 3. Values of society are considered in agrobiotech industry's actions Shareholders/Investors' concerns about GMOs 1. Instable share rates/ corporate profits 2. Disregard of ethical and social values 3. Bad reputation of company Interests in Sustainable Agriculture Shareholders and investors' interests in Sustainable Agriculture and GMOs are basically financial aspects, but also ethical and social issues are considered to a higher degree. The current and future financial success of agrobiotech industry is dependent on their investments in profitable technologies, their values, their flexibility and their reputation. For this reason, shareholders today do not only look at short-term profits. They look also at factors, which determine the long-term viability of a company.

Table 5.3: Shareholders'/investors' interests in and concerns about GMOs and their interests in Sustainable Agriculture

5.2.3. Key stakeholder: Society/World population

Global society/Less developed countries

Agrobiotech industry declared the whole human population as stakeholder of its business. Companies confirmed unanimously that they want 'to feed the world' and GM crops will be the means. They refer to the growing population and the need to use an increasing surface for agricultural production. To increase productivity on a given surface and not to erode virgin land for agriculture is the core sustainability strategy of agrobiotech industry. By this approach, companies want to address especially the needs for an increased food supply of less developed countries.

But critics argue that the products they developed are conceived for developed and not for less developed countries (Macilwain, 1999) Andrew Simms, member of Christian aid, a UK third world pressure group, says that "there is no genetic fix for hunger and the new technology is being used to strengthen the grip of big business over farming". The organisation published the report ‚Selling suicide: Farming, false promises and genetic modification in the developing world', arguing that the more appropriate solution to hunger lie in changing policies on food distribution and storage than in technological change. (Dickson, 1999)

Some scientists from Africa claim the opposite. The African Scientist, Florence Wambugu, argues that biotechnology is needed to improve food production levels. China produces three times the average of Africa and Africa imports at least 25 % of its grain requirements. (Wambugu, 1999) John Wafula from Kenya Agricultural Research Institute is convinced that "the continent stands to benefit enormously [from GMOs] in terms of food production levels and environmental conservation". Furthermore he emphasized possible use of biotechnology for development of GM crops reducing the need for water as well as the effects of diseases and pests. (Wafula, 2000)

In contrast, some experts of less developed countries also express their fears that higher seed prices and technology fees associated with transgenic crops could widen the gap between developed and less developed countries. Furthermore they criticise that agrobiotech industry is taking profit out of DNA sequences of plant species indigenous to their lands. (Thelen, 2000) A further concern for developing countries is the imbalance of negotiating strength between agrobiotech industry and farmers, in poor countries. (Macilwain, 1999)

Florence Wambugu thinks that the attitude of less developed countries towards industry is not clever. "African countries need to think and operate as stakeholders, rather than accepting the 'victim mentality' created in Europe". She emphasises that Africa has local germ plasm in seed banks and knowledge about local field ecosystems for product development. She is convinced that indigenous knowledge and capacities are required by agrobiotech industry. (Wambugu, 1999)

In general, interest in GMOs is high in less developed countries because industry started initiatives to promote GMOs in these countries e.g. India. But they sometimes met fierce resistance of local NGOs and scientists like Vadana Shiva in India. (Krishnakumar, 1999)

European society

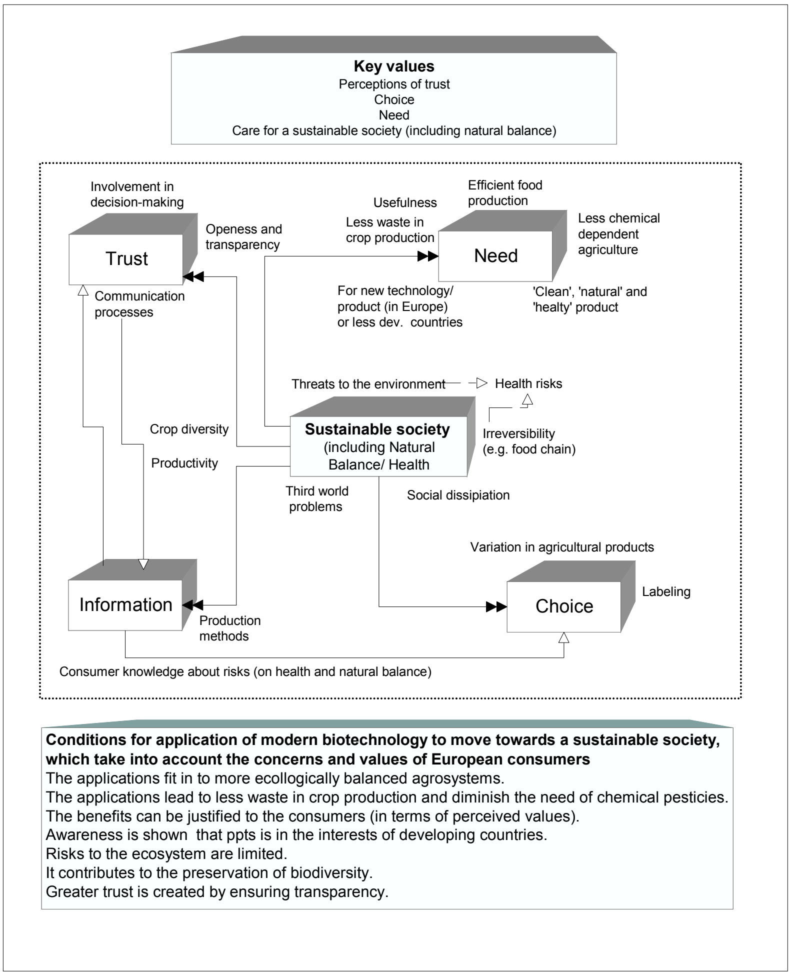


Figure 5.1: European society's key values (Adapted from Bahrling, 1999 and CEC, 2000)

European public concerns have included ethical issues about GMOs' 'interfering with nature', environmental and health damage, long-term effects on agriculture, and the commercial motives of agrobiotech industry. An underlying issue has been agrobiotech industry's stated aim of an "industrializing agriculture, i.e. treating nature as a 'bioreactor' whose industrial efficiency must be optimized" (Levidow et al., 1996)

By following the European debate about GMOs one is getting the impression that the whole discussion is not only about biotechnology, but also about a lack of trust in agrobiotech industry. Issues are raised which are not specifically due to GMOs but due to general problems in traditional agriculture and the globalisation of the food market.

Europeans in general see no need in the current application of transgenic plants not even for developing countries. They only fear risks, which they do not know very well, because they are not informed enough about GM food. (CEC, 2000)

Deeply held values and concerns of the Europeans are the perception of trust, choice, need and care for a sustainable society. The value of care for a sustainable society covers concerns about: the natural balance, the usefulness or necessity of the application of modern biotechnology, health, social dissipation and third world problems. For instance perceived need was associated with agricultural applications in which modification appeared to improve third world problems (such as drought resistance crops). (Bahrling et al., 1999)

The companies currently involved in the GMO business have been heavily criticized for too much emphasis on economic profits by focusing on 'input traits' which dictate the type of input used with a particular crop rather than on 'output traits' which directly impact food quality. Some argue that society would be more receptive to biotechnology if the first applications would have dealt with resolving more humanitarian issues such as third world malnutrition. (Thelen, 2000)

Conclusions
Society's interests in GMOs (depending on key values of society) o Globally accepted values 1. Increase of food availability for less developed countries - reduction of hunger and poverty 2. Improved environmental quality 3. Improved food quality (health benefits) 4. Property rights o European key values (see p. 56)
Society's concerns about GMOs 1. Ethical concerns (depending on social and cultural background) 2. Environmental and health concerns 3. Agrobiotechnology industry itself (commercial motives, power, responsibility...) 4. Social and economic changes in agriculture
Interests in Sustainable Agriculture Society demands from agrobiotech industry to care for a sustainable society. For Europeans, responsible agriculture is linked to 'clean', 'natural' and 'healthy' products. Europeans establish an evident link between their health and the environment and their most feared health threat are chemicals such as pesticides. (DG XI, 1999) Sustainable practice would be for them producing high quality products while protecting the environment. For people in less developed countries, Sustainable Agriculture is linked to food security. Society in less developed countries is in general more open-minded towards novel 'artificial' products in agriculture like GMOs. But violent public protests in India against companies like Monsanto demonstrate deep (partly justified) mistrust to industry.

Table 5.4: Society's interests in and concerns about GMOs and their interests in Sustainable Agriculture

5.2.4. Stakeholder: Non Governmental Organisation (NGO)

NGOs involved in the GMO debate are consumer organisations, environmental protection agencies, 'third world' and ethical pressure groups. It exists a variety of NGOs with different motives and interests. But the most influential NGOs for agrobiotech industry are GMO opponents.

(→ Various arguments raised by opponents of GMOs are listed in section 1.5 Can Genetically Modified Organisms (GMOs) contribute to a Sustainable Agriculture? page 24)

NGOs have an important influence on public opinion. The European public sees consumer organisations (26%) as the trust-worthiest source for biotechnological issues. 14% of the Europeans trust environmental protection agencies. (CEC, 2000)

It can be distinguished between two basic groups of NGOs opposing GMOs (and forms in between).
First, the “radical activists” who take the law into their hands and fight a war of terrorism against agrobiotech industry. All over Europe but particularly in the UK groups calling themselves 'Genetics Snowball' or ‘Superheroes against genetics’, have executed, well planned raids on GMO test trial sites. (Gartland and Gartland, 2000)
Second, groups who assess risks of GMOs, point out social implications of biotechnology, develop strategies for less developed countries or propose improved monitoring approaches,… Some of them are willing to collaborate with agrobiotech industry in order to find a common path towards a Sustainable Agriculture.

Some very well known and influential NGOs like for example Greenpeace have a long tradition to challenge industry by revealing environmental scandals and managing public relations perfectly. In the GMO debate, together, with other environmental pressure groups they succeeded on the one hand in demonstrating potential hazards of GMOs, on the other hand, in ruining the image of GMOs and the involved industry.
These NGOs are criticised by agrobiotech industry, but also by scientists for playing an unfair game with public opinion. “Some NGOs have developed into powerful protest industries and are not interested in a thorough scientific analysis, since this could blur populist argumentation, which they need to keep up in order to get more donors, which are in fact their shareholders”. (Ammann and Papazov, 1999)
Other scientists blame GMO opponents for not quoting data to prove assumptions like ‘the level of risk of GMOs is too high’ or ‘GMOs are unnecessary since alternative practices could feed the world’. (Boulter, 1995)

In addition, it astonishes many scientists that NGOs only attack the use of GMOs and defend conventional breeding methods. UV radiation to enhance mutations is for instance used in conventional mutation breeding. Furthermore, by NGOs heavenly criticised pest resistant GM crops can be and have already been produced by conventional breeding methods. Some of the impacts of these crops are the same as those of GM crops.

Conclusions

NGOs' interests in GMOs

1. Diverse interests (depending on NGOs)
2. Improved life quality in less developed countries - reduction of hunger and poverty
3. Improved environmental quality
4. Improved food quality (health benefits)
5. Reputation increase
6. Attraction of donors

NGOs' concerns about GMOs

1. Diverse concerns (depending on NGOs)
2. Ethical concerns (depending on social and cultural background)
3. Environmental and health concerns
4. Agrobiotechnology industry (commercial motives, power, responsibility...)
5. Social and economic changes in agriculture
6. Risk assessment and labelling issues
7. Globalisation trend

Interests in Sustainable Agriculture

To determine interests of NGOs in Sustainable Agriculture is impossible, because opinions are wide spread and cannot be summarised in a short paragraph. Interests of NGOs can only be analysed if the are split in subgroups. A fact is that the goal of many NGOs with powerful PR apparatus is to challenge agrobiotech companies and to profit from their weaknesses.

Table 5.5: NGOs' interests in and concerns about GMOs and their interests in Sustainable Agriculture

5.2.5. Stakeholder: University/Public Research/Scientist

There is considerable disagreement among experts as to the extent of the risks involved in specific aspects of GMOs like release in the environment and food safety. (Boult, 1995) Although most of specialists (mainly life scientists) involved in the GMO debate tend to promote GM crops under the premise of control and monitoring, some scientists turn against GMOs and call partly for guarantees which cannot be given by science today. Social science is not much involved in the discussion although many concerns about GMOs are of philosophical, ethical or societal nature.

An important issue that plagues public researchers is the fact that agrobiotech industry controls research in plant biotechnology by important patents. Researchers in the public sector play a significant role in making important discoveries, but industry is becoming more engaged as the development comes closer to realisation and gets often the patent awarded. This happened for instance with a key development for plant biotechnology, the Agrobacterium vector. (Nuffield Council on Bioethics, 1999)

In general, public research and universities cannot compete with agrobiotech industry on the market stage. For instance, the estimated sum that Monsanto spent on the development of RoundUp Ready soybeans is $500 million. In comparison, the entire annual budget of the Consultative Group for

International Agricultural Research (CGIAR), a consortium of international research centres that form the world largest public-sector breeding effort, amounts to $400 million. (Halweil, 1999)

Some researchers are afraid that anti GM food campaigns will drive away biotechnology investors from Europe. They think that Europe would loose both a huge potential for contributing to a more Sustainable Agriculture and economic benefits.

Conclusions
Scientists' interests in GMOs 1. Risks and benefits of biotechnology 2. Stake in the GMO research Scientists' concerns about GMOs 3. Power of agrobiotechnology industry (licenses,...) 1. Limits in biotechnology techniques and negative effects on investments because of GMO hysteria 2. Biosafety (possible environmental and health effects of GMOs Interests in Sustainable Agriculture The interests of scientists are hard to characterise because many stakeholder subgroups exist. Most life scientists, after all plant biotechnologists, are convinced that GMOs have a huge potential for contributing to Sustainable Development. These scientists deeply believe in innovation and progress. They think that most problems can be solved by novel technologies. They often view nature as a machine or object to study not as a living organism (the picture of nature that many GMO opponents have). Many life scientists have problems to accept alternative techniques and social sciences' involvement in agriculture.

Table 5.6: Scientists' interests in and concerns about GMOs and their interests in Sustainable Agriculture

5.2.6. Stakeholder: Retailer/Corn processor/Food manufacturer

Deutsche Bank predicts in its report, Ag Biotech: Thanks, but no thanks?, that "food processors will line up quickly in the "No-GMO" camp. The message is clear: GMO foodstuff such as tomatoes, cooking oil,...are just ingredients. They have costs and benefits. GMOs just became too costy". (Mitsch and Mitchell, 1999)

The report coincides with growing official unease in the US about claims made for GM crops, because the main GM markets in Europe are food processors, who are turning their back on GMOs. (Guardian, 1999) The American Corn Growers Association recommended its members not use GM seeds the following year (2000). (Hund, 1999)

In some EU countries, several major food chains have indicated that they would stop selling biotech foods under house brand names. (ERS, 2000)
US food manufacturers such as Gerber and Heinz initiated a GMO food boycott. (Hund, 1999)
Nestle, Unilever and others have already banned the use of GMO products in their food

formulations. (Mitsch and Mitchell, 1999) Companies such as Kraft Foods, Kellogg and PepsiCo have promised not to use GM grain. (Jessen, 2000)

Even Novartis, producer and major defender of GMOs, declared in its HSE report 1999 " in light of the consumer focus, we have decided to take practical steps to avoid using GMOs in our food products worldwide until such time as consumers' concerns are addressed". (HSE Novartis, 1999)

Also DuPont, producer and proponent of GMOs, is offering growers premium prices for conventionally bred STS soybeans. "With DuPont actively promoting that STS soybeans are non-GMO, with tacit acknowledgement that this is a good thing, it appears somehow self-defeating for the long-term prospect." (Mitsch and Mitchell, 1999)

In general, it seems that agrobiotechnology industry has a double morality concerning GMOs. On the one hand, they promote GMOs at all costs, on the other hand, they try to avoid them in food processing and make premium business with non-GM crops.

Conclusions
Processors'/ retailers' interests in GMOs 1. Cost savings 2. Consumers' satisfaction 3. Values of society are considered in agrobiotech industry's actions
Processors'/ retailers' concerns about GMOs 1. Consumer protests and boycotts 2. Reduction in sales due to GMOs
Interests in Sustainable Agriculture Retailers, corn processors' and food manufacturers' main interest is the satisfaction of the consumer. If the European public's view of Responsible Agriculture is to use no pesticide, they will buy pesticide free corn. But some food processors like Unilever realise that Sustainable Development is more than satisfying consumer preferences and have started programmes to support more sustainable farming practices. (Savio, 1999) These more environmentally and socially responsible companies realise that agriculture is the basis of their business and needs to be protected in order to deliver the same goods (as today) in the future.

Table 5.7: Processors'/ retailers' interests in and concerns about GMOs and their interests in Sustainable Agriculture

5.2.7. Stakeholder: EU/Government

Studies demonstrate a lack of confidence in the effectiveness of EU and national regulations and institutions. (Barling et al., 1999) Despite the creation of more than 60 Directives to regulate GMOs, public opinion is not satisfied. (Albovias, 1999)

EU and governments' interest is to create a good regulatory framework for GMOs. The current EU framework has to be proven not to be efficient enough. There are many open questions about liability, risk assessment, forms of public participation and long term monitoring which are not addressed by legislation now. Furthermore, the lack of definition of some key statutory terms like ‘risk’ or ‘adverse effect’ in the Release Directive 90/220/EEC has led to widespread national legislation. However, a new legislative framework, especially the novel Release Directive, has to better address the concerns of the European public and has to lead to a harmonisation of Member States’ GMO legislation. (More details about EU legislation see page 38)

From a political and economic point of view, EU officials and politicians are dismayed that European public opinion has hardened so quickly about GMOs over the past few years. They fear that Europe would loose its stake in the GMO market. (Albovias, 1999) A collapse in consumer confidence has led to a standstill of the authorization procedure for GMOs under Directive 90/220/EEC. (Jessen, 2000)

Since 1996, difficulties in placing GMO products on the EU market has given rise to trade tensions with the US. The differences in regulatory treatment of GMOs have turned out to be a very difficult issue to handle trans-Atlantic relations. (Jessen, 2000) American exports of soybeans to the European Union decreased from 11 million tons in 1998 to 6 million tons in 1999. American corn shipped to Europe dropped from 2 million tons in 1998 to 137,000 tons last year causing a combined loss of nearly one billion dollars in sales for American agriculture. (Halweil, 2000)
On the international level, the WTO has declared the European import ban on GMO crops and products (due to the ‘de facto’ moratorium) as unjustified, because there would be no scientific evidence that they are unhealthy or hazardous for the public. (Hund, 1999)

Conclusions

EU/ governments' interests in GMOs

1. Harmonisation of biosafety regulations in the EU
2. Regulations about impacts of GMOs on health and environment, risk assessment and food labeling
3. Stake in the GMO market/ economic aspects

EU/ governments' concerns about GMOs

1. Public opinion, worries of the Europeans about GMOs
2. Economic losses
3. Trade relations
4. Increasing technology gap between Europe and the US

Interests in Sustainable Agriculture

The interests of the EU and governments in a Sustainable Agriculture are on the one hand maximising returns from agriculture while minimising costs. But the concept of multifunctionality in agriculture (see page 31) is becoming increasingly important for these stakeholders. What role GMOs might play in a Sustainable Agriculture is not clarified in the European Union. Agricultural reforms are high on the EU Agenda and approaches towards sustainability are in discussion.

Table 5.8: EU’s/ governments’ interests in and concerns about GMOs and their interests in Sustainable Agriculture

5.2.8. Stakeholder: International Organisation

The main international organisations, agrobiotech industry deals with are the World Health Organization (WHO) and the Food and Agriculture Organization (FAO). (Interview, Dr. Brassel)

In 1996, a joint report from an expert consultation sponsored of the WHO and FAO of the United Nations concluded that “biotechnology would provide new and powerful tools for research and for accelerating the development of new and better foods”. The WHO/ FAO expert consultation also stated that it would be vitally important to create and apply appropriate strategies and safety assessment criteria for food. (Agbioworld, 2000)
In March 2000, FAO called for a “cautious case-by-case approach to determine the benefits and risks of each individual GMO” and to address the “legitimate concerns for the biosafety of each product and process prior its release”. (FAO, 2000(1))

WHO and FAO are actively involved in the creation of internationally accepted principles for the safety assessment of GM crops and food.

They have actually produced a number of joint Expert Consultation reports defining the principle of ‘substantial equivalence’ as basis for GMO safety assessment. (WHO Food Safety Programme, 2000) This means if a GM food can be characterised as ‘substantially equivalent’ to its ‘natural’ antecedent, it can be assumed to pose no new health risks and hence to be acceptable for commercial use. At first sight, the approach seems to be plausible and simple, but some scientists believe that it is misguided and favours only chemical testing of a product.
Millstone et al. states that science is not yet able to reliably predict the biochemical, toxicological or immunological effects of GM food from the knowledge of its chemical composition. For this reason additional physiological tests are necessary to predict human health impacts of GM food. (Millstone et al., 2000)

For evaluating the food safety of GMOs, the Codex Alimentarius Commission of the WHO/ FAO established an ad hoc Intergovernmental Task Force on Foods Derived from Biotechnology. This Panel, comprised of government-designated experts, will develop standards, guidelines or recommendations for foods derived from biotechnologies or traits introduced into foods by biotechnological methods. (FAO, 2000(2))

The FAO Commission on Genetic Resources for Food and Agriculture aims at developing a Code of Conduct on Biotechnology. The Code will be based on scientific considerations and will take into account the environmental, socio-economic and ethical implications of biotechnology. In addition, the Organization is working towards the establishment of an international expert committee on ethics in food and agriculture. (FAO, 2000(2))

Conclusions

International organisations' interests in GMOs

1. Biosafety Assessment of GMOs (determination of impact on human health and the environment)
2. International agreements on biosafety legislation
3. Compliance with environmental international Conventions (e.g. Convention on Biological Biodiversity)
4. Social and ethical implications of the technology

International organisations' concerns about GMOs

1. Effects on the ecosystem
2. Effects on human and animal health
3. Concentration of biotechnological research in the private industry
4. Technology transfer to less developed countries

Interests in Sustainable Agriculture

The FAO and WHO cover by its panels, groups, expert consultations and publications all aspects of agriculture. The WHO has its focus more on food quality and safety issues. Both organisations promote biotechnological applications in a Sustainable Agriculture, but call for the following of the Precautionary Principle.

Table 5.9: International organisations' interests in and concerns about GMOs and their interests in Sustainable Agriculture

5.2.9. Stakeholder: Competitor

Serious competition is only among agrobiotech groups. Competitors are on the one hand, allies in the promotion of GMOs, on the other hand they compete in the development of novel GM crops. They have a common interest in the adoption of similar information strategies and they founded together the Council for Biotechnology Information (www.whybiotech.com).

Conclusions

Competitors' interests in GMOs

General aspects

1. High profits
2. Environmental quality
3. Food security

As partners and competitors

4. Coordination in GMO information and arguments
5. Advantages in market competition by means of new GMO products

Competitors' concerns about GMOs

General aspects

1. Problems in Europe
2. Negative financial trend of GMOs at the moment
3. High development risks

As partners and competitors

4. Competition for licenses and market leadership

Interests in Sustainable Agriculture
Agrobiotech companies have a common interest in Sustainable Agriculture. Agricultural productivity has to be increased on a given surface in a sustainable way. By this strategy on the one hand food security shall be ensured, on the other hand wildlife protection areas will be spared. 'The sustainable way' is for instance selling pest resistant plants, which require fewer pesticide or herbicide applications. Simple technocratic problem – solution approaches dominate the research agenda. Industry is in general interested in creating one product for Sustainable Agriculture and sell it in large quantities on the world market. More integrated strategies like product combinations accompanied by service and consulting are not common. The only service offered is Integrated Pest Management (IPM) supporting farmers in the targeted application of pesticides.

Table 5.10: Competitors' interests and concerns about GMOs and their interests in Sustainable Agriculture

5.3. Patterns and ways of interactions

The stakeholder analysis demonstrates that polarised opinions and arguments determine the GMO debate. Most arguments are not based on facts and are only disseminated to win society's trust.
The European public gains its knowledge about GMOs mainly from the media, which supplies biased information to increase viewing or reading quotes. This development explains the low science content and missing objectivity in the debate and the widespread unreferenced assumptions like 'GMOs are necessary to feed the world or we do not need biotechnology to ensure food security'.

The GMO opponents' main communication medium is the Internet. PR experts even speak of a "netwar" referring to opponents' capacity to use successfully the Internet in order to exchange cheaply and extensively information, to disseminate their arguments and to create loose, but moving networks. Agrobiotech companies have in the opinion of the PR experts a disadvantage because they use costly and outdated PR methods and a hierarchical command and control approach to communications. They have difficulties to interact with the 'flexible network' of GMO opponents because there are no persons to turn to and the network is fluctuating continuously. These conditions are not a basis for discussions and agreements. The PR experts' proposal to agrobiotech industry is to create a network in order to "fight" a network (Irvine, 2000)

With the expression "fight" PR experts describe precisely the feelings in the GMO debate. Concerned parties make few constructive proposals and most GMO opponents do not have much interest to support industry in order to find viable solutions.
Industry is unable to handle the situation. Economic interests and the incredibly overheated discussion in Europe make it difficult for all parties to collaborate or to even exchange views. None of the actors dares to approximate to the adversary party because of the fear to lose face.

It seems that more honesty and objectivity of some actors would reverse the deadlock situation. But, there are risks linked to the 'honesty and objectivity' strategy especially for industry because public trust is low, but also for environmental pressure groups who lost constantly reputation in the last few years. (CEC, 2000)

However, further roundtable discussions do not make sense if the participants are not willing to make trade-offs and do not want to see a common basis. It is characteristic for the GMO debate, that there seem to exist only proponents and opponents; moderate views are rare.
What makes the debate even more complicated is the fact that it does not revolve around GMOs anymore. All possible problems in agriculture and society are taken up and linked to GMO issues. Deeply held feelings like 'the evilness of industry' and 'the unrealism of the ecowarriors' are expressed in GMO arguments. Since discussing about feelings is difficult, the debate is turning in a never-ending circle.

In general, science does not lead the GMO debate, because there is considerable disagreement among experts due to not enough useful data and differing concept bases. (Boulter, 1995) There is also not much collaboration within life sciences as well as between life and social sciences. Multidisciplinary approaches are rare. Furthermore, scientists cannot solve all questions in the debate, because many of them concern society. Science can only provide facts, estimations and models, but cannot interpret them as 'socially or ethically acceptable'. (Schulte and Kaeppeli, 2000) Interaction between society and science is necessary in order to provide 'scientifically proven and socially acceptable' solutions. The failure of agrobiotech industry to address society successfully is partly based on its approach to prove social acceptability of its products by biosafety arguments.

Ironically, the party whom the agrobiotech industry wants to feed and GMO opponents want to save is not asked much for its opinion on the subject. In general, stakeholders in less developed countries would welcome the use of GMOs, but they mistrust agrobiotech industry, which tries to explore new markets in Asia and Latin America. Recent press releases about massive GMO protests in India do lead to the conclusion that industry did not learn much from the debacle in Europe.

In conclusion, the stakeholder analysis shows that society is the key stakeholder of agrobiotech industry in the GMO debate. Negative sentiments about GMOs of investors, retailers, food processors and also farmers have been created by the refusal of GMOs by society. Most interactions in the GMO debate aim at gaining society's trust.
Agrobiotech industry should have learnt from this fiasco that it cannot afford to ignore public opinion. In contrast, it has to work hard in the coming years to establish an acceptable reputation, otherwise it has the guarantee for more troubles to come.

5.4. Management options

Brian Halweil from the Worldwatch Institute writes cynically "in industry gatherings, biotech industry appears as some rare hybrid between corporate mega-opportunity and international social program". (Halweil, 1999)
This is the way many stakeholders view agrobiotech industry. Even GMO proponents do not trust industry's social promises. Fighting for patents and inventing seed-protection technologies are necessary for industry to protect their inventions for which they spent enormously high development costs. But these measures are not viewed as socially correct and may in addition compromise agrobiotech industry's goal to ensure food security in less developed countries, because resource poor farmers will simply not be able to pay for the products.

The main stakeholder management problem of agrobiotech industry is that promises are not followed by actions, which demonstrate the sincerity of the words. For instance, telling European public that a major goal of industry is ensuring food security by enhancing productivity might not proof to be enough. Industry has to present an action plan how this goal will be realised.

It is evident, that agrobiotech companies cannot satisfy all their stakeholders' interests. But they have to know whom they will please with their inventions and whom they will probably upset. Companies have to sort out the stakeholders they have to satisfy. Needs of those key stakeholders have to be found out and understood. But understanding is not enough. Their interests have to be considered in planning of strategies and also in product development.

'Secrete development strategies' do not increase trust to industry. All concerned parties should be able to declare their interests and respect those of others. There has to be an open dialogue and no hidden agenda on any side. This approach would perhaps also lead to a greater acceptance in society for GM crops and limit the development risk of industry. (Ammann, 2000)

According to the results of the stakeholder analysis, society is a powerful, but by industry neglected stakeholder.

In the table below, rules, limitations and some management options for the engagement of society have been summarised:

Rules for engagement of society	Management options to meet society's interests	Challenges for engagement of society
Avoidance of contradictions and promises that cannot be met	Taking an active part in initiatives to foster useful monitoring framework for GM and non GM crops and to create knowledge transfer about monitoring results and practices between basic research, applied research, regulators, industry and NGOs.	Direct implication of public is difficult due to complexity of GMO issue.
Setting of clear social and environmental targets	Creation of a Code of Conduct and a Genetic Science and Ethics Advisory Group composed of external experts in the fields of genetics, bioethics, law and sociology in order to alert agrobiotech industry to potential social and ethical questions linked to biotechnology and GMOs (example Ethics Advisory Group of Roche Genetics)	Segmentation of society makes it difficult to treat public as one homogenous stakeholder group.
Honesty and transparency has to reign in communication with society – that means not only talking to society, but also listen to it…	Creation of public forums	Low level of trust can suffocate every initiative.
Reporting on social, environmental and ethical issues	Fair negotiations with less developed countries, development of local strategies and scientific cooperation	Possibly only large scale action will draw attention to agrobiotech industry's will of change.

Table 5.11: Stakeholder management options - Society

6. Case Study Novartis

The aim of the case study is to examine the 'sustainability approach' of agrobiotech industry. The case study Novartis is mainly based on first, documents found on the company's webpage, second on annual reports and finally, on interviews and informal contacts with three Novartis managers.

Note:
The 'Putting values into action' section is a critical part of the case study, because internal management structures, decision making processes and business strategy of Novartis were only studied by reports and interviews. As a consequence, the study is an external view on Novartis business, <u>but it might not necessarily reflect the business reality</u>.

6.1. The 'sustainability approach' in the business community

6.1.1. Introduction

For over a century, the dominant model of business has been a large impersonal organisation whose single goal was increasing shareholder value and whose governance was defined in terms of investor protection. (Mathew, 1998) Business leaders were convinced that first, prosperity for all was best achieved through minimum regulation and maximum flexibility of business activity and second, that the relationship between business and the rest of society has to take place through the market. (McIntosh et al., 1998) Recently however, this model is being called more and more into question, because societal structures and business requirements are changing rapidly. Trends to new technologies, global economic integration, increase of media power as well as environmental expectations of society and changing consumer preference challenge the traditional view of business. (Business Week, 1999)

Business operations have become increasingly visible and companies are made accountable for their actions by society. Corporate Social Responsibility or Corporate Citizenship are the catchwords in the new business reality. Key issues linked to these terms according to the World Business Council for Sustainable Development (WBCSD) are: Human and Employees Right, Environmental Protection, Community Involvement, Supplier relations and Stakeholder Engagement. (WBCSD, 2000)

Corporate Social Responsibility (CSR) is the basis for the 'sustainability approach' in the business community. A company, which is value orientated, will also consider social and environmental issues in its business strategy and will have a long-term scope. Such a company will make an effort to produce eco-efficient products, serve society and local communities.

The very basic steps to integrate the sustainability concept in business activities are:
Firstly, to create a Code of Conduct, in which values are defined, secondly, to choose sustainability goals according to the Code of Conduct and put them into action, thirdly, to evaluate achievements and progress of the 'sustainability approach' and report them to stakeholders and finally to redefine goals and integrate lessons learnt in the 'sustainability approach'.

Realising this business strategy also seems to have a positive influence on the financial performance of a company. Improved investor relations, high level of public trust, cost savings by environmental measures and highly motivated employees seem to make socially and ethically correct business practice even profitable.

6.1.2. Driving forces for and against the 'sustainability approach'

In the scheme below, forces for and against change of business practices have been presented. The analysis of driving forces shall point out benefits and risks of the 'sustainability approach' for agrobiotech companies.

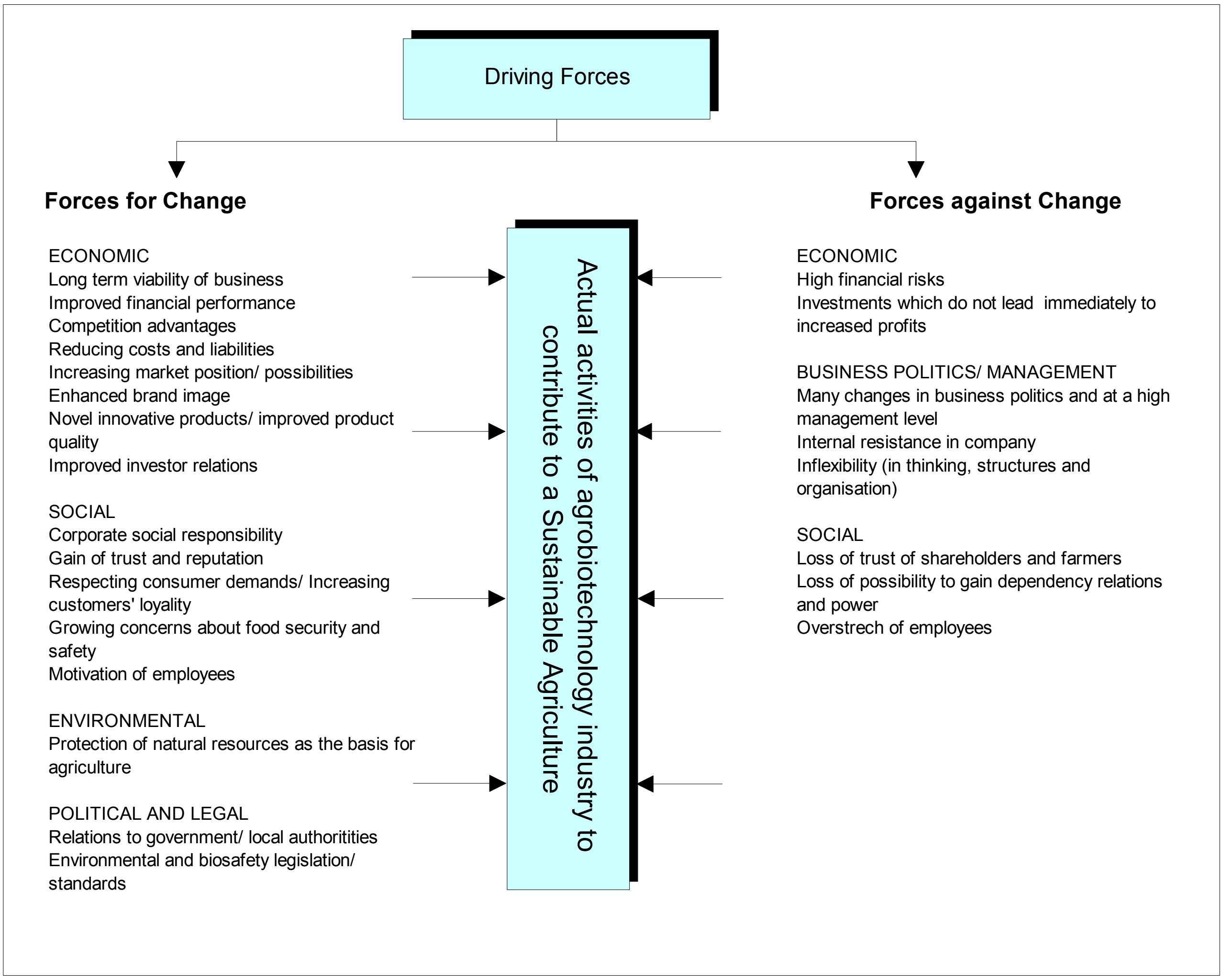


Figure 6.1: Agrobiotech industry's driving forces towards and away from sustainability

The key driver for the realisation of sustainability strategies is the long-term viability of business. High reputation and good relations to investors and authorities as well as satisfaction of society are prerequisites for the company's success in the future. Major forces against change are high costs linked to the reorganisation of business that will probably not lead to short-term revenues and might cause loss of shareholder trust.

However, many companies believe in the reorientation of their business focus towards environmentally friendly and socially acceptable practices.

6.2. Novartis' efforts to integrate the sustainability concept into its business compared with those of Novo Nordisk

Novartis as a representative of agrobiotech industry has been chosen to study the 'Sustainable Development approach' in this type of industry. Novartis' efforts to improve environmental and social performance are compared with those of the biotech company Novo Nordisk, a leader in bioethics, stakeholder engagement and sustainability reporting. By evaluating the two businesses' strengths and weaknesses, Novartis' sustainability approach shall be evaluated. Sustainability principles, implementation of the same and reporting practice are examined.

6.2.1. Presentation of the companies

Novo Nordisk is an international biotechnology and pharmaceutical company with its headquarter in Denmark. "Novo Nordisk is a world leader in insulin and diabetes care and also manufactures and markets a variety of other pharmaceutical products. Furthermore, the company is the world's largest producer of industrial enzyme products".
The company is not involved in agricultural applications of biotechnology, but is concerned by the GMO debate because it produces biologically active proteins for food industry by using genetically modified microorganisms (contained use) and fertiliser (open use). Novo Nordisk claims that its products do not contain any GMOs, because products are purified and fertiliser is inactivated. (Novo Nordisk, 2000)

Novartis is a leading international company in the health but also in the agro sector and has its headquarter in Switzerland. Novartis' agro business units are developing seeds, crop protection and animal health products. Novartis Seeds developed a GM pest resistant maize variety (commonly known as Bt maize) which is one of the most controversial products in the GMO debate in Europe.

In the table below, key figures of the two companies are presented.

Facts	Novo Nordisk	Novartis
Business sector	Health care and enzyme business	Health care, consumer health and agrobusiness
Employees (end 1999)	15, 184	85, 000
Operating countries	68	140
Profitability (last 12 months starting 17/06/99) (E*TRADE, 2000) Revenues Rise % Gross Margin (TTM) % Operating Margin (TTM) % Profit Margin (TTM) %	 13 67,31 19,74 13,42	 2 69,75 22,62 20,09
Sustainability charter/ vision/ Corporate social responsibility principles	yes	yes
Putting values into action	yes	controversial
Reporting	Annual report Environmental and Social report 1999 (Novo Nordisk Report, 2000)	Annual report Health, Safety and Environment report, 1999 (Novartis Report, 2000)

Table 6.1: Key figures of Novartis and Novo Nordisk

Although the business sector and the business size of Novartis and Novo Nordisk are not comparable, it is obvious that both are very profitable companies. If and how the implementation of sustainability principles and their application influences business success of the two companies can only be estimated on a long-term scale.

6.2.2. Code of Conduct/ Sustainability principles

Codes of Conduct and sustainability principles of the two companies are not easy to compare.

Novo Nordisk describes its principles for the whole business group in 'The Charter' and in 'Our Way of Management'. (Novo Nordisk Report, 2000)

Novartis, in contrast, has a two sentence Code of Conduct for the whole business and no commitment for its Agribusiness as a whole, which comprises Novartis Seeds, Crop Protection and Animal Health. The Crop Protection Unit has its own Code of Conduct, the Carta Nova, which consists of 'The Charter', 'To Be the Best', 'Our Vision', 'Our Principles', 'Our Commitments' and 'The Challenge'. (Carta Nova Novartis, 2000)

The Carta Nova has been chosen for the comparison to Novo Nordisks ‘Charter’ and ‘Way of Management’ because the two commitments contain similar elements and principles.

In general

Novartis gives in its *Carta Nova* a very clear and precise outlook how agriculture and company's involvement will look like in the future. Key terms are ‘yield intensiveness’ and ‘increasing productivity’ in a ‘sustainable fashion’. ‘Sustainable fashion/ way’ means for Novartis that increasing productivity on a given surface will prevent or delay the conversion of natural land and wildlife habitats to agricultural land. By this strategy, natural resources and wildlife can be protected for future generations. Novartis states that it is a leading supplier of crop protection products and that it wants to maintain this position and develop innovative technologies, products and services in this field. (Carta Nova Novartis, 2000)

Novo Nordisk does not specify in its Charter and Way of Management how it sees the company’s involvement in the enzyme and health business in the future. The company states in its charter that it wants to be ‘accountable’, ‘ready for change’, ‘engaged with stakeholders’, ‘responsible’ and ‘ambitious’. (Novo Nordisk Report, 2000) In the Way of Management, three additional principles ‘Open and honest’, ‘Close to our customers’ and ‘Responsible neighbour’ are presented. (Sustainability strategy and goals are not explained in the Charter.)

When comparing the two companies, it seems that Novartis states what it wants to achieve and by which strategy. In comparison, Novo Nordisk says how it wants to act in the future and which basic principles it will use to guide its actions.

‘Ambitious’, ‘accountable’, ‘open and honest’, ‘responsible’ and ‘ready for changes’

While Novo Nordisk defines its basic principles very clearly, one has to look closely at the different sections in the Carta Nova to find out the values of Novartis.

Novo Nordisk defines the principle ’ambitious’ as “We shall set the highest standards in everything we do and reach challenging goals”. Novartis expresses this principle in a more concrete way – “We strive for operational Excellence” and “We seek innovative solutions which support Sustainable Agriculture”

The other principles, ‘accountable’, ‘open and honest’, ‘responsible and ready for changes’ are hard to find in Novartis’ Carta Nova.
A readiness for change and openness statement can be found in the ‘To Be The Best’ section: “We achieve continuing success”…”by clearly communicating our principles and objectives and by

being open to criticism and new approaches".
Further indirect statements of values are given in the 'Our Commitment Section' like for instance "We sell only beneficial products" or "We comply with all laws and regulations".

'Satisfaction of customers' and a 'responsible neighbour'

Both companies claim that they want to satisfy their customers. Novo Nordisk wants to be 'close to customers' and Novartis is 'customer-driven'. In addition, Novo Nordisk wants to be a 'responsible neighbour' – " We shall all over the world conduct our business as socially and environmentally responsible neighbours, and contribute to the enrichment of our communities."

Stakeholders

Another important issue, which is treated in Novartis' Carta Nova and Novo Nordisk's Way of Management, is the relationship to stakeholders.

Novo Nordisk's definition of 'engaged with stakeholders' is the following: "We shall seek an active dialogue with our stakeholders to help us develop our businesses".

Novartis describes in 'Our Commitments' section stakeholder communication. "We provide factual and timely information about our products and processes. We communicate complex technical and scientific material in an understandable and accessible manner. …"

The difference between the two companies is that Novo Nordisk is seeking stakeholder engagement and Novartis stakeholder communication.

Novo Nordisk wants to improve its business and its financial strengths by 'team work', what also requires a certain will of change and the courage to leave power to stakeholders.

Novartis has expressed its will to communicate with stakeholders, to accept criticism and to consider proposals of stakeholders. But it is not ready to engage stakeholders - thus to give them a more active role in strategy and development planning.
Jakob Nüsch, the former president of the Federal Institute of Technology in Switzerland, hits the nail squarely on the head by stating at the Novartis Roundtable in February 1998 that " you [Novartis] create a project and try to sell it to others – this you call dialogue. You should ask different people – even outside of Novartis – to participate even before you create a project". (Novartis Report, 1998)

Commentary on Novartis' Carta Nova

Since the Carta Nova is created for Novartis' Crop Protection, the focus is laid on pest control and accompanying services like Integrated Pest Management. The future strategy of the Crop protection is very well explained as well as principles like "We minimise waste" or "We acknowledge and manage the Risk". But company's values like for instance openness or accountability are not defined.
A Code of Conduct for the Agribusiness Unit as a whole is urgently needed. Values have to be described and a joined commitment (of all agro-units) for Sustainable Agriculture has to be formulated.

6.2.3. Putting values into action

In general

Novartis main sustainability goals are:
First, to ensure global food security by developing technologies, which increase agricultural production and/or are more environmentally friendly. Second, to reduce environmental impacts of production activities. Furthermore, Novartis created the Foundation for Sustainable Development to promote social and economic development in less developed countries. The Novartis Foundation for Sustainable Development states on its Homepage: "We are engaged in programmes in the developing countries that directly contribute to an improvement in the quality of life of the poorest people". (Novartis Foundation Mission, 2000)

Novo Nordisk tries to put the above mentioned values into action. They claim that their values are not much different of those of other companies, but "the significance is determined by the fact, that we consciously apply our values as the driving force behind our behaviour at Novo Nordisk". They built up management structure to ensure that their values are integrated in decision making, considered by their management stuff and also by their employees. A focus is led on social, environmental and bioethical performance. Weaknesses shall be brought into light by stakeholder processes. (Novo Nordisk Report, 2000)

Sustainability framework

Contribution to a Sustainable Agriculture is a primary goal of *Novartis.* But it does not seem to be clearly defined and promoted. No strategic framework for organisation of sustainability activities seems to be in place.

The global scale of Sustainable Agriculture is more recognised than local aspects. That means, that the dominant approach is first, to develop an innovative product which has improved agronomic or

environmental traits, second, to get a patent and third sell it on the global market place. By this strategy, Novartis wants to improve farming practice worldwide.
But, it is not a common approach to adapt products at local level and sell them accompanied by services. Except on a case study basis, so called 'technology baskets' considering local social, economic and environmental conditions are conceived or know-how is transferred to less developed countries for the stimulation of research activities. (Interview, Dr. Brassel)
The Crop Protection seems to be the most advanced unit regarding the 'sustainability approach'. A service that is increasingly offered is Integrated Pest Management (IPM) promoting a targeted use of pesticides. (Novartis Report, 2000), (Interview, Dr. Diriwächter and Dr. Einsele)

At *Novo Nordisk*, the ten 'Fundamentals' (a part of 'Our Way of Management') serve as basic rules for the 'sustainability approach' and they apply at all levels within the group. A team of 'facilitors' is deployed to assist with ensuring that the Fundamentals are applied throughout the businesses. Furthermore, an internal project 'Values in Action' was started in 1997. 40 people from all over the organisation were asked to spend one day a week for six months looking at the environmental, bioethical, social and economic responsibility of Novo Nordisk and how it performed against its values. (Novo Nordisk Report, 2000) In addition, *Novo Nordisk* started its first environment department 25 years ago and created the Corporate Committee on Environment and Bioethics eight years ago. Furthermore it has a Health and Safety Committee and local committees around the world. (Novo Nordisk Report, 2000) In comparison, Novartis created its Health, Safety and Environment (HSE) department 3 years ago.

Commentary

At first sight, when studying reports and documents found on the Internet page of Novartis, the impression was created that Novartis has no clear sustainability goals or guidelines. Moreover, a sustainability framework and the accompanying management context are missing.

In general, the key tone in reports and documentation is defensive and presented 'sustainability approaches' contradictory.
For instance – in the article 'Novartis' Commitment for Sustainable Development', the Novartis Foundation for Sustainable Development claims that a corporate business like Novartis "has to be as economically successful as possible in selling their products and services and has to satisfy customers' needs on markets where spending power is high. If it would not act in this way, no means for social engagement could be raised". [Translated from German] (Novartis Foundation, 2000)

On the other hand, a declared aim of Novartis is to provide affordable products and technologies for less developed and not only for developed country. This publication contradicts Novartis stated principles.

But, when getting in touch with Novartis managers, another picture of Novartis is presented.
The interviewed managers have a commitment to integrate sustainability principles in Novartis' business practice. The 'sustainability approach' is viewed as a moral obligation and a necessity for the long-term business success.
In conversations, openness, transparency and a strong will of change, but also insecurity and helplessness in handling the situation were conveyed.
Moreover, an amazing lack of knowledge about interests and reasons for mistrust of the public was observed. (Interviews, Dr. Brassel, Dr. Einsele and Dr. Diriwächter)

For instance, Novartis had a one and a half year long dialogue with the Applied Ecology Institutes, Vienna and Freiburg to discuss about a sustainability evaluation system for Bt maize. In a joint approach economic, social and environmental indicators have been chosen. Dr. Einsele, Head of Public Affairs and Communication of Novartis Seeds, stated that his main motivation to lead this dialogue was to "to learn to talk to the others and to understand their views". The main success of the dialogue was that both parties had learnt a lot during the process and that a high level of trust had been created. The choice of the sustainability criteria was a more difficult process. The parties could agree on sustainability indicators for Bt maize, but were partly not persuaded of their usefulness and measurability. However the dialog met the expectations and further collaborations will follow. (Interview, Dr. Einsele), (Stiftung Risiko-Dialog, 2000)

Issues like this dialogue are not reported to a broader public by Novartis. Instead, short PR stories and defensively written GMO statements can be found in the company's reports and on its Homepage.

In conclusion, Novartis is trying to put values into action, mainly by local activities or single stakeholder dialogues. But there seems to be no framework, no plan how to progress towards Sustainable Development. In addition, Novartis very badly represents itself in its publications and on its Internet page. It would be wise to replace hollow phrases by documentation about activities that really happen at Novartis.

6.2.4. Reporting

Environmental and social reporting is a possibility for companies to communicate openly targets and achievements to their stakeholders every year.

Novo Nordisk was the winner of the 1995, 1996 and 1997 European Award for Environmental Reporting.
In 1999, Novo Nordisk reported for the first time about their environmental and social performance in one single report 'Putting values into action'. This report consists of a Sustainable Development, social, environmental, bioethical and site report section. The report presents in a very transparent way the attitude of Novo towards critical issues, their targets, indicators, achievements and failures in reaching their targets. It is very well documented which targets were set in which year and how data were collected. In addition, results of an employee survey and site specific reports are published. (Novo Nordisk Report, 2000)

Novartis' Health, Safety & Environment (HSE) report (1999) is divided into three parts, Product Stewardship, Business Review and Corporate Health, Safety & Environment.
The HSE report contains description of activities, targets for HSE and results. Environmental data are presented quite in detail. Although sustainability activities are described, they are not very well documented and explained. (Novartis Report, 2000)

As a whole, the report is written in a PR style with many statements about beneficial activities, Sustainable Development and stakeholder dialogues. Many disconnected success stories are presented, but not seriously explained and analysed.

The best-documented parts of the report are: first, the HSE data section where performance is measured by means of four business and four environmental indicators, second, the short presentation of HSE targets and third, the results of the Business Review. (Novartis Report, 2000)

The HSE report 1997, published one year after the creation of the HSE department, is more transparent than the new one (published in 2000). In this report, a roundtable discussion of Novartis and an employee survey are presented. Furthermore several analysis of environmental data are provided in a more comprehensive way. (Novartis Report 1998)

Commentary

In the future, Novartis should present more data, facts and analysis in the HSE report. For instance, it is several times mentioned that Novartis was seeking dialogue with various stakeholders (Listening to consumers on GMOs p.7, Partnership and Mutual learning in India p.9, Public forums p.19, ...), but neither targets nor outcome of these processes are documented.

Furthermore, the environmental data presentation could be improved and more than four indicators defined. At the moment the environmental indicators are: energy consumption, water consumption, global warming potential (own sources) and total waste (hazardous plus non-hazardous).

For comparison, in the table below, Novo Nordisk’s environmental indicators are presented:

ENVIRONMENTAL INDICATORS

Indicators	Impact on environment
CONSUMPTION OF WATER	
Quantity and EPI	Depletion of drinking water
CONSUMPTION OF RAW MATERIALS AND PACKAGING	
Quantity	-
CONSUMPTION OF ENERGY	
Quantity (GJ) and EPI	Depletion of fossil fuels
DISCHARGE OF WASTE WATER	
Volume	-
Suspended solids	-
COD	Oxygen depletion
Nitrogen	Eutrophication
Phosphorus	Eutrophication
DISPOSAL OF SPENT BIOMASS	
Volume	-
Dry matter	-
Nitrogen	Fertilisation
Phosphorus	Fertilisation
DISPOSAL OF WASTE	
Amount per disposal type:	-
• Recycling	
• Landfill	
• Incineration	
• Controlled destruction	
AIR EMISSIONS	
Emissions from our production:	
• Organic solvents	Global warming and ozone layer depletion
Emissions from energy production:	
• CO_2	Global warming
• SO_2	Acidification
• NO_x	Acidification, eutrophication
COMPLIANCE	
Breaches of regulatory limits	-
Accidental releases (GMOs, chemicals, waste materials)	-
Complaints over nuisances	-
Environmental projects	-

Figure 6.2: Novo Nordisk’s environmental indicators (Novo Nordisk Report (2000))

It would also be a good idea to publish the environmental data of the most important production sites and include indicators for compliance status (like Novo Nordisk).

In general, both companies raise similar subjects like stakeholder relations, bioethical, social and environmental issues. But Novo Nordisk is more convincing in demonstrating its continuing efforts, strengths and weaknesses by means of transparent data presentation and coherent discussion.

6.2.5. Conclusion

When talking to Novartis managers, reading reports and following the company's activities, it becomes clear that Novartis has a commitment to contribute to a more Sustainable Agriculture.
But it also seems that the way towards this goal is rocky. Frequent consolidations are not a good background for establishing a sustainability framework. Actions within the company do not seem to

be well co-ordinated and the necessity for non-economic performance is not integrated in company's philosophy and employees' mentality.

Public announcements of commitments like "we want to feed the world" are dangerous if there is no strong will or possibility to keep the promise. A recently to Novartis awarded gene technology patent that would tie a whole set of plant development processes, including germination, flowering, and fruit ripening, to externally applied chemicals - perhaps even to Novartis' own chemicals shows no trend in order to support less developed countries. It creates the impression that Novartis wants to create dependency relationships and sell "technology packages". (Halweil, 1999) These activities will not help to improve stakeholder relations. It is evident, that poor farmers cannot be Novartis' target customers at the moment, but if this is not the case, the company should be careful with “social” proclamations.

It is necessary that Novartis creates a Code of Conduct for its agribusiness. Furthermore, a sustainability framework should be developed and not only HSE goals, but also social and bioethical targets have to be set every year. Industry has to control by means of adequate management structures and assessment methods if the goals are reached. A further step forward would be the creation of targeted transparent sustainability reports.

7. Business opportunities derived from the ‘sustainability approach’

After analysing first, characteristics of agrobiotech companies, second, their contribution to driving forces in agriculture and appropriate responses, third, their key stakeholders and fourth their efforts to realise the sustainability concept by means of the case study Novartis, finally the results of all studies shall be applied in this chapter.

In the beginning of the chapter, three examples for novel business approaches are presented in order to demonstrate implementation possibilities for the sustainability concept. Then, by means of the SWOT Framework, business opportunities or threats respectively have been derived from the in the previous chapters identified strengths and weaknesses. In the following, the current ‘sustainability approach’ of agrobiotech industry is reviewed, weaknesses are highlighted and questions for further reflections conceived. Finally, future challenges linked to the ‘sustainability approach’ are identified and suggestions how to use them as opportunities have been made.

7.1. Sustainability as core of business

As discussed in the case study, Novartis has a commitment for Sustainable Agriculture. Environmental targets are set and implemented every year in order to improve production processes. For promoting more responsibly managed agricultural systems, environmentally sound pest management solutions (e.g. Bt crops) have been developed.
Although a positive trend can be observed, agrobiotech industry does not implement a far-reaching concept for Sustainable Development. On the contrary, environmental and social actions are not embedded in a framework leading the company towards sustainability. That means social and environmental issues are not viewed as core business and are not considered in every day decisions.

The challenge of the 21st century is to except new, unusual business demands; and not try to do business as usual plus some additional environmental and social policies.
The opportunity is to combine economic, social and environmental goals, accept them as core of business and realise novel solutions, which were unthinkable a few years ago.

Three little case studies are presented as examples for novel unusual business solutions in order to improve the environment or to support social development in less developed countries.

7.1.1. Unilever – Creation of the Marine Stewardship Council

In 1996, Unilever and the World Wide Fund (WWF) created in collaboration with other environmental groups and various actors in the fishing community the Marine Stewardship Council (MSC). This collaboration partnership is an effort to preserve jobs, maintaining the booming market for fish and protect this vital resource. The MSC, an independent non profit, non governmental membership body will accredit third party certifiers to label products from sustainably-managed fisheries with a prominent logo – letting customers know that their choices make a difference. Unilever itself, which has 20% of the world frozen fish market, has committed itself to buying only certified fish by 2005. In effect, the MSC is attempting to accomplish through market mechanisms what government regulations failed to do. (WBCSD, 1997), (Business Week, 1999)

7.1.2. Garmeen Phone – Doing business in less developed countries

Garmeen phone is a company operating in Bangladesh, a country where phonelines are rare partly because of widespread poverty and lack of infrastructure. Seeing an opportunity, the company is building cellular relay towers around the country and has begun selling cellular phone service to remote villages. In each village one person is contracted to be the operator of the cellular phone and charged a per-minute rate. The operator in turn charges villagers a slightly higher rate to use the phone. By this approach, telephone communication is available and affordable for the first time in such remote areas. The company intends to distribute 70,000 phones over six years. This cooperative business model is proving so effective that other multinational companies are looking to develop similar systems in other countries and regions. (Business Week, 1999)

7.1.3. Merck – Investing in the Rainforest

For centuries, the rainforests have provided medicines for indigenous people. Today, many key active substances of medicines derive from rainforest plants. Alarmed over the rapid destruction of rainforest world wide, Merck, one of the largest pharmaceutical companies in the world, has formed a partnership with a Costa Rican research centre (the profit non-governmental National Biodiversity Institute) to study and preserve plant and insects of Costa Rica's rainforest. Since 1991, Merck has provided INBio with funding and technology. In exchange, INBio collects a limited number of plants, insects and bacteria and provides them to Merck for further scientific exploration. Ten percent of Merck's research budget and 50% of the potential royalties go to support the Costa Rican rainforest. (McIntosh et al., 1998)

These three examples shall demonstrate that novel business approaches regarding social and environmental issues are also realisable for agrobiotech industry and that they might be also profitable – only impulses are needed.

7.2. Strengths - Weaknesses - Opportunities - Threats analysis (SWOT)

SWOT analysis is an effective tool for identifying strengths and weaknesses as well as potential opportunities and threats of a business.

Strengths	Weaknesses
- Good financial position and high profit margins - Size and power - Merging tactics - Political influence - Strong performance and advantages in research, development and licensing - Action on global market place - 'Oligopoly' position - Innovative high quality products	- Inflexibility - Strong believe - size and power will solve all kind of problems - Neglect of social and cultural values in business strategy - Misjudgement of power of certain stakeholders - Bad reputation management - Do first – justify later tactics - Inflexibility - Failure of stakeholder engagement
Opportunities	**Threats**
- Population growth - Globalisation trend - Good information and communication management - Quick adaptation to changing business conditions - Values and trends awareness - Social responsibility principles and implementation - Development of markets in less developed countries - Partnerships and collaborations - Multidisciplinary Research - Stakeholder engagement - Consumer-oriented products - Research in sustainable agricultural technologies - Financial success by products improving environmental quality - Agricultural services - GMOs and biotechnology - Risk management	- Globalisation trend - Command and control hierarchies - Competition for information and communication - Ignorance of values and trends - Pressure to take social responsibility - Sustainability options realized by other companies - Opposition of society to new technologies/ hesitant position of governments and EU - Globalisation of the media - PR disaster and loss of public image followed by financial losses - Liability for environmental damage caused by products or accidents - Legislation (food, environment, GMOs) - High financial risks in research - Fast moving trends, but long development time of products

Figure 7.1: Strengths – Weaknesses – Opportunities – Threats (SWOT) Analysis

The strengths of agrobiotech industry are mainly due to its financial power and political influence. By these qualities, companies get an advantage in research and development. Consequently, they can bring rapidly innovative high quality products on the market.
The main weaknesses of agrobiotech companies are their inflexibility and their ignorance of stakeholders' wishes and needs. Moreover a continuous misjudgement of the situation might pose threats to those companies in the future.

The analysis shows that many business opportunities and threats for agrobiotech industry are due to the globalisation trend, population growth, values' awareness of society, environmental problems in agriculture, information and communication management and research capabilities of industry. Globalisation brings the advantages of new market opportunities, but also threats like growing power of the media, enormous pressure for a faster 'moving' business and competition for information and communication.
Corporations with a strong command and control hierarchy and inflexible management structures have a lower chance to survive on a more competitive market stage.

In order to increase financial market power and enhance research resources, agrobiotech industry consolidated its business by merging tactics and gained by this strategy more political power and economicl strength. But neglect of social values and bad media coverage even pose threats to such powerful international groups like Monsanto or Novartis.
For this reason, a value driven corporate attitude might prove necessary for the long-term viability of agrobiotech industry. Industry leaders should be aware that companies' practices are increasingly visible and that they are being called to account for their behaviour. Society strongly believes that increasing business power is linked to a corresponding social and environmental responsibility. (Mathew, 1998)

Population growth is on the one hand a challenge for agrobiotech industry, because it has a social responsibility to ensure global food security. On the other hand, this trend offers great chances to explore new markets in less developed countries. The risk for industry linked to this approach is not being able to do business in these countries and to respect at the same time values and human rights.

Environmental degradation is another trend from which agrobiotech industry can profit. Revenues can be generated from nature by gaining technological insight in natural processes and strengthening natural resources. Conserving the natural basis for agriculture will be necessary to support agrobiotech industry's goal to increase agricultural productivity. Biotechnology and GMOs can be means to reach this goal.

Industry should use their strengths in research to find rapidly efficient technological solution for problems threatening a sustainable agriculture system (e.g. Global Warming). But not only novel technologies contribute to a Sustainable Agriculture, correct application and combination of products, technologies and services are at least of similar importance. Moreover, collaboration strategies, partnerships and a multidisciplinary approach will help to speed up technological progress.

The creation of every new product is linked to a development risk. Trends are fast changing, but development costs are high and the product development process lasts for many years. New legislation on biosafety or environmental issues may pose a threat to agrobiotech industry, since at the starting point of development, it cannot be estimated how legislation will look like in ten or fifteen years (when the product is commercialised). In addition, it is hard to determine if the product will be useful and accepted by society after such a long development time. It is advisable to cooperate with stakeholders at an early stage of the development process to reduce the risk that novel products are not accepted. When choosing this approach, agrobiotech industry has to give up secrecy in development processes and it has to accept the threat that stakeholder may want to condition inventions.
Furthermore, agrobiotech industry has to establish a thorough biosafety assessment of products and risk management procedures in order to avoid and/or handle liability claims.

In general, the SWOT analysis demonstrates that opportunities and threats for different approaches in this type of industry are always linked to high financial risks.

7.3. Critical review of agrobiotech industry's approach towards Sustainable Agriculture

Until now, man often tried to regulate the ecosystem without understanding and following the complex systems' rules. For instance, micro- as well as macro-ecosystem always work in effectively regulated cycles. Communication, information as well as feedback loops ensure proper functioning. Human intervention in natural cycles ensured food security and satisfaction of human needs but also caused destruction and disaster. Stable ecosystem cycles can only be ensured by copying its functioning mechanisms and by conserving and restoring its balance.

In this context, the question arises if for example the currently realised solutions to fight insects can be viewed as sustainable. GMO strategies like Bt resistant crops might have spared million tons of pesticides and this might have led to an improvement in environmental quality.

But it can be doubted that an approach, by which nearly 30% of transgenic croplands is planted with varieties designed to produce one sort of insect toxin (Bt), is sustainable. (Halweil, 1999) Furthermore, the Bt toxin gene is expressed permanently and insect resistance is only due to one gene. This sort of prophylactic control and the use of only one toxin on such extended areas, increase selection pressure on insect species and thus the likelihood of fast resistance development (despite of resistance management schemes).

In general, the crop protection problem – solution approach resembles early end of pipe solutions of chemical industry like "we have a pollution problem, we need a filter to reduce emissions". Today chemical industry uses other approaches to handle pollution problems. Experts try to find solutions at source like for instance improved production processes.
Pesticides and also current more sophisticated approaches to fight pests (e.g. GM Bt corn) are end of pipe solutions. A problem is solved by fighting consequences (pests), not causes (often – bad farm practices).

Questions on the path to more sustainable practices would be:

- Why do we have a pest problem and how could we avoid the permanent development of pest resistant insects?
- Would changes in farm management practice improve pest problems?

Questions that could be asked by industry would be:

- How could company's profits be increased by fighting pests in a more integrated way considering well known as well as alternative methods?
- Are there possibilities on industry level to influence farm practice e.g. crop rotation practices, soil fertility and improved water use?
- Do those measures contribute to improved income of farmers?
- Can these farm management approaches be combined with GM crops?
- Can be money earned in the future in a farming service or consultant sector?

In general, pressing environmental concerns like soil erosion, potential global warming and increased water usage have to be considered in a more complex way. Providing help for fighting insects has to be one measure combined with many others in order to create a more sustainable farming system. Pest resistant GM crops may be the optimal solution for instance in regions in less developed countries where enormous amounts of pesticides are currently applied. But it has to be emphasized that prerequisites for a Sustainable Agriculture are different approaches adapted to local problems. Industry's 'just apply chemicals or just take pest resistance crops' approaches are too simplistic for being really sustainable. However, industry has to decide how much it can contribute to a more responsible Agriculture, how it could achieve fundamental changes in current farm practice and it has to express these targets clearly.

7.4. Future opportunities and challenges linked to the 'sustainability approach'

"The 21st century company which succeeds in this new market place will have to accept a growing array of public and social obligations as the price of incorporation. Whether this is a subject of regret or celebration depends on your political stance - but it is undoubtedly the new business reality". (Hutton, 2000)

Some agrobiotech companies are not aware of the new business reality and demands of the public and other stakeholders and they have consequently troubles to put sustainability principles into practice.
The consumer back slash in Europe can be interpreted as an early warning sign what can happen when society's opinion is ignored and concerns dismissed ignorantly.

Traditionally, farmers have been the major economic stakeholders of agrobiotech industry. Industry complied with their needs for cheap and efficient plant protection solutions and agronomically improved seeds. But today, society (especially in Europe) is more willing to use their consumer power to support their ethical and moral concerns. (Hutton, 2000) New products of industry have not only to meet farmers' needs but also consumers' expectations. Ideally, Western society should identify with products of a certain company and will pay a higher price for them (kind of brand image). As a consequence, farmers using these new products and seeds will profit indirectly from this development by premium prices on European markets. For instance an accreditation system for environmental friendly farm management standards could be created together with prominent NGOs or international organisations. By such a certification system good agricultural products could be promoted. (→ see Example Marine Stewardship Council – Unilever, page80)

But not only the needs of consumers in developed countries have to be addressed. Population growth will mainly happen in less developed countries and availability and affordability of food will become an even more pressing issue. Ensuring food security in those countries is a complex issue. Production increase is only one little contribution to fight hunger and poverty. Current corporate practice of giving development aid for specific projects is charitable but will not be a solution. Technology transfer possibilities, creation of cooperation, farming services and new

economic models for doing business in less developed countries need to be developed in order to tackle the problem.
An other difficulty concerning mainly less developed countries is that industry is extremely interested in both, property right restrictions for farmers in order to avoid seed saving and technology packages (like herbicide resistant crop plus herbicide), because development costs for novel products like GMOs are extremely high. The troubling aspect is that these measures do not go along with industry’s goal to ensure food security. Agrobiotech industry has to find ways to make profits with novel products while ensuring affordability of them for resource poor farmers.

One major profit source for industry in the future may be restoring environmental damage. The basis of agriculture (soil and water) is threatened. Global climate is changing. There is a danger that agricultural production will decrease in some years because of soil erosion, water scarcity or increased temperatures. Agrobiotech industry has to react today to potential future threats because the development of suitable products will last ten to twenty years.

In the seed development approaches today, it also has to be considered that crop diversity is not reduced to an absolute minimum in the future. Currently, agrobiotech industry does only provide a few varieties, which are grown by US farmers on extensive areas. This causes already today pest problems, but may also lead to famines in the future, when novel pest organisms are created or weather conditions are changing. Reducing drastically genetic diversity in the field can be compared to a parachutist who is not using a spare parachute. Perhaps nothing is happening or only after a long time, but if an accident occurs the extent of damage is enormous. Biotechnology and improvements in breeding techniques in general should not be used to develop a low number of ‘supercrops’, but to develop a range of new varieties, thus to enhance crop diversity.

Furthermore, agrobiotech industry has to consider that environmental conditions for agriculture as well as the social and economic environment are variable in time and space. Industry's "one product for every location" approach is highly unsuitable for complex regional problems in agriculture. For contributing to local ‘sustainability approaches’, agrobiotech industry might have to diversify its product range. Products could be viewed as building blocks combinable according to specific local needs of agriculture. What products and what services to use for improving the agricultural situation could be a consulting task of agrobiotech industry. Research institutions and certain NGOs would be able to provide knowledge for the development of suitable products and services. At first sight, this proposal might seem to involve too high risks for industry, but on closer inspection, it could also be a business chance or become a necessity in the future

In conclusion, the following principles should be considered - first, agrobiotech industry has to be aware that their products and business strategies represent the social and environmental integrity of its business.
For instance, Monsanto’s approach, stating the wish to improve the economic and social situation of resource poor farmers while introducing a technology that prevent them from seed saving, is a violation of this principle.

Second, industry has to realise that developing a product with improved environmental (or social) qualities and sell it on large-scale might not be enough first, to satisfy stakeholders and second, to increase significantly environmental quality. Only a product sold with an appropriate strategy and service can contribute to a more sustainable agricultural system. In addition, the product strategy has to be adapted to local economic, social and environmental conditions.

Finally, the need for knowledge should not be underestimated. Education, information and communication are more powerful tools on the path to Sustainable Agriculture and to business success than products.

PART III - OUTLINE OF A SUSTAINABILITY ASSESSMENT FOR AGROBIOTECH INDUSTRY

In the third part, the results of Part I and II shall be applied practically by conceiving a Sustainability Assessment for agrobiotech industry comprising two parts – the Product Development Support and the Product Evaluation. The tool can be used by industry to obtain economically viable, environmentally friendly and socially acceptable agricultural products and to assess their effects on human and ecosystem wellbeing. In addition, further usage, development possibilities, strengths and weaknesses of the proposed Sustainability Assessment are discussed.

8. Introduction

When a business builds environmental or social benefits into products, it creates added value for the customer. The search for these benefits normally brings unforeseen enhancements to product performance, cost, quality, safety and serviceability. (Business Week, 1999)
Traditionally, decision on product development has been dominated by financial and feasibility criteria. The new criteria for whether a proposal is right for a company to pursue will increasingly depend on a third dimension - its contribution to corporate standing and reputation. (Mathew, 1998)
The rule that all that counts is profit in corporations is no longer an adequate barometer of success. Performance indicators must include social, ethical and environmental targets. But while most companies pay lip service to this new cultural business exigency, the practice is inadequate. (Hutton, 2000)
The outline of the Sustainability Assessment (SA) shall provide a basic framework to support agrobiotech industry in both, the development of sustainable products and the evaluation of their economic, social and environmental performance.

8.1. The Sustainability Assessment (SA) in the business framework

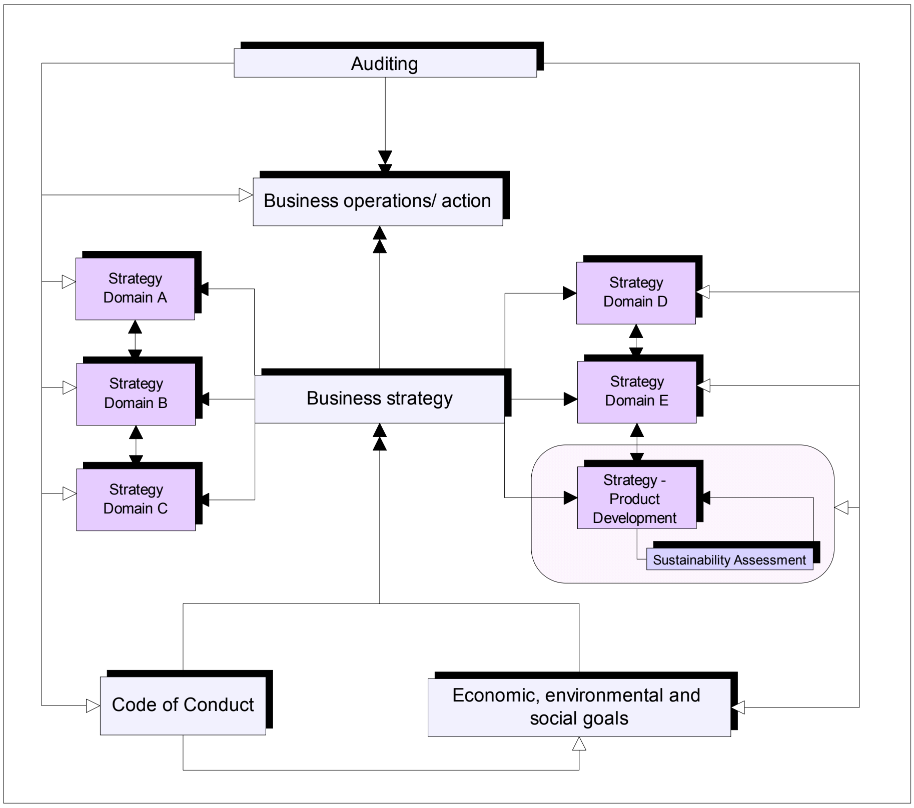


Figure 8.1: The Sustainability Assessment in the business framework

As identified in the previous chapter, in a good ‘sustainability approach’ social, ethical and environmental goals are treated together with economic goals as core of the business unit. The basis

for the formulation of goals is the Code of Conduct of a company where it specifies its values and what role to play in society. The selected goals are transformed in a business strategy, which is divided in the strategies of the different business units. Each unit has to implement the set strategy. In order to check if business operations are successful and the goals are met, regular auditing procedures have to be carried out.
The Framework for the Sustainability Assessment is a strategic as well as a performance evaluation tool. It shall support product assessment, but also allow a critical view on current product development strategies of agrobiotech industry.

8.2. Aim of the Sustainability Assessment

The roots of the proposed Sustainability Assessment (SA) lie in the Technology Assessment (TA). The TA can be defined as “the assessment of a technology in terms of impacts on economy, ecology and society” (Kaeppeli, 2000)
The Technology Assessment was originally an institutional assessment targeted at protecting society from bad impacts of a new technology.
But, for a while, also the business community uses a form of TA. The corporate TA can be distinguished from the institutional one that it is rather ‘goal pulled’ than ‘uncertainty driven’. The TA in the business community focuses on the economic implications of a technology or product. Environmental and social factors are considered to a lesser extent. (Kaeppeli, 2000) Unlike the institutional TA, carried out after the market introduction of a novel technology or product, the TA in the business community is utilised before and during the product development process.

The aim of the proposed Sustainability Assessment is to help industry to conceive products, which support a sustainable agricultural system (see Paragraph 1.4 page 21) and meet economic, social and environmental demands of industry’s stakeholders as well as agrobiotech industry’s own requirements. In the SA, the forecast character of the business TA shall be linked to the performance evaluation traits of the institutional TA.
The Sustainability Assessment is especially designed for the evaluation of GM crops, but the framework can be used for every product created for the use in agriculture.

9. Conceptual framework for a Sustainability Assessment

The proposed Sustainability Assessment will first provide a support for conceiving a 'sustainable' product. Second, an evaluation system is developed by which impacts of a product can be assessed on the basis of a set of economic, social and environmental criteria.

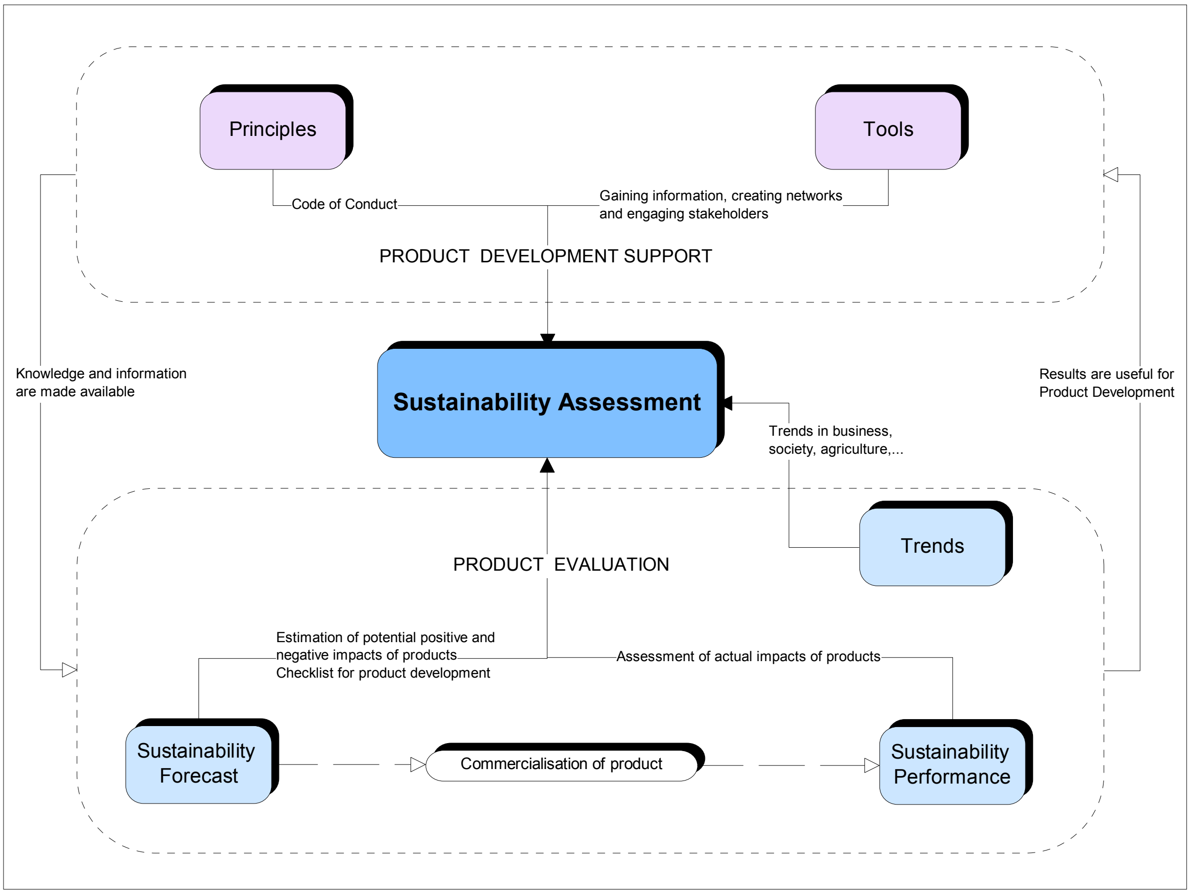


Figure 9.1: Sustainability Assessment Framework

As illustrated above, the Sustainability Assessment consists of two parts, the *Product Development Support* and the *Product Evaluation*.

9.1. Product Development Support

The Product Development Support (PDS) comprises basic principles and tools. The principles shall serve as Code of Conduct for designing 'sustainable' products. The proposed tools are an information system and a cooperation building strategy. They shall help to catch the dynamic aspect of Sustainable Agriculture. Those tools shall be used to provide knowledge and information for the whole system.

9.2. Product Evaluation

The Product Evaluation (PE) is the assessment aspect of the framework.

By using the Sustainability Forecast (SF), a new product is assessed before, during and shortly after the development process.

SF criteria can be used as checklist for:

- firstly, determining the necessary specifications of a product,
- secondly, deciding if scientific discoveries (basic research) are worth to be further developed for commercial use
- thirdly, controlling during development process if requirements are met
- and finally, evaluating the product before commercialisation.

Sustainability Performance (SP) should be checked after commercialisation of a product. Above described SF criteria have as counterparts SP indicators in order to assess both, the actual impact of a product in practice (SP) and the validity of the predicted impacts of the product respectively (SF). The time span for checking impacts of products after commercialisation is dependent on the degree of novelty and performance results of the product. In the end, an array of economic, social and environmental impact data should be available for every product.

Trend indicators (TI) are sustainability indicators, which do not determine the performance of a product. They rather describe the actual state of agriculture. These indicators should be measured because they describe the state of agriculture and can be used to predict trends to which industry can react by adequate products.

Sustainability Forecast and Sustainability Performance criteria are chosen on the basis of economic, environmental and social goals and targets. (Chosen goals and targets see page 96)

9.3. System Review and Decision-making

Although a system review and the actual use of the framework in decision-making are no core functions of the SA, they have to be considered as important.

A system review is needed to update the Sustainability Assessment regularly and to integrate new ideas into product planning and the assessment process.

Since agrobiotech industry has severe problems with stakeholder communication and engagement, it is indispensable that stakeholders are invited to evaluate the system and make proposals for improvement. Industry should also consider the development of criteria demonstrating sustainability progress of the company to stakeholders.

The usage of the SA in decision-making is a prerequisite for the success of the framework.

10. Vision, goals and targets

The most critical and controversial part of the Sustainability Assessment is the creation of a vision, goals and targets. These three components will in the end determine how sustainability is defined, which aspects are considered and which sustainability indicators are chosen.

It has to be emphasised that there is neither a common definition for a Sustainable Agriculture Framework, nor defined roles and responsibilities for actors in it. Sustainability-related issues can be viewed by actors in agriculture in completely different ways. As a consequence, it is inevitable that personal views are reflected in the choice of vision, goals and targets.

Note
The best way to develop the contents of the system would be to follow Bellagio's Principles (Principle 6 – Openness, Pr. 7 – Effective Communication and Pr. 8 – Broad participation) for assessing Sustainable Development. (Hardi and Zdan,1997)
Only a mutual approach in the creation of sustainability goals and targets leads to a good system and to satisfaction of agrobiotech industry's stakeholders.
The below presented sustainability vision, goals and targets as well as indicators have to be viewed as a starting point for that mutual approach.

10.1. Vision for Sustainable Agriculture

In Bellagio's first principle for assessing Sustainable Development it is stated that "assessment of progress toward Sustainable Development should be guided by a clear vision of Sustainable Development and goals that define this vision".

10.1.1. Novartis' Charter and Vision for a Sustainable Agriculture

(→ Novartis' Sustainability Charter and Vision are discussed in Paragraph 6.2.2 page 71)

Charter

The challenge of the 21st century will be to achieve the required increased production while reducing adverse environmental effects. This can only be done if agriculture is managed in a yield-intensive and sustainable fashion.

Vision

We strive for profitable growth by providing products and services, which support the principles of Sustainable Agriculture.

Sustainable Agriculture uses those practices and systems that maintain and enhance:

- Sufficient and affordable supplies of high-quality food and fiber.
- The economic viability of world agriculture.
- The natural resources of agriculture and the environment.
- The ability of the world's population to continually provide for its own well being.

Urbanization in the world will spread. The number of people engaged in farming will diminish and the amount of arable land will shrink. Thus, farmers need more effective methods and means for agricultural production. Novel crop protection solutions contribute to ecological, economic and sustainable practices in high-technology agriculture. (Carta Nova Novartis, 2000)

10.1.2. Alternative Vision for a Sustainable Agriculture

Vision

Sustainable Agriculture is to improve the quality of human life within the carrying capacity of the ecosystem and it is to help people satisfy their needs.

It is an agriculture which is economicly viable, socially acceptable and protects natural resources and the environment if it is to guarantee for our and future generations access to sufficient healthy food.

It is to be considered that agriculture is based on dynamic biological, physical and chemical systems and that man lives in a constantly changing economic, social and political environment, thus what is sustainable at a certain place to a certain time will only remain sustainable for a limited period.

As a consequence, the development of products and technologies for a Sustainable Agriculture is to ensure the ability of the world's population to continually provide for its own well being on a global as well as on a regional and local level.

The scale of the task is so large and the challenge so urgent that all concerned parties – governments, aid agencies, international organizations, academia, private sector, NGO's and society must work together to create our common future.

The vision is adapted from (Agenda 21, 1992), (Global Crop Protection Federation, 1999), (Carta Nova Novartis, 2000) and (Reeves, 1998).

10.2. Goals and targets for Product Development Support and Product Evaluation

10.2.1. Product Development Support

***Goal:* Organisation of fast progress towards Sustainable Agriculture**

Sustainability Principles

1. Products represent the social and environmental integrity of the company.
2. Knowledge and information is sold together with product.
3. Global and local product strategies are pursued.
4. …

Sustainability Supporting Tools

- Creating an information system
- Creating cooperation and networks for exchanging knowledge and building-up capacities

Table 10.1: Goal/ targets for the Product Development Support

By creating the PDS, the principles of 'dynamics' and 'flexibility of 'sustainability approaches' are considered in the SA.

The 'Sustainability Principles' are thought as a guideline for product developers and decision-makers to check if a product complies with the identified requirements for a sustainable agricultural system. The three above listed principles serve only as examples. A set of development principles should be created by industry.

The two 'Sustainability Supporting Tools', the information system and the network building strategy, first, shall provide knowledge and information for measuring the indicators determined in the PE. Second, they may help to understand stakeholders' views and to exchange knowledge. Finally, the tools will aid to recognise novel aspects of Sustainable Development and integrate them in the SA.

10.2.2. Product Evaluation

The goal of the PE is both, to predict impacts of a product before/ in the development phase and to assess their actual effects after commercialisation in relation to set goals and targets.

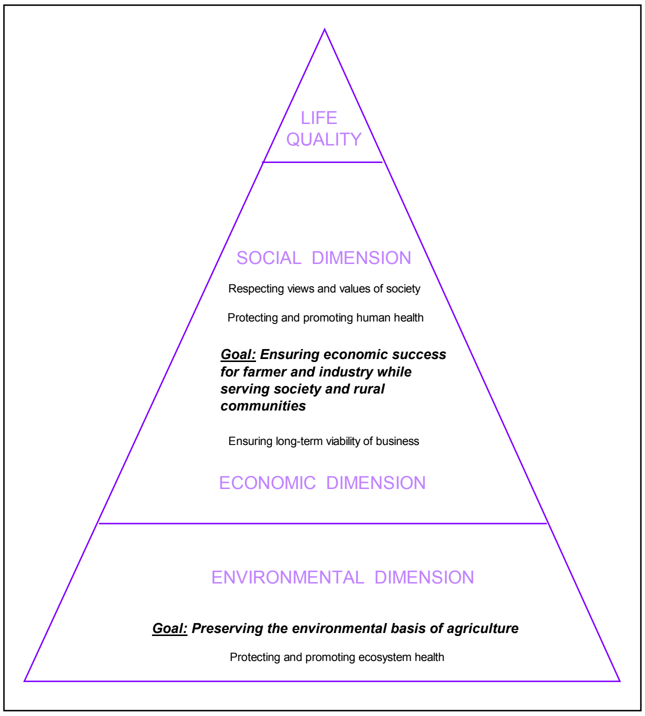


Figure 10.1: Sustainability Dimensions

The choice of the goals represents the identified requirements for Sustainable Agriculture. Goals concerning Quality of Life have been omitted because of difficulties to measure them with standard (Western) evaluation techniques. Real Life Quality indicators would be for instance happiness, harmony or fulfilment. Some indirect life quality indicators like suicide rate of farmers, average education level of farmers' children or community contacts have been proposed as trend indicators. Sustainability Forecast and Performance indicators do not measure those because industry's impact on these issues is hard to determine.

In the table below, goals, targets and sub-targets, which are evaluated by Forecast and Performance indicators, are listed.

<table>
<tr><td colspan="2"><u>Goal:</u> Ensuring economic success for farmer and industry while serving society and rural communities</td><td><u>Goal:</u> Preserving the environmental basis of agriculture</td></tr>
<tr><td rowspan="2">Ensuring long-term viability of business
- Promoting global and local economic rural development while considering social structures
- Meeting and exceeding needs and expectations of farmers, consumers and shareholders
- Considering strategic, financial and technological development factors</td><td>Respecting views and values of society
- Following corporate ethics principles
- Considering societal values (Study focus – European values)</td><td rowspan="2">Protecting and promoting ecosystem health
- Conserving/ recovering ecosystem balance and development of strategies targeted at areas and resources at environmental risk
- Improving environmental farm management and ensuring environmental safety of GM and non-GM crops
- Determining environmental impacts of products (during life cycle)</td></tr>
<tr><td>Protecting and promoting human health
- Caring for food security of world population
- Improving food quality and ensuring food safety (especially for GM and non-GM crops)</td></tr>
<tr><td colspan="3"><u>Assessment Tools:</u>
- Sustainability Forecast
- Sustainability Performance</td></tr>
</table>

Table 10.2: Goals and targets of the Sustainability Evaluation

Trend indicators have been chosen in the domains Environment, Rural Development and Food.

11. Outline of the Product Development Support (PDS)

The first goal of the Product Development Support is to provide basic principles for conceiving economicly, socially and environmentally acceptable products. The second one is to support Product Evaluation by providing knowledge and up to date information.

11.1. General Aspect of the PDS

Basic Sustainability Principles should be considered in design and development of products. First, products should reflect by their environmental and social performance the company's efforts to contribute to a more responsible Agriculture. Second, products should be less extensive in material but more intensive in knowledge. Finally, as explained in the previous chapters, needs for Sustainable Agriculture are not the same at any location and at every time. As a consequence, products have to be adapted to local conditions, but must at the same time meet global needs. Further principles and guidelines should be conceived by industry.

11.2. Dynamic Aspect of the PDS

To catch the dynamic effect of Sustainable Development all aspects of knowledge (information, education and communication) have to be handled in a well-coordinated manner.

11.2.1. Target: Creating an Information System

The goal 'Organisation of fast progress towards Sustainable Agriculture' implies that information and data about Sustainable Development have to be easy to find and to be accessible. Today much information is available, but it can often not be used because the distribution and organisation of this resource is insufficient. For this reason the creation of an information system would be useful for agrobiotech companies.

In the following table an outline of an *Information System* is presented.

Outline of an Information System	
Kind of information	The system could contain diverse information: E.g. trend indicators (see p. 121), results from ecosystem mapping, contact addresses of specialists in agronomic fields (inside and outside the company), monitoring results of field trials, useful links in the Internet…
Profit for business success and for Sustainable Development goals	In general - The system may help people to solve problems effectively and prevent different people from doing the same work. - Progress towards Sustainable Development may be faster, because important data are available in an easy accessible and organised form. - In the future, if the system is well-organised, it may be even possible to sell data about agriculture, specialists, trials, … Product development - Product strategies could be based on readily available information and data - Argumentation with stakeholders about risks and benefits of products could be improved when statements are based on information rather than assumption. - The current lack of ecosystem data could be filled and more complex modelling could be possible. That would help to predict impacts of novel products and technologies and to facilitate risk assessment. - For developing product accompanying services and farm management strategies, knowledge and up to date information about environmental trends are indispensable.
Organisational Aspect	- User rights - Who is allowed to check what information? - Data sharing with other organisations - Certain type of information could be made freely available at the Internet.
Technical Aspect	Data base system (with GIS functions – allows linkage of different data sources and offers presentation possibilities)
Challenges/ Risks	Security risks (data protection, hacking), overview over the system, update of the system

Table 11.1: Information System

11.2.2. Target: Creating cooperation and networks for exchanging knowledge and building up capacities

But not only information has to be collected, it also has to be communicated. Sharing knowledge with different stakeholders may create understanding and trust as well as a knowledge lead. By creating cooperation and networks, both, information exchange and mutual learning can take place Results can be transformed in technological progress. Especially in the field of sustainability only a multidisciplinary approach can lead to success.

In the following table opportunities for *cooperation with stakeholders and creation of networks* are presented.

Partners	Issues/ Activities	Purpose	Form
Single partners			
Farmers	- Education in Sustainable Agriculture and offering of farming services - Information about field experiences of farmers with products - Promotion of interaction between farmer and consumer	- Promoting the use of sustainable practices in agriculture - Correct use of product - Use of the knowledge of farmers in product development	- Seminars - Field trials, test sets - Consulting for farmers - Actions in rural communities
Society/ consumers	- Information about activities and products - Consideration of the needs of the public in product design	- Build up trust - Understanding of values and needs of the public - Support for product ideas	- Forum - Report feedback - Creation of a certification system (see Example – page 80)
Research (see Example – page 81)	- Promoting basic research by public institutions in developed and less developed countries	- Use of research results for product development - Identification of potentially interesting genes and active substances - Social development in less developed countries	- Research Collaboration
Multiple partners			
<u>Monitoring cooperation:</u> Regulators, Farmers, Research Institutes, NGO, Local authorities and interest groups	- Collection of ecosystem data, monitoring of product impacts on agriculture - Development of legislation and monitoring procedures - Information exchange and creation of research networks	- Contributing to the protection of natural resources - Assessment of risks of products (GMO)	- Dialogue - Informal contacts - Field Trials
<u>Ethics Advisory Group:</u> Social scientists, Life scientists, Lawyers (International Organisations, Research institutes, NGOs, …)	- Clarification of ethical and social questions - Information and communication of research results - Advice for product development	- Knowledge of the social and ethical implications of a potential or already developed product	- Meetings - Informal contacts
<u>Local product strategy teams:</u> NGOs, Research Institutes, Farmers, Local interest groups	- Gain of knowledge - Data for information system - Global progress in sustainability - Organisation of local action and product strategies	Locally adapted sustainability strategies	- Meetings - Informal contact - Visits at locations - Discussion forums

Table 11.2: Cooperation and creation of networks

Example – Monitoring cooperation

To assess (positive and negative) long-term effects of GMOs on the ecosystem and their impacts on farm management, monitoring procedures as well as an early warning system should be established. For guaranteeing objectivity and information exchange, all actors involved should form a monitoring network and have certain monitoring or evaluation tasks.

Actors	Tasks
(1) Industry	Novel product-related farm management concepts, monitoring proposals
(2) Research	Basic research, field trials, monitoring proposals (especially for ecosystem parameters)
(3) Farmers	Monitoring for 'unusual' phenotypes or not normal changes in the field, notification duty
(4) NGOs/ Local interest groups	Monitoring proposals, control of monitoring procedure, public participation in form of interest groups
(5) Regulators/ Authorities (national/ local)	Development of strategies on national and local level, lay down of assessment and control procedures according to legislation and voluntary agreements

One problem of the impact assessment is that many fundamental ecosystem parameters are unknown or only measured for a short time. Thus, it is partly impossible to measure specifically the impacts of GMOs on agriculture, because effects of conventional agriculture are not sufficiently known. For this reason, not only the consequences of GM crops have to be assessed, but also the influence of non-GM crops and chemicals on the environment have to be studied. The final aim of the cooperation is to guarantee thorough and fair monitoring procedures. Agrobiotech industry would benefit from the cooperation by both, having data for proving the expected benefits of GMOs and building up trust to stakeholders especially to the public. Furthermore, knowledge about negative effects of products can be used for developing novel products with improved traits. Financing of the cooperation has to be clarified. A cost sharing model between authorities and industry seems to be reasonable.

11.2.3. Indicators for proper functioning of the information system and the cooperation/ network building

Indicators are proposed to check of the two tools are used and if they serve the foreseen purpose.

Target: Creating an Information System

Implementation indicators	Success indicators
Complexity/availability/ quality and cost of information	Gained sustainability knowledge and information is actually used in decision making
Forms of evaluation/management and presentation of information	
Usage of data in decision making	
Linkage of disparate data sources in a meaningful way	Actual use of system (Number of accesses/ time unit)
Comprehensibility of data presentation by users and decision makers	
Check for correctness and actuality of data	Update and further development of information system

Table 11.3: Indicators for proper functioning of the Information System

Target: Creating cooperation and networks for exchanging knowledge and building up capacities

Implementation indicators	Success Indicators
Form of cooperation and networks	*Outcome criteria:* Gained sustainability knowledge and information is actually used in decision making Implementation of decisions taken in stakeholder processes Promotion of research and technological progress Gain of knowledge Understanding of values and views Willingness to work together again Level of trust
Issue specific choice of stakeholders	
Engagement of stakeholders of major interest for industry	
Processing of views and knowledge in business strategy	
Potential integration of gained knowledge and information in information system	*Process Criteria:* Problem solving capacity of stakeholder process Information exchange Mutual learning
Potential use of information in product development	

Table 11.4: Indicators for proper functioning of Cooperation and Networks

12. Outline of the Product Evaluation (PE)

The aim of the Product Evaluation is both, to predict potential and to assess actual impacts of a product.

12.1. Introduction

Criteria for PE are chosen according to defined economic, social and environmental goals and targets.
(Presentation of goals, targets and sub-targets, see page 96)

Sustainability Forecast (SF) criteria are created in order to anticipate potential effects of non-commercialised products. They can be used as a checklist before/ during and after product development in order to control if sustainability requirements have been considered. Sustainability needs can sometimes not be met by a single product, but by a combination of products or by a product linked to a service.

Sustainability Performance (SP) indicators are conceived as counterparts of SF criteria. SP indicators can be applied on the one hand for assessing the actual impact of a product for a certain time span and on the other hand for checking the correctness of the Sustainability Forecast by comparing estimated with actual effects of a product.

To make this clear an example for SF criteria and SP indicators is presented in the table below.

Sustainability Forecast Criteria (SF)	Sustainability Performance Indicator (SP)
Sub-target: Promoting global and local economic rural development while considering social structures	
Product reduces the use of chemical substances (e.g. pesticides) and promotes use of less toxic substances	Amount of pesticide applied per ha Consideration of quantity and toxicity of applied pesticide Toxicity of pesticide - type applied (profiling, positive list, weighting factor) (Savio, 1999)
Sub-target: Improving environmental farm management and ensuring environmental safety of GM and non GM crops	
Potential decrease of labour hours by product use ☺ ☹	Labour hours/ year in agriculture in country x Women's labour hours/ year in agriculture in developing countries Manual weeding hours/ harvest Employment level in local communities → Jobs/ha (Savio, 1999)

Table 12.1: Example for Sustainability Forecast Criteria and Sustainability Performance Indicators

Furthermore, some examples for *Trend Indicators (TI)* are given. TI are sustainability indicators, which do not reflect the performance of a product. They describe the state of agriculture and can be used to predict trends to which industry may react by adequate products. Agrobiotech industry also has an important influence on these indicators by their product strategy although its impact cannot be measured directly. Examples for TIs would be for instance % of farmers using soil conservation techniques or % of water consumption from irrigation/ global water consumption from ground water.

12.2. Indicator Selection

12.2.1. General aspects

Some indicators, presented in Paragraph 12.3, are collected from different sources about sustainability assessment and sustainability performance evaluation. These indicators are referenced and key sources are listed in the Annex (page 156). The other ones are created for this specific purpose.

Furthermore, it has to be emphasised that the proposed indicators are a first choice. For utilisation in the evaluation of a product they have to be refined, experts and stakeholders of industry have to be consulted and they have to be adapted to a certain product range.

This indicator set is mainly conceived for GM and non-GM crops. Most of the parameters could also be used to evaluate crop protection products.

12.2.2. Definition of Indicator Types

The sustainability indicators can be divided into *different classes* according to their evaluation aspect.

(1) *Condition indicators* measure a system's state (ecosystem or socio-economic system,…), e.g. soil erosion, biodiversity or product availability in less developed countries. System changes can be measured directly by condition indicators, but they often do not give information about the source or reason of change.

(2) *Impact indicators* aim to measure the effects of a product on a system. Since this is not always possible, impact is measured indirectly by *operation indicators*, e.g. amount of pesticide used, water use for irrigation, or size and distribution of fields. The draw back of operation indicators is that they often do not have a meaning by themselves. Assessing that a smaller amount of pesticide is applied does not mean anything, if effects on ecosystem quality are not known.

For this reason, especially for evaluating the impact of a product on the ecosystem both, condition and impact/ operation indicators have to be used. A further important aspect is that these two classes of indicators have to be studied over a certain time span in order to see trends and correlation between data e.g. pesticide application - ecosystem quality. Moreover, in order to determine the relative effect of a novel product, reference values of conventional products must be available.

(3) *Management indicators* are used to determine the effect of regulatory measures applied for stabilising the system state, reducing impact on system or improving product's traits, e.g. farmer education or multidisciplinary teams in product development.

(4) *Product trait indicators* evaluate directly different quality aspects of a product like nutrition value, allergenic or eco-toxicological potential.

(5) *Law indicators* point out when system development possibilities are restricted by legislation, for instance compliance with Biosafety Directive.

(6) *Success indicators* determine profitability and stakeholder acceptance of a product. Examples for indicators are level of trust or market share of product.

In the table below, symbols for pointing out indicator class are presented. (These are used in the Forecast and Performance Indicator section.)

Symbols	Indicator class
	Condition
	Operation/ Impact
	Management
	Product trait
	Law
	Success

Table 12.2: Indicator Symbols

In the Forecast and the Performance indicator list, it is also determined on what *scale* the sustainability indicators shall be applied. Most of them should be measured at a global scale and locally on a case study basis at different locations.

The time frame of performance evaluation is not indicated because too many factors like novelty of product, potential impacts, legislation,… are unknown. But some years have to be expected for a meaningful assessment.

12.3. Presentation of Indicators

12.3.1. Forecast and Performance Indicators

Note:
The indicators listed below are a first choice. For actual usage of the indicator system, the list has to be revised and a smaller set of indicators chosen. Furthermore, it has to be clarified, how criteria are weighed, evaluated (quantitatively or qualitatively) and aggregated.

Goal: Ensuring economic success for farmer and industry while serving society and rural communities

❖ ***Target: Ensuring long-term viability of business***

- Sub-target: Promoting global and local economic rural development while considering social structures

An economicly stable agricultural system is only possible if profits and life quality of farmers are ensured. Agrobiotech industry has influence on farmers' financial situation and indirectly on their lives and social activities.
Life quality of farmers is closely linked to their social environment, the rural community. Action of agrobiotech industry should be targeted at first, enhancing profits of farmers, second, promoting the local economy and third to promote social contacts in rural communities. The challenge of a responsible environmentally friendly agriculture is increasingly a social one. Collective action and knowledge sharing in rural communities can make an important contribution to progress in agricultural practices.

Class	Sustainability Forecast	Scale	Sustainability Performance
Social	(1) Product suitable and affordable for resource poor farmers	National	Market share in less developed countries Product price in country x/ monthly income of average farmer
Economic	(2) Potential increase of farmers' profit due to product's traits (e.g. potential productivity increase)	Global and Local	Yield/ hectare/ year Profit/ yield/ year Enhanced farmers' profit due to premium prices for environmental or/ and social performance of product Premium/ yield/ year Enhanced farmers' profit due to productivity increase/ Higher costs for new product
Social Economic	(3) Potential decrease of labour hours by product use ☺ ☹	Global and Local	Labour hours/ year in agriculture in country x Women's labour hours/ year in agriculture in developing countries Manual weeding hours/ harvest Employment level in local communities → Correlation ⇩ in labour hours – ⇧ unemployment in agriculture Jobs/ha (Savio, 1999)
Social/ Environmental	(4) Product influences agronomic criteria and farm practice in general ☺ ☹	Global and Regional	Change in number of planting Change in planting season Crop rotation Change in machinery use Change in size and distribution of fields Change in quality or storage capabilities (Raps et al., 1998) (Also see the section – environmental farm management)
Social/ Economic	(5) Product is creating dependency relations of farmers to industry (e.g. technology packages)	Global and Local	Access for farmers to alternative products and seeds Possibility to reuse seeds without extra costs Extra costs of product/ Profit Increase by product
Social	(6) Accompanying product strategies – Education of sustainable use of product for rural communities and creation of knowledge-sharing contacts	Regional and Local	Promotion of group dynamics/ collaboration in rural community (Savio, 1999) Awareness of sustainable agricultural practice of rural community (Also see the section – conservation/ recovery of ecosystem balance)

Table 12.3: Indicators for sub-target: Promoting global and local economic rural development while considering social structures

- Sub-Target: Meeting and exceeding needs and expectations of farmers, consumers and shareholders

Satisfying these three groups of stakeholders will determine business success of agrobiotech industry in the future.

Class	Sustainability Forecast	Scale	Sustainability Performance
 Economic	(1) Farmers' benefits: Product meets potential market demands/ will satisfy farmers' expectations	Global and Local	Level of satisfaction and trust Market share of product/ sales Number of complaints by farmers (due to products' deficiencies) Number of lawsuits with farmers Number of liability claims by farmers (due to product deficiencies) Informal feed back Reputation/ Image of company (view farmer)
 Social Economic	(2) Consumers' benefits: Potential decrease in food price due to future commercialisation of product Improvement of product's traits (e.g. in seeds) are relevant for consumers (e.g. enhanced vitamin content)	Global and Local	Actual decrease in food price Product tests (e.g. consumer organisations) (Stiftung Risiko-Dialog, 2000) Satisfaction of consumers/ target society (surveys) Demand for product/ sales
 Economic	(3) Shareholders' benefits: Increase in shareholder value by product	Global	Gained turnover/ profit/ market share due to product

Table 12.4: Indicators for sub-target: Meeting and exceeding needs and expectations farmers and consumers and shareholders

- Sub-Target: Considering strategic, financial and technological development factors

The business success of agrobiotech industry is dependent on what products are developed. Development costs are extremely high and development time is between ten to fifteen years. This means that not negligible financial risks are linked to the development of a novel product. For this reason product factors have to be considered at various checkpoints before and during the development process.

Class	Sustainability Forecast	Scale	Sustainability Performance
	Development outcome:		*Development outcome:*
 Economic	(1) Estimation of development risks of product (e.g. similar product is developed by competitor/ already on the market)	XXX	Actual development costs/ profit by product Gained turnover/ profit/ market share due to product
	(2) Development costs/ potential profits of product are considered		

	(3) Potential Patent for product (Stiftung Risiko-Dialog, 2000)		Award of a patent for the product
Economic	(4) Potential market share of product	Global and local	Actual market share (Gain of) qualitative market power (Stiftung Risiko-Dialog, 2000)
Quality	(5) Estimation of effectiveness of product traits (e.g. potential resistance capacity of Bt protein)	XXX	Actual quality product – desired traits have been realised
Usefulness of product	(6) Product can be used in the society or the environment to which it is targeted (e.g. Vitamin A in Vit. A enhanced rice can be assimilated by metabolism when fat free diet is consumed (common diet of poor people for whom this rice has been developed))	Target society or environment for product	Actual usefulness of product in a certain social or environmental background
Quality	(7) Estimation of biological activity of a product (e.g. pesticide) and ecotoxicological potential (e-mail, Dr. Diriwächter)	XXX	Actual activity of product and ecotoxicological potential
Biosafety	Limitations in product development due to regulatory framework (e.g. for GMOs)	Internat. and National	Permission for commercialisation of responsible authority
	Development process:		*Development process:*
	(8) Availability of know-how for product development	XXX	Reaching of development goals Quality/effectiveness of product
	(9) Multidisciplinary approach and collaboration in product development	XXX	
	(10) Checkpoint criteria for potential difficulties during development process	XXX	
	(11) Estimation of potential development time	XXX	Actual development time

Table 12.5: Indicators for sub-targets: Considering strategic, financial and technological development factors

❖ *Target: Respecting views and values of society*

- Sub-Target: Following corporate ethics principles

Being socially responsible is becoming a prerequisite for business success. For agrobiotech industry, the following issues are of major importance. First, ensuring food security by fair trade principles and acceptable product prices in less developed countries, second, remunerating less developed countries for active substances/ genes form their rainforests. Third, preserving basic rights for resource poor farmers, e.g. seed saving and fourth checking social and ethical implications of product.

Class	Sustainability Forecast	Scale	Sustainability Performance
 Social/ Ethical	(1) Product corresponds to the Code of Ethics of the company (2) Involvement of social scientists to assess ethical implications of a novel potentially controversial product (e.g. GMO)	Global Code of Conduct	Fewer problems for commercialisation of the novel product (e.g. GMO) Increased social benefits of product No ethically controversial products are sold
 Social/ Ethical	(3) Property right restrictions of product do not worsen radically social and economic situation of resource poor farmers and do not prevent development of less developed countries (Negative example: Terminator Technology)	Global Code of Conduct	Reputation Level of trust to industry in less developed countries Publications/ Press releases Pressure of NGOs concerned with less developed countries issues
 Social/ Ethical	(4) Fair trade principles and new product selling models are a product accompanying strategy	Especially in less developed countries	

Table 12.6: Indicators for sub-target: Following corporate ethics principles

- Sub-Target: Considering societal values (Study focus – European values)

The products that agrobiotech industry develops have an influence on the way people will live in the future. In the development of novel products, industry needs to take into account the multi-faceted demands of society.

Class	Sustainability Forecast	Scale	Sustainability Performance
 Economic  Social/ Ethical	(1) Views/ key values of society to which product will be potentially addressed are well known and understood in order to estimate usefulness and acceptability of product (awareness of societal differences between countries)	Different societies and cultures	Successful engagement of public New business ideas which satisfy needs and expectations of public
 Economic  Social/ Ethical	(2) Engagement of NGOs and public at an early phase of product development in order to reduce potential resistance at market release and gain knowledge about desired product traits	XXX	Reaction of NGOs to new product after commercialisation
 Economic/ Social	(3) Product corresponds to consumers' preferences	Different societies and cultures	Acceptance of food's taste and colour (e.g. yellow colour of Vitamin A rice)

 Economic  Social/ Ethical	(4) Key values of society are considered in product design and development	Different societies and cultures	Press releases Consumer acceptance/ boycotts of product Positive/ negative media statements Public trust to industry Gain of image and reputation Brand image
	(5) Adaptation of product to local needs (e.g. introduction of pesticide on a market can improve the environmental situation (less developed countries,…) or worsen it (Europe,…)	National and local	Comparison of environmental, social and economic performance of a product in different economic/social and environmental context
If the product is conceived for the EU market, following criteria should be considered (also see page 35, 56)			*Key values of European society*
 Economic  Social/ Ethical	(6) Perceived need for product	Europe	Press releases Consumer acceptance/ boycotts of product Positive/ negative media statements Public trust to industry Gain of image and reputation Brand image
	(7) Social and environmental benefits of product can be justified.		
	(8) Information about product (potential benefits)		
	(9) Right of product choice of public is not impaired		
	(10) Product fits in the image of 'clean', 'natural' and 'healthy'.		
	(11) Chemical use in agriculture is reduced by product.		
	(12) Product is ethically acceptable for EU public.		

Table 12.7: Indicators for sub-target: Considering societal values (Study focus – European values)

❖ *Target: Protecting and promoting human health*

- Sub-Target: Caring for food security of world population

Food production has to meet the needs of the growing world population.

Class	Sustainability Forecast	Scale	Sustainability Performance
 Social	(1) By using the product, agricultural productivity rate on a given surface can be potentially increased	Global and local	% Increase of productivity (yield/hectare/ year) on a given surface
 Social/ Economic	(2) Product contributes to reduction in harvest losses due to improved traits (GM crops, pesticides).	Global and Local	Actual harvest yields (% increase) Pest infests (% of crop loss)

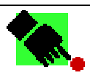
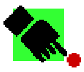
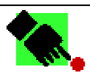
 Social/ Economic  Social	(3) A product management strategy is in place to promote food availability in less developed countries Criteria for strategy: - Local food self sufficiency of region - Self sufficiency of farmers - Seasonal food availability patterns - Availability of transporting infrastructure - Average 'food miles' of product from producer to consumer - % of goods/ labour/ services sourced locally (Savio, 1999)	Regional and local (first, on case study basis)	Local and regional self sufficiency Improvement of organisation of food supply (e.g. transport, storage, local trade, ...) Steady food supply over year

Table 12.8: Indicators for sub-target: Caring for food security of world population

- <u>Sub-Target</u>: Improving food quality and ensuring food safety (especially for GM and non GM crops)

Food quality has to be ensured and if possible improved.

→ *Marked indicators are only applicable to GM crops.*

Class	Sustainability Forecast	Scale	Sustainability Performance
 Quality	(1) Improvement of food quality by product - Product (GM crop) lacks common food allergens, thus cause less allergic reaction in population	XXX	Level of product allergenity compared to normal product
 Quality	(2) Product has an improved nutrition value (e.g. 'design' of GM crops with enhanced vitamin content (Vitamin A rice - Novartis)	XXX	Actual nutrition value and composition of product (also examined with plants grown under different environmental conditions)
	(3) Product will be compliant with legislation	Global and national	Product is actually compliant with legislation
 According to legislation	(4) Estimation of toxicological, allergenic, carcinogenic and mutagenic potential of product	Global and national	Compliance with - Toxicity - Allergenicity - Carcinogenity - Mutagenity Standards
	Food Safety of GM and non GM crop product:		
 Biosafety	(5) Product does not contain antibiotic and herbicide resistance genes for selection	XXX	Actual health effects Rise of food allergies Toxicity of product
 Biosafety	(6) Product can be compared with products already on the market stage	XXX	Actual health effects of GMOs (not documented yet):

 Biosafety	(7) Gene (product) used in product has already been in significant amount in food chain (if not – special care) (see below and estimation of allergenic and toxicological potential)	XXX	e.g. - Influence on immune system - Influence on digestive system - Influence on metabolism - Influence on cancer rate
 Biosafety testing	(8) Product has been passed or will pass following tests: - Biochemical characterisation of GM and non GM crops → Altered cellular regulatory mechanisms which lead to altered nutrition value or food properties - In vitro analytical tests for screening for known toxins and food allergens - In vivo feeding tests/ Human physiology tests → Test for unknown allergens and toxins and unpredictable interactions of regulatory or marker elements of transfer vehicle with metabolism	XXX	

Table 12.9: Indicators for sub-target: Improving food quality and ensuring food safety (especially for GM and non GM crops)

<u>Goal: Preserving the environmental basis of agriculture</u>

❖ *Target: Protecting and promoting ecosystem health*

- <u>Sub-target:</u> Conserving/ recovering ecosystem balance and development of strategies targeted at areas and resources at environmental risk

Ecosystem health has to be ensured and strategies have to be found to improve the ecosystem quality. It has to be taken into account that the ecosystem is a flexible network with various inter-relationships.

Class	Sustainability Forecast	Scale	Sustainability Performance
Management of biological circles and interconnections of ecosystems and protection of sources at environmental risk			
 Environmental  Environmental	(1) Product (combination or/ and accompanying services) takes into account natural cycles	Local (on case study basis)	Productivity (yield/ hectare/ time) Population trends of species which should be protected Reduced pest infests General improvement of ecosystem quality (see indicators below)
 Environmental  Environmental	(2) Product contributes to a higher production capacity on a given surface without destroying environmental base of agriculture (especially resources at environmental risk like soil and water)	Global and local (first, on case study basis)	- Soil balance: Soil loss rate/redeposition and soil forming processes Inherent soil quality (mismatch between soil capability and actual use) (OECD, 2000) % Increase of productivity (yield/hectare/ year) on a given surface) /% increase or decrease of soil erosion rate - % Increase of productivity (yield/hectare/ year) on a given surface) /% increase or decrease of water use Groundwater reservoir (liter) other water resources/ use in agriculture (liter/year) minus consummation for other purposes % of ground water use for agriculture → calculation if reduction of water use is enough to ensure water supply for the next generations (See single indicators in Improving Environmental Farm Management)
 Environmental	(3) Product contributes to a higher production capacity on a given surface without increasing the use of fertiliser, pesticide, energy and soil treatment	Global trend and local application	- % Increase of productivity (yield/hectare/ year) on a given surface) /% increase or decrease of energy use/ fertiliser use/ pesticide use/ soil treatment (See single indicators in Improving Environmental Farm Management)
 Environmental	(4) Product promotes reduction of chemical resistant species or prolongs time of resistance development	Global trend and local application	Spread of pesticide resistance relative to the time to develop a new pesticide (Meadow, 1998)
 Environmental	(5) Product positively interacts with the ecosystem (chemical, GM and non GM crops)	Global trend and local application	Effects on non targets pathogens and pests Effects on beneficial organisms and antagonists Effects on bees and other pollinators General effects on near flora and fauna

 Social/ Environmental	(6) Accompanying product strategies – like education in sustainable use of product	Regional and Local	Awareness of sustainable agricultural practice of rural community Attitude towards environmental friendly farming practices (change) % of farmers using more environmentally friendly farming practice (e.g. Conservation tillage, Integrated Pest Management)

Table 12.10: Indicators for sub-target: Conservation/ recovery of ecosystem balance and development of strategies targeted at areas and resources at environmental risk (1)

Biodiversity management			
 Environmental	(7) Product (combination or/ and accompanying services) promotes genetic crop biodiversity	Global and local (case study)	Number of crop varieties on farm per ha/time
 Environmental	(8) Product (and product accompanying measures/ services) potentially promotes biodiversity off site	Global and local (case study)	% of retreatment areas (hedgerows, ponds, non cropped areas)/ total area Size of connected biotopes and average natural evolution to anthropogenic species loss (Stiftung Risiko-Dialog, 2000)
 Environmental	(9) Product (and product accompanying measures/ services) will potentially influence population dynamics (on site and off site)	Global and local (case study)	Population trends of chosen widespread species (Raps et al., 1998) Population trends of indicator species by each habitat type (primary producers, pollinators, herbivores, carnivores → selection of indicator species) (Werner et. al., 2000)
			Changes in population density (Ammann et al., 1999): Decrease of number of indigenous species/ time unit (BATS) Population distribution (Werner et. al., 2000)
			Changes in population composition (Ammann et al., 1999): Number of wide spread species of a taxonomic unit (BATS) Competition/ suppression effects (Stiftung Risiko-Dialog, 2000) Change in predator-prey relationship by product (Stiftung Risiko-Dialog, 2000)
			Loss of function of ecosystems (Ammann et al., 1999): Population dynamic effects and impacts of bio-geochemical cycle (Stiftung Risiko-Dialog, 2000)
Management of ecosystem variety and variability			
Definition of: Variety: Many qualitatively different processes and patterns of environmental variables occur and appear in the environment constantly or intermittently. Variability: The state of the environment fluctuates around the normal environmental state in random ways, and the fluctuations may occasionally take the environment far from normal state. (Bossel, 1999)			

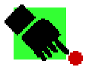
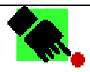
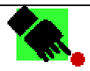
 Local strategy	(10) Adaptation of a product (combination or/ and accompanying services) to specific local environmental conditions	Regional and local	Actual adaptation to local conditions: Productivity (yield/ha/time) Environmental trends (see Improving Environmental Farm Management and Promoting/ Protecting Ecosystem Health) Variability of yields of product due to climate variability, due to ecosystem variety (e.g. soil composition) (also see rural development section → Adaptation of a product (combination or/ and accompanying services) to specific local social and economic conditions)
 Local strategy	(11) Germplasm of area of commercialisation is used (e.g. Local African germplasm is used for seeds that will be grown in Africa) for development of product (seeds) in order to ensure optimal adaptation to given environmental conditions	Regional and local	
  Environmental strategy	(12) Product (combination or/ and accompanying services) stimulates use of polycultures and optimised crop rotation	Regional and local	Actual use of polycultures and optimised crop rotation by farmers (customers)
 Local conditions	(13) Product (seed) is adapted to hostile conditions (e.g. water shortage, high temperature and drought)	XXX	Supplied water/ time → % of survival of crops/ total area Average temperature and min. and max. values → % of survival of crops/ total area

Table 12.11: Indicators for sub-target: Conservation/ recovery of ecosystem balance and development of strategies targeted at areas and resources at environmental risk (2)

- Sub-target: Improving environmental farm management and ensuring environmental safety of GM and non GM crops

Current farm practices have to be improved to reduce impact on the ecosystem.

- Side effects of pesticides on non-target organisms shall be reduced. Pesticides shall be substituted (whenever possible) by natural control mechanisms or/and pesticide resistant crops. Accumulation of pesticides in soil and food as well as escape to water shall be minimised.
- Novel crops which consuming less water shall reduce water usage for irrigation. Water input in agriculture shall be targeted by water management solutions.
- Energy balance in agriculture has to be improved. Energy supply form non-renewable resources has to be reduced.

Class	Sustainability Forecast	Scale	Sustainability Performance
		Pest management	
Environmental	(1) Estimation of pesticide risk (OECD, 2000) (if product = pesticide)	Global and local	Actual profile (tested in environment)on a large-scale basis
Environmental	(2) Product reduces the use of chemical substances (e.g. pesticides) and promotes use of less toxic substances	Global and local	Index of pesticide use (OECD, 2000) Pesticide use efficiency (technical/ economic) (OECD, 2000) Amount of pesticide applied per ha (Savio, 1999) Consideration of quantity and toxicity of applied pesticide Toxicity of pesticide - type applied (profiling, positive list, weighting factor) (Savio, 1999)
Environmental	(3) Product's traits reduce accumulation, mobility and distribution of chemicals (4) Biodegradability of product	Global and local	Concentration of pesticide residues in soil and ground and surface water (Ammann et al., 1999) Leaching of and runoff of pesticides to surface and ground water (Savio, 1999)
		Water management	
Environmental Environmental	(5) Product reduces water usage	Global and local	Amount of water used per ha or ton of product (irrigation) (Savio, 1999) % of water storage in soil
		Energy management	
Environmental	(6) Product reduces use of non-renewable and renewable energy in agriculture	Global and local	Actual reduction in energy use Balance: total energy input/ total energy output, including transport Energy input (Ammann et al., 1999) - Ratio renewable over non-renewable energy inputs
		Greenhouse Budget	
Environmental	(7) Product leads to less greenhouse gas emissions	Global and local	Balance: Emissions of nitrous oxide, methane and carbon dioxide from agriculture production systems/ adsorption of carbon dioxide by agriculture production system

Table 12.12: Indicators for sub-target: Improving environmental farm management (1)

Soil fertility has to be ensured by a balanced nutrient management and conservation/ restoration of soil ecosystem. Soil protecting farming methods shall prevent soil erosion.

Class	Sustainability Forecast	Scale	Sustainability Performance
Soil, nutrient and land use management			
 Environmental	(1) Product contributes to a reduction in soil erosion risk.	Global and local	Soil erosion (loss of top soil in percentage per annum or in t/ha/annum) (Savio, 1999)
 Environmental	(2) - Reduced risk of water erosion (AAFC, 2000) - Reduced risk of wind erosion(AAFC, 2000) - Reduced risk of soil compaction (AAFC, 2000) - Reduced risk of soil salinisation (AAFC, 2000) - Reduced risk of tillage erosion (AAFC, 2000)		Soil cover index (proportion of time soil is covered with crops) (Savio, 1999) Number of days per year when soil is left exposed under specific crop and land management regimes (AAFC, 2000) Crop rotation (Stiftung Risiko-Dialog, 2000) Crop cutting frequency (Stiftung Risiko-Dialog, 2000) Plants/square meter (Stiftung Risiko-Dialog, 2000) Mechanical soil stress(Stiftung Risiko-Dialog, 2000) Actual tillage frequency/ culture/ time
 Environmental  Environmental	(3) Change in physical, chemical and biological soil parameters due to product's influence - Effects on degrading organisms (e.g. earthworm) (Raps et al., 1998) - Effects on microbiotic (microbiell) diversity and chemical degradation conditions in soil (Raps et al., 1998) - Effects on specific indicator organisms (e.g. mycorrhiza, rhizobia) (Raps et al., 1998) - Effects on in soil living pathogens (Raps et al., 1998)	Global and local	Soil physics (Raps et al., 1998) Soil texture/ diameter (Raps et al., 1998) Water buffering capacity (quantity of water stored in soil) (OECD, 2000) Soil chemistry (Raps et al., 1998) Pollutant concentration (Raps et al., 1998) Nutrient concentration(Raps et al., 1998) Nutrient balance(Raps et al., 1998) Concentration of soil organic matter (C org) (Raps et al., 1998) Soil biology (Raps et al., 1998) Soil fertility (Stiftung Risiko-Dialog, 2000) Bioindicators (collemboles, eventually mycoflora) (Ammann et al., 1999) Number of beneficial organisms (e.g. earth worms)/ square meter (Savio, 1999) Number of predatory mites/ square meter (Savio, 1999) Number of beneficial microorganisms (e.g. rhizobium)/ square meter) (Savio, 1999) Number of pathogens in soil % of organic matter (fertiliser)/ hectare (Sustain, 2000)

Environmental	(4) Product reduces use of chemical fertiliser or/and stimulates efficient fertiliser uptake by plants (5) Product reduces the runoff of fertiliser from the land	Global and local	Soil surface balances of nitrogen and phosphorus (OECD) Farm gate nutrient balances (OECD, 2000) Balance on N/P/K over crop rotations (Savio, 1999) Nutrient use efficiency (technical, economic) (OECD) Concentration of nitrate, phosphor in soil, ground and surface water (Raps et al., 1998)
Environmental			Amount of inorganic N/P/K applied (per ha or per ton of product) (Savio, 1999) Proportion of N fixed on site/ imported (Savio, 1999) Amount of residual Nitrogen/ phosphorus Leaching of and runoff of N/P/K to surface and ground water (Savio, 1999)

Table 12.13: Indicators for sub-target: Improving environmental farm management (2)

Environmental Safety of GM and non-GM crops has to be ensured.

→*Marked indicators are only applicable to GM crops.*

Class	Sustainability Forecast	Scale	Sustainability Performance
	Management of GM and non GM plants		
Biosafety	(1) Compliance with legislation/ international biosafety protocol (Cartagena)	Global and local	Monitoring and review processes of product after commercialisation
Biosafety	(2) Product has similarities with already commercialised product	global	Reduced biosafety concerns of stakeholders Long term monitoring in the field in order to prove benefits/ disprove risks
Biosafety	(3) Application of new technologies in product development improving biosafety of GM crops (e.g. reduction in cross pollination capability)	XXX	
Biosafety	(4) Experience from environmental trials used in product development	XXX	
Biosafety	(5) Avoidance of antibiotic and herbicide resistance genes (GM)	XXX	
Biosafety	(6) Modelling, genetic/ biochemical characterisation in laboratory and environmental trials	XXX	
	Gene and Gene product and cultivated plant (Raps et al., 1998)		
Biosafety	(7) Potential stability of genotype and phenotype (Stiftung Risiko-Dialog, 2000)	Global and local	Actual stability of genotype and phenotype (Stiftung Risiko-Dialog, 2000)

	(8) Gene expression and stability of transgene (Raps et al., 1998)		Actual stability of gene expression and stability of transgene in the field under various environmental conditions
	(9) Potential position effects (Stiftung Risiko-Dialog, 2000)		
	(10) Potential pleiotrophic effects (Stiftung Risiko-Dialog, 2000)		Changed components, substances (Raps et al., 1998) Changed nectar production (Raps et al., 1998) Unusual observations in the field (Raps et al., 1998)
 Biosafety  Environmental	(11) Potential survival/ establishment and spread possibilities of plants (Stiftung Risiko-Dialog, 2000)	Global and local	Change in growth and outcrossing tendency ((Raps et al., 1998) Establishment of plants outside the field
	(12) Invasion tendency in different ecosystems (Stiftung Risiko-Dialog, 2000)		
 Environmental  Biosafety	(13) Interactions with abiotic environment (Stiftung Risiko-Dialog, 2000)	Global and local	Amount of harvest waste (Raps et al., 1998) Degradation of gene product in harvested crops and harvest waste (Raps et al., 1998)
	(14) Accumulation of transgene/ gene product in the soil (Raps et al., 1998)		Degradation of gene product in soil (e.g. accumulation of Bt toxin in soil) (Raps et al., 1998) Degradation of DNA (Raps et al., 1998)
	Potential horizontal gene transfer of recombinant genes to microorganisms (Stiftung Risiko-Dialog, 2000)		Actual horizontal gene transfer of recombinant genes to microorganisms (Stiftung Risiko-Dialog, 2000)
Target organisms (Raps et al., 1998)			
 environmental  Pest resistance management	(15) Potential resistance and new virus development and management possibilities (Stiftung Risiko-Dialog, 2000) *only for crops with resistance ability*	Global and local	Time of resistance development (Stiftung Risiko-Dialog, 2000) (also see Pest management an Managagement of Biological Circles) Creation of new virus forms, enlargement of host circle (Raps et al., 1998) Pathogen-host relationship (Stiftung Risiko-Dialog, 2000) **only for crops with resistance ability*
Non – target organisms (Raps et al., 1998)			
 environmental	(16) Potential hybridisation and introgression of genes in indigenous mating partners	Global and local	Actual hybridisation and introgression of genes in indigenous mating partners
	(17) Potential transfer of transgene in ecosystem indigenous mating partners (Stiftung Risiko-Dialog, 2000)		Actual transfer of transgene in ecosystem indigenous mating partners (Stiftung Risiko-Dialog, 2000)

Table 12.14: Indicators for sub-target: Improving environmental farm management and ensuring environmental safety of GM and non-GM crops (3)

- Sub-Target: Determining environmental impacts of products (during life cycle)

Although the focus of the assessment has been put on the use of products in a Sustainable Agriculture, analysis of the product's lifecycle cannot be neglected. For instance, a product supporting Sustainable Agriculture might cause considerable negative environmental impacts during e.g. the production phase.

Class	Sustainability Forecast	Scale	Sustainability Performance
Soil, nutrient and land use management			
 Environmental	Estimation of product's impacts by comparing with similar already carried out Life Cycle Assessment	XXX	Life cycle assessment: Research and Development Processing of raw materials and productions processes Transportation (Use of product in agriculture) Disposal (on site/ in agriculture)
 Environmental	Maximisation the sustainable use of renewable resources Reduction of material intensity Reduction of water use Enhancement of material recyclability Increase of service intensity of goods and services	During Life Cycle	Consumption of water (Novo Nordisk Report, 2000) Amount of BOD in Water effluents Discharge of waste water (Novo Nordisk Report, 2000)
		During Life Cycle	Consumption of raw materials and packaging ((Novo Nordisk Report, 2000) Total amount of materials used Disposal of waste (of production processes Ratio of solid agricultural waste re-used/ recycled over solid waste disposed to landfill (Savio, 1999)
 Environmental	Reduction of energy intensity Maximisation the sustainable use of renewable resources	During Life Cycle	Consumption of energy (Novo Nordisk Report, 2000)
 Environmental	Reduction of dispersion of toxic substances	During Life Cycle	Air emissions (Novo Nordisk Report, 2000) Nutrification emissions Volatile organic Compound emissions Persistent Organic Pollutant Emissions Priority Heavy Metal emissions SO2/ NOx emissions Ozone depleting substances emissions Greenhouse gas emissions

Table 12.15: Indicators for sub-target: Determining environmental impacts of products (during life cycle)

12.3.2. Examples for Trend Indicators

Trend Indicators play an important role in the Sustainability Assessment, but are hard to grasp. The major difficulty is that products developed by agrobiotech industry have an indirect effect on environmental TIs like for instance on the % of endangered species/ % of native species or on the number of breaches of pesticide regulations in drinking water.

TIs are basically included in the SA, because industry can follow the trends to conceive appropriate products and to evaluate if novel strategies are successful. For instance, when Integrated Pest Management is a common practice of farmers, breaches of pesticide regulations for drinking water should be reduced.

Global Warming Trend
Global and local water usage/ quality pattern
Groundwater reservoir (liter) / per habitant consummation (liter/year) and use in agriculture (liter/year) (local)
% of water consumption from irrigation/ global water consumption form ground water
% of area transformed to agricultural land/ year
Availability of wildlife habitat or farmland (AAFC, 2000)
% of endangered species/ number of native species (Stiftung Risiko-Dialog, 2000)
% Farmers using soil conservation techniques
Number of breaches (legislation) of pesticide (agricultural) regulations and nitrate content of: 1. drinking water, 2. natural water (Sustain, 2000)

Table 12.16: Environmental trend indicators

Contextual indicators (OECD, 2000): - Covering land, population and farm structures - Changes in agricultural land use and land cover - Numbers of full time farmers - Numbers of types of farms
% Farmers living under subsistence level
% Closing farms/ time unit
% Farmers in Debts
Education of farmers' children/ country
Sources of income (%)
Relationship production costs/ consumer costs
Size of farms
Rural community's awareness of relevance of sustainable practices
Types of agricultural systems and distribution
% of working population by age in agriculture (organic / conventional / other) (Sustain, 2000)
Suicide rate of farmers (%)
Group dynamics/ Collaboration between farmers
% of goods/ labour/ services sourced locally (Savio, 1999)

Table 12.17: Rural development trend indicators

Enough food for human population - Population Growth (Rate)/ Global Productivity (Rate) - Global Productivity (rate)/% of Global Population living in subsistence conditions
Availability of food/country/ region/ year
Calorie uptake/ person
Composition of global/local diets
Global and local food production patterns/ Regions of over and underproduction
% of death and illnesses caused by lack of food/malnutrition and food poisoning
% of toxins, allergens, pesticide residues, nitrate in food (Stiftung Risiko-Dialog, 2000)
% of chemicals in food (Stiftung Risiko-Dialog, 2000)
Frequency of food allergies
Affordability of food (especially in less developed countries)
% of income spent on food
Prices of conventional and organic food (Sustain, 2000)
Local and national self sufficiency and independence
Scientific and social biosafety concerns of stakeholders
Number (or %) of food poisoning cases such as salmonella and E.coli. (Sustain, 2000)
Environmental trends (e.g global climate change (see trend env.)

Table 12.18: Food availability/ quality and safety trend indicators

13. System Review and Decision making

The Sustainability Assessment may provide support for decision-makers for critical decisions in product development and for evaluating the holistic performance of a product. The success of the SA in practice is dependent on its acceptance and actual usage in decision-making.

In the table below, some factors important for the usage of the SA in decision-making are presented.

Factors on which DM is based	Process factors	Challenges
Business focus/goals, Code of Conduct	Multidisciplinary approach (social scientists involved in DM)	Increasing complexity of decision making process
Experience of senior management		Compromise between secrecy about novel technologies/ products and transparency toward stakeholders
Information (by information system, cooperation, analysts...)	Internal formal and informal network structures between managers	Prolonged decision making time
Sustainability Forecast Criteria		Potential wishes of stakeholders to condition novel products and technologies
Results from Performance Evaluation of already commercialised products		

Table 13.1: Decision-Making

In the outline of the framework for the Sustainability Assessment a system review and Evaluation of the system by stakeholders is planned. This internal and external control shall ensure correctness and actuality of the Sustainability Assessment. Furthermore a process can be initiated to integrate sustainability elements into corporate strategy and institutionalise them.

From the managerial point of view, monitoring activities of the SA have to be organised. It has to be clarified how and when the system is reviewed and who will be responsible. In addition, indicators for a successful review process have to be created.

14. Further Development of the Sustainability Assessment

The outlined SA is a theoretical framework conceived for agrobiotech industry. For ensuring the actual usability of the system, it has to be further developed, refined (after all PE indicators) and adapted to industry's specific needs. It offers many opportunities like the improvement of stakeholder relations and the image of a company. But it also poses challenges, because the implementation of the SA requires change in management practice and creates costs.

14.1.1. Strengths and weaknesses of the proposed Sustainability Assessment

In the table below, strengths and weaknesses of the SA outline are discussed.

Strengths	*Weaknesses*
Many aspects of Sustainable Agriculture are considered in the proposed Sustainability Assessment. The SA is adapted to the needs of agrobiotech industry.	The SA provides only a very subjective view on the system.
The SA framework is flexible and easy to further develop. A broad spectrum of indicators has been provided, but targets and indicators can be easily replaced and new ones added.	No final indicator set has been chosen.
Indicators are divided in classes and the scale of indicator evaluation is determined. The indicator class could be an aid to aggregate indicators.	----------
SA is twofold. Sustainability requirements are examined before the commercialisation of the product and impacts are assessed after market release.	Data availability has not been examined because of lack of time. Especially the availability of reference data to compare already existing products with new ones has to be ensured.
SA takes into account stakeholders' values and needs.	SA has not been developed with stakeholder cooperation. Normally, such a system should be developed by participation of experts from multidisciplinary fields and stakeholder views have to be integrated.

Table 14.1: Strengths and weaknesses of the proposed Sustainability Assessment

14.1.2. Further development of the indicator system of the Product Evaluation

The actual usability of the SA is mainly dependent on indicator choice, weighing, aggregation and evaluation procedures.

Indicator choice is dependent on who is going to use the Sustainability Assessment – People involved in product research and development, strategic or issue managers, society, media and interest groups...

Moreover, it has to be defined at which scale a system is analysed – farm level (case study), community level, national level...
It has to be considered that the scales are interdependent and that the analysis can be linked to already existing national and international assessment systems

A further issue to consider is that indicators have to make sense and be measurable. Some indicators are meaningful, but can only be measured qualitatively and on a long-term scale like for instance the level of trust or group dynamics in rural communities. It is therefore hard to 'prove' to stakeholders that changes are occurring and that products or accompanying strategies have a positive influence on those parameters. Quite easily measurable and quantifiable parameters are in most cases not the most powerful indicators and do not indicate an actual improvement of the situation. For instance, a higher yield per hectare does not necessarily improve life quality of farmers or reduction in pesticide use does not implicitly mean an improved ecosystem quality. But, if approaching the core of the problem like ecosystem health or life quality of farmers, indicators are again not easy to measure as described in the first point. The art of creating good indicators is moving between targeting problems and being able to measure them.

Weighing and aggregation of indicators

The most difficult part of the assessment of environmental and social performance is the validation of the acquired information and its comparableness.

One difficulty is that objectively weighing indicators is simply impossible – how to judge if it is more important to increase farmers' life quality or to conserve biodiversity.

For this reason, a two-fold approach for weighing indicators is suggested.

First, the most important indicators are system viability criteria and consequently for agriculture carrying capacity indicators for the environment. Examples for viability indicators are "the rate of increase in resource use efficiency (matter, energy, information) relative to the rate of erosion of resource availability" (Bossel, 1999) or the time of spread of pesticide resistance in relation to the time to develop a new pesticide. (Meadow, 1998) A possibility of quantifying this approach is to calculate the ratio of rate of system response/ rate or system threat or respite/ response time. (Bossel, 1999)

In general, viability criteria ensure the further existence and balance of a system or the possibility to adaptation to changed conditions.

They have to be fulfilled to ensure the sustainability of the agricultural system. Thus those criteria have the same weight and are the basis of agriculture in the future.

Further weighing procedures have to be subjectively determined by integrating sustainable development goals of stakeholders. If for instance sustainable agriculture is linked for key stakeholder to the replacement of antibiotic selection markers or to the usage of biodegradable pesticides, these issues also have to be of high priority to agrobiotech industry.

The problem is to find one single indicator-set, because opinion on the relevance of indicators will differ between stakeholders and also within industry. A solution would be to develop different criteria sets with various stakeholders. While insurances might be more interested in risk criteria, food processors' major interest would health criteria. Key indicators of each indicator set could be aggregated to one index.

Other weighing procedures are applied by insurances. Weighing is applied according to risk statistics. If agrobiotech industry wants to cover as many stakeholder interests as possible, a statistic can be created to identify high priority issues of each stakeholder group. The weight will be applied according to results of the survey.

A further challenge is the quantification of indicators in order to conceive a sustainability index – monetary units can be hardly weighed up with in social and environmental sciences commonly used evaluation units. The question is how to transform pesticide application units in degrees of consumer satisfaction.

Opinions are divided on the aggregation of indicators. While some experts think that indicators have to be as much aggregated as possible in order to be comprehensible; others believe that the assessment looses too much information by this approach. Most experts in the field agree that different indicators cannot be combined into one number describing the sustainability-state of the system.

A viable approach would be to aggregate indicators in different classes. Easiest to measure are subjectively set sustainability goals or agreed level of satisfaction. For instance the replacement of an antibiotic resistance in a GM crop by a novel technology could meet the level of satisfaction of some stakeholders. In the case of pesticide application reduction, it seems to be useful to use the carrying capacity of the environment as a limit (if it is known). For example a viability criterion, linking pesticide application to ecosystem quality indicators might be used.

Participative Approach

According to the literature published about assessing sustainability, participation of experts and grass roots is necessary to choose indicators. People of different social and scientific backgrounds, world-views and political persuasion should participate in the indicator selection process. Science alone cannot provide appropriate indicators because the candidates for potential criteria are very large, while the indicator-set must be relatively compact. Hence there has to be an aid for selection, weighing and aggregation of indicators. (Hardi and Zdan, 1997), (Bossel, 1999)
According to Dr. Einsele, Head of Head Public Affairs at Novartis Seeds, Novartis wants to address especially the concerns of the Swiss public, food industry and large supermarket chains, which do not want to use GM crops. (Interview, Dr.Einsele The opinion of these stakeholders on indicator selection, weight and aggregation is therefore decisive.)

14.1.3. Action plan for the application of the Sustainability Assessment

The usability of the SA can be checked by a case study on a GM-product.

The core of the Sustainability Assessment, the Product Evaluation part, should be tested first. If the usability of the indicator system is demonstrated, it may be institutionalised and applied for every product. At this stage, the test-company should think of establishing a Product Development Support.

In the scheme below, four phases for further development of the SA are presented.

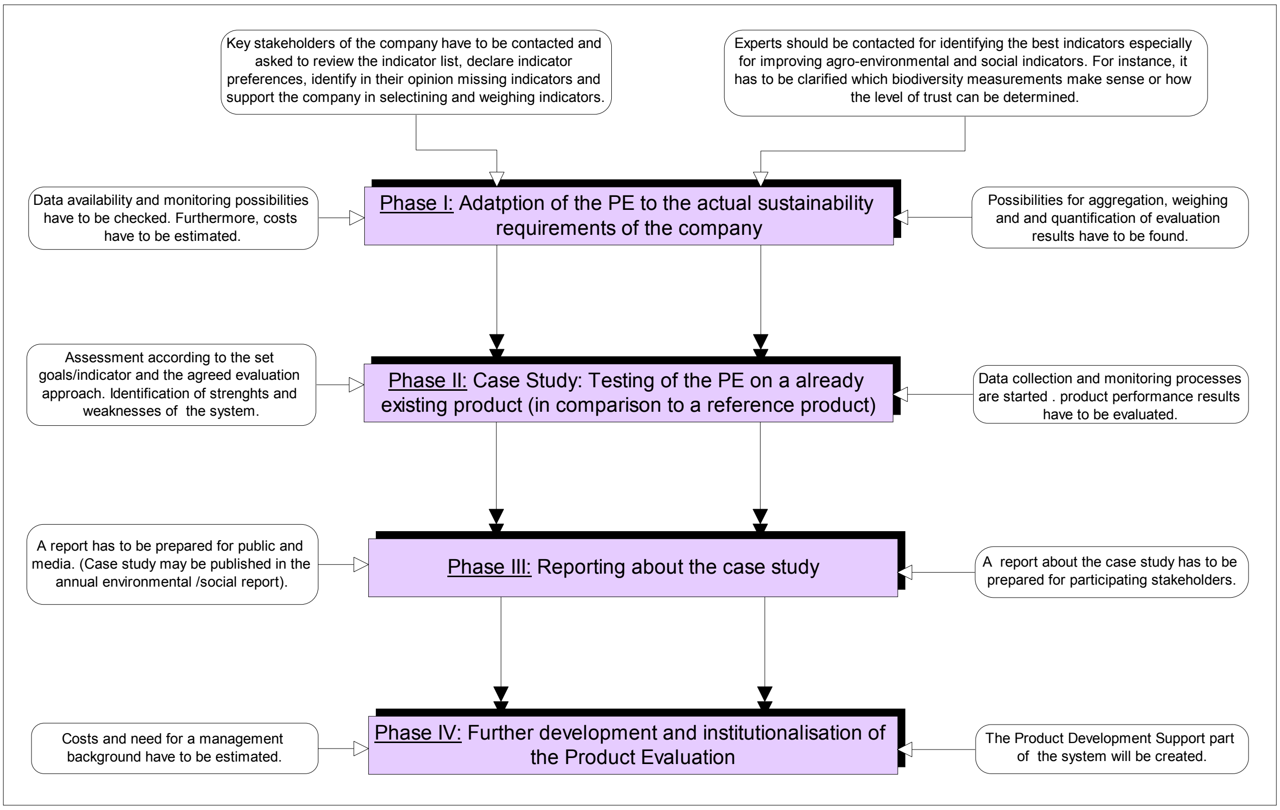


Figure 14.1: Action plan for further development of the Product Evaluation

In the first phase, the PE is adapted to actual sustainability requirements of the company. Targets and indicators are redefined with the aid of experts of different fields and stakeholders of the company. Moreover, data availability has to be checked.

In the second stage, the case study is started with the evaluation of one or several products of the test-company. Strengths and weaknesses of the PE are identified and in the third phase reported to stakeholders.

In the last step it is to decide if the PE met the expectations and if the SA shall be further developed.

SYNTHESIS OF THE RESEARCH PROJECT

In the synthesis, the results of the project are discussed, possible advantages of the ‘sustainability approach’ for agrobiotech industry reviewed and the potential use of the Sustainability Assessment for stakeholder engagement, product management and decision-making are shown.

15. Discussion of key results

15.1. Background of the European GMO debate

The legal and social climate in the European Union is not at all favourable for agrobiotech industry. Novel GM crops, highly profitable in the US, are viewed as threat to human health, the environment and life quality in general by the Europeans.

With the introduction of GM crops into the EU market, a debate about risks and benefits of GMOs has been initiated, which escalated and lead to an EU de 'facto' moratorium on GMO approval processes under the Release Directive 90/220/EEC in October 1998. Moreover, protests spread to Asia and swept back to the US, where GMOs had been commercialised without problems before.

Characteristics of the European GMO debate are that first, it moves in a never-ending circle, second, that the quantity of arguments is enormous, and third that most of them are not based on scientific facts.
Moreover, the discussion often suffers from a failure to differentiate between risks inherent in gene technology and those, which transcend it.
'Sustainable Agriculture' is used as a 'catch word' by GMO proponents and opponents to defend their philosophies and visions.

GMO opponents raise concerns regarding food safety, environment, intellectual property rights and less developed countries' economics. They also criticise the involved agrobiotech industry for too much emphasis on corporate profits and for neglecting risks of GMOs. (Thelen, 2000)

GMO proponents argue the opposite. They emphasize that transgenic crops will help to protect the environment, to improve food quality and to contribute to solve problems in less developed countries. (Thelen, 2000) GM crop supporters are convinced that the so-called 'Green Gene Technology' will improve agricultural practice. They argue that by cultivation of improved genetically modified crop varieties, it would be possible to apply fewer agrp-chemicals in a more targeted way, to anticipate harvest losses by pest resistant crops and to enhance nutrition value of vitamin or mineral poor plants. (Maeschli, 1998)

At the moment, there is only little evidence that already commercialised GMOs would have a negative impact on human and ecosystem well being. But serious and controversial scientific publications point out risks inherent in the novel plant biotechnology applications.

Weighing risks and benefits of the technology, it does not seem to be possible to predict what role GMOs might play in a Sustainable Agriculture.

In the proposed Framework for Sustainable Agriculture, technological development was identified as one of four key drivers for progress in farming systems.
For this reason, it is questionable if a strict ban for GM crops, promoted from some GMO opponents, is the right way to react to the novel technology.

But, GMOs and biotechnology as such are not the only cause for the communication difficulties in the European debate. Economic interests and deeply held values of the actors are the reason for the stuck and emotionally overheated discussion.

Economic motives of agrobiotech industry are evident. GMOs were, before the protests in Europe reached its height, the mega-deal of the century. In contrast, economic interests of industry's rivals are diverse. For instance, some GMO opponents want to satisfy the public by fighting industry and getting by this strategy more donors. Others produce test equipment for tracing GMOs in food.

However not only commercial motives, but also a lack of understanding of the world-views of the opposing side are a reason for the emotional debate.

Strong GMO opponents typically view nature as a living organism and for this reason, they promote organic agriculture. They are convinced that novel technologies would disrupt 'natural cycles' and they can hardly accept that making steps backward cannot solve the problems that have to be handled today.

Many life scientists and industry, the developers of GM crops, tend to see nature as a machine. Their thinking is influenced by in science common 'problem – solution approaches'. A trend in science in the last decades was to fight consequences and not causes. Moreover, problems were 'solved' without considering the complex regulatory mechanisms in nature. For instance, although it was known, that pest problems are often due to bad farm management practices, the 'just apply pesticides' approach was promoted by industry. Scientists closed their eyes to complicated ecosystem interactions and were not willing to view nature as a whole.

The path between the two realities would be to treat nature with respect, try to understand it and to integrate technologies in complex natural circles. Knowledge from different sources, scientific or not, should be tested and used.

The best way to support Sustainable Agriculture would be to avoid conflicts between 'modern' and 'organic' farming supporters. This is often difficult because world-views and political stance influence actors' way of thinking and argumentation patterns. However, further roundtable discussions do not make sense if the participants are not willing to make trade-offs and do not want to see a common basis.

15.2. Agrobiotech company's role in the GMO conflict and their efforts to contribute to a Sustainable Agriculture

GM herbicide, pest and virus resistant crops are novel products of agrobiotech industry and were an incredible financial success in the US.
The problems for agrobiotech industry started only with the introduction of GMOs into the European market. First protests against GMOs were ignored and the opinion of the European public was not taken seriously. For this reason, the situation escalated. Food processors refused to use GMOs due to consumer boycotts and US farmers decided for the year 2000 to grow non-GM crops to get premium prices from retailers. Even investors protested against the previously celebrated GM crops. As a consequence, shareholder value dropped and PR strategies initiated by agrobiotech industry to calm down the European public failed completely their goal.
Some experts even predict that agricultural gene technology could go the way of nuclear energy – falling out of favour because of public fears and unfavourable economics. (Mitsch and Mitchell, 1999), (Halweil, 2000), (Washington Post, 1999)

Today, the public is increasingly willing to use their consumer power to support their ethical and moral concerns. (Hutton, 2000) The GMO debacle in Europe demonstrates impressively that this novel consumer behaviour poses threats even to such powerful and financially strong international groups like Monsanto or Novartis. (Mitsch and Mitchell, 1999)

The biggest mistakes of agrobiotech companies in the reaction to public concerns were that they did not admit mistakes and even worse, made further promises that they could not held.

Moreover, industry tried to prove social acceptability of its products by scientific arguments.
Many questions in the GMO debate, which do exceed biosafety aspects of GM crops, cannot be answered by scientists. Science can only provide facts, estimations and models, but cannot interpret them as 'socially or ethically acceptable'. (Schulte and Kaeppeli, 2000) For instance, science cannot decide for society if environmental and societal benefits of a technology outweigh the risks.

Experts think that the main reason for agrobiotech industry's problems are that it would have no commitment to sustainable development and would introduce products aggressively into the market place without considering the opinion of a broader stakeholder community. (Montague, 1999)

The case study of Novartis shows that there is a strong will of change, but also insecurities about the way to target the problem and to implement new policies.
The company has a commitment to integrate sustainability principles in its business practice. The 'sustainability approach' is viewed as a moral obligation and a necessity for the long-term business success. (Interview, Dr. Diriwächter and Dr. Brassel, Dr. Einsele) But a framework supporting sustainability does not seem to exist in the company and the frequent consolidations are an unfavourable background for developing sustainability strategies.

Already organised activities promoting sustainability are often not recognised as such by the company.
For instance, agrobiotech industry is often accused for neglecting environmental performance of its products. But Novartis makes an effort to improve ecotoxicological product traits. Products have to meet a set of environmental criteria during the development process, otherwise they fall out of the research pipeline. Those criteria are not secret but nobody had the idea to publish them in order to refute at least untrue accusations. (Interview, Dr. Diriwächter and Dr. Brassel)

In general, sustainability is viewed from a global perspective by Novartis. Improved products shall improve farming worldwide. But it is not a common practice at the company to adapt products to specific needs at a local level and sell them together with farming services. The only established service of agrobiotech industry in Europe is Integrated Pest Management (IPM) supporting farmers to use chemicals in a targeted way.
Moreover, an amazing lack of knowledge about interests and reasons for mistrust of the public was observed. (Interviews, Dr. Brassel, Dr. Einsele and Dr. Diriwächter)
For instance, Novartis has a longstanding tradition in stakeholder processes with Applied Ecology Institutes or created on a case study basis 'technology baskets' adapted to specific local economic, social and environmental problems in less developed countries. These issues are not reported to a broader public. Instead, short PR stories and defensively written GMO statements can be found in the company's reports and on its Homepage.

The major problem of the current approach towards sustainability of agrobiotech industry is that social and environmental goals are often split off from financial affairs and treated independently.

That means social and environmental issues are not viewed as core business and do not seem to be considered in every day decisions.

15.3. Stakeholders' demands of industry

Agrobiotech industry promoted an intensification of agriculture, which lead on the one hand to an increase in productivity, necessary to feed a growing world population. On the other hand, it caused, by supporting this trend, damage to the ecosystem and also a disruption of social structures in rural communities.

European society mainly demands from industry to reduce technological forces on agriculture like pesticide use and to care for a sustainable society. The value of care for a sustainable society covers concerns over: the natural balance, the usefulness or necessity of the application of modern biotechnology, health, social dissipation and third world problems. For Europeans, the ideal product, that agrobiotech industry could produce must be 'clean', 'natural' and 'healthy'. (Bahrling et. al., 1999), (DG XI, 1999)

Societies in less developed countries have clearly other interests. Farmers are worried about the growing power of agrobiotech industry and limitations in seed saving. Stakeholders in less developed countries want agrobiotech industry to ensure food security by cheap products and by enabling agriculture under hostile conditions by novel drought resistance GM crops. Furthermore, scientists demand of industry technology transfer of novel molecularbiological techniques. (Wambugu, 1999), (Wafula, 1999)

The average farmer, the customer of agrobiotech industry's products, is not interested in environmental quality, as long as no acute environmental problems emerge. He seeks short-term profits and is not much concerned about the reduction of technological driving forces on the environment and the long-term conservation of the agro-ecosystem. He wants industry to produce cheap, but effective products. (Anderson, 2000), (e-mail, Dr.Diriwächter)

Agrobiotech industry has difficulties to meet the different demands of its stakeholders. For instance, novel GM pesticide resistant crops were very well accepted by US farmers, but found not useful or even dangerous by European consumers.
The industry's difficult task is now to develop products, which comprise agronomic as well as quality traits to satisfy both farmers and consumers.

To address developed and less developed countries by one product is a declared goal of Novartis. (Interviews, Dr. Einsele and Dr. Diriwächter) This might be a difficult strategy, because needs of societies are varying considerably.
While in Europe for instance the reintroduction of nearly extinct corn varieties might be viewed as useful, less developed countries are waiting impatiently for the development of drought resistance crops.

To be able to take into account the different stakeholders' demands, agrobiotech industry has to involve them in their business activities.
Current uniform and secret product development strategies are the wrong way to proceed in the future. Stakeholders have to be asked for their interests and an open dialogue has to be started. This approach would lead to a greater acceptance in society for novel products and would limit the development risk of industry.

In general, agrobiotech industry follows outdated approaches in stakeholder engagement. It does not seem to realise that not specific GM seeds are the heart of all problems, but the very low level of public trust. To tell people thousands advantages of GMOs and bring a million scientific arguments for the safety of GM crops do not make sense if nobody is going to believe them. In the case of GM crops, agrobiotech companies themselves, increased the protests and undermined their credibility by making promises they could not keep. Helplessness in addressing the public and fears to lose a key technology paralyse agrobiotech companies. They do not report their efforts and difficulties, but try to defend themselves by any means.

The most important fact that agrobiotech industry has to comprehend is not only to listen to stakeholders, but also to react to their demands. Jakob Nüsch, the former president of the Federal Institute of Technology in Switzerland, hits the nail squarely on the head by stating at the Novartis Roundtable in February 1998 that " you [Novartis] create a project and try to sell it to others – this you call dialogue. You should ask different people – even outside of Novartis – to participate even before you create a project". (Novartis Report, 1998)

15.4. Integrating the 'sustainability concept' in agrobiotech industry's business operations

Although opportunities enabled by the 'sustainability approach' are possible and a positive trend has been observed in the case study, the sustainability concept is not accepted as core business by agrobiotech companies.

But progress towards Sustainable Agriculture can be best promoted if sustainability principles are treated within the business unit. The opportunity is to combine economic, social and environmental goals, accept them as heart of the business and develop novel solutions in agriculture, which were unthinkable a few years ago.

Three basic characteristics for the realization of a sustainable agricultural system (see p. 21) have been identified. Actions have to take place on a *global as well as on local scale,* agriculture has to be viewed as a *multidimensional network* and *system dynamics and evolvement of the sustainability concept* need to be considered. (Reeves, 1998), (Legg, 1999), (UC Sustainable Agriculture Research and Education, 2000)

Agrobiotech industry has theoretically accepted Sustainable Agriculture principles, but started only a few activities to support them.

Agriculture is not regarded as a whole by industry. Only single problems are treated without considering the complexity of environmental interactions in the system. For instance, pest problems are fought by crop protection solutions. Agrobiotech industry makes an effort to reduce eco-toxicity of these products and promotes targeted use of them. The newest development are pest-resistant crops, which do reduce pesticide use. But the basis of these applications is a one-sided end of pipe approach like 'We have a pest problem, we have to fight it'. The alternative would be to follow a two-fold approach. On the one hand, agrobiotech industry has to continue selling crop protection chemicals and further reduce the application of pesticides after all in less developed countries. On the other hand, a goal for the future should be to correct causes, not consequences. Causes for the rapid spread and frequent pest infests are for instance monocultures and a low crop diversity.

Moreover, agrobiotech companies *follow the same product strategies* and cause therefore, negative changes in today's agriculture.
For instance, Novartis cannot be directly blamed for the low crop diversity that exists today in agriculture. However, by providing a very low product range it contributes to the trend. By selling maize producing the insect toxin Bt, they contribute to the highly unsustainable condition that

(Halweil, 1999) 30% of transgenic cropland is planted only with varieties resistant against a single toxin. By this approach, rapid pest development is a forgone conclusion.
Biotechnology and improvements in breeding techniques in general should not be used to develop a low number of 'supercrops', but to develop a wide range of new varieties with for instance differing resistance genes.

The business strategy of agrobiotech industry is in general conceived for a global scale.
First, a product is developed with improved agronomic or/and ecotoxicological traits, second, it is licensed and third the product is sold in high quantities on the global market place.
If for instance, the product promotes the use of fewer pesticides worldwide, a global progress towards sustainability can be reached. But industry's "one product for every location" approach is highly unsuitable for complex regional problems in agriculture. It has to be considered that environmental conditions for agriculture as well as the social and economic environment are variable in time and space.
Agrobiotech industry offers, in comparison to other companies with a better sustainability concept, very few services. Education of farmers and adaptation of products to local conditions happens on a case study basis. Only integrated pest management is an established service in Europe.
A chance for the future would be a reorientation to consulting services. Products and seeds could be viewed as building blocks combinable according to specific local needs of agriculture. Agrobiotech industry has to transform in the long-term its business focus from a chemical producer to a farm service provider.

A major difficulty for industry is to consider the *dynamics of sustainability* (in practice and as a concept). If agrobiotech industry reacts by developing a product to satisfy today's sustainability needs, the approach might be out of date after ten or fifteen years when the product is ready for commercialisation.
To face this challenge, agrobiotech industry has to handle all aspects of knowledge. Information and communication has been identified as driver for a sustainable agricultural system as well as an opportunity for industry to get a competition advantage. Moreover, the current weakness of agrobiotech companies to create partnerships and to engage stakeholders could be counteracted by new communication strategies.
To meet these challenges and transform it to chances, agrobiotech companies have to clarify what sustainability means for them and integrate the concept in its business activities. Clear goals have to be set, existing and new activities have to be coordinated and progress towards sustainability has to be measured and communicated continually.

15.5. Opportunities and challenges of the Sustainability Assessment for agrobiotech industry

It is as hard to evaluate a ‘sustainability approach’ as to catch the concept of ‘Sustainable Agriculture’, because first, it is not clearly defined. Second, efforts of companies to integrate the sustainability concept cannot easily compared with each other. Third, what might seem sustainable to a company is unsustainable for its stakeholders – this is especially true for GM crops.

In the case study, Novartis’ efforts to increase its social and environmental performance were evaluated. For this reason, management context and activities indicating social and environmental performance and stakeholder engagement of the company were examined. But this is only an indirect method to assess the ‘sustainability approach’ of a company.

The Sustainability Assessment would provide a direct way to evaluate the ‘sustainability approach’ of agrobiotech industry. The performance of a company’s product can be determined by means of a set of economic, social and environmental criteria. Moreover, a Code of Conduct for product development and information and communication tools are the basis of the assessment and ensure its proper functioning and regular update.

In order to avoid disagreements about the ‘sustainability’ of products with key stakeholders, they have to participate in the further development of SA criteria. Their opinion on weighing, aggregation and evaluation procedures is absolutely necessary.
The challenge of this approach is that stakeholders might have very different opinions on the importance of issues. Consequently, it will not be easy to develop a single set of weighed indicators.

It can be expected that the SA will not satisfy some stakeholders pointing out most critically industry’s weaknesses. A few pressure groups would appreciate industry to stay like it is, a stable and calculable target, which fits perfectly in the ‘bad guy’ image.
The company’s task is to find out its key stakeholders – the ones who have to be pleased by novel products and engage them.

The Sustainability Assessment could be also a first step of agrobiotech industry to a sustainability framework. If environmental and social performance of products is measured, it is obvious to use them in decision-making on novel products or activities. Moreover, product performance studies may reveal new business opportunities.

The question is if agrobiotech industry is ready for changes or if it has to encounter further difficulties until the executive management level perceives the need for a reorientation of the business focus.
At the moment, managers supporting a Sustainability Assessment might have problems to justify it within the company. The business philosophy of agrobiotech industry is not to actively change its attitude, but rather to avoid problems like liability claims, environment polluting accidents or consumer boycotts. That deeply rooted changes are necessary to prevent in the long-term these threats is not well understood.
For some managers in agrobiotech industry a Sustainability Assessment might not be worth the costs and they might not understand that short competitive disadvantages and financial losses have to be accepted in order to ensure the long term viability of business.

16. Conclusion

European consumer protests against GMOs demonstrate that agrobiotech industry has reached a turning point. Problems, misunderstood by industry as concerns about biosafety, reflect the mistrust and the dissatisfaction of society with current business practice.
It is now up to the agrobiotech companies to decide if they want to continue to do business as usual or to tread new paths.

The study demonstrates that agrobiotech companies have to change its business philosophy and to improve its stakeholder relations. They are moving slowly but surely towards a deadlock situation. If they do not gain the trust of the public, they will not be able to place further GM products on the European market, because consumers would oppose them anyway. They would probably not believe in proclamations of agrobiotech industry anymore, no matter how good their products might be.

For this reason, agrobiotech companies have to handle two major problems.
First, companies have to engage stakeholders in order to get to know their needs and demands. Moreover, they have to know their own ‘sustainability promoting activities’ and their weaknesses. Both has to be communicated to stakeholders along with strategies (not to confuse with hollow phrases) to improve the current situation.
A mutual approach to further develop the proposed Sustainability Assessment could serve first, as means for companies to get to know precisely values and views of key stakeholders. Second, stakeholders’ demands could be captured in the product evaluation system. The performance of agrobiotech industry’s products and their potential to satisfy stakeholders would become clear for

the first time. Moreover, the realisation of the SA would demonstrate the efforts of a company towards sustainability even if the results were not perfect.

The second task for industry is far more difficult. It has to change its business philosophy and its way to view agriculture. Agrobiotech companies have to accept that chemicals cannot solve every problem in agriculture and have to rethink their responsibility in the creation of a sustainable agricultural system.
Services and communication are often far more potential tools for promoting sustainability than products. A growing population and a worsening of the global environmental situation will increase the trend towards services and knowledge management in the future.

To accept these new sustainability-related business requirements and to integrate them in corporate strategies might not only cure current reputation problems, but also open unforeseen opportunities in the future.

ANNEX

In the annex, the bibliography, indexes of tables and figures as well as a glossary and abbreviations are provided.

1. Bibliography

1.1. References

AAFC (2000), *Measuring Sustainability with Indicators*, Report of the Agri-Environmental Indicator Project, Agriculture and Agri-food Canada, 2000

Download: Agriculture and Agri-food Canada:
http://www.agr.ca/policy/environment/sustainability/performance/indicators/aeireport.html
(5.6.2000)

AgBiowold (2000), *Food Safety Background Information and Reference Material*, 2000

Original reference:
FAO/WHO (1996), Biotechnology and food safety. Report of a Joint JAO/WHO Consultation. FAO, Food and Nutrition Paper 61, Rome Italy
Download: AgBioworld.com: http://www.agbioworld.org/articles/background1.html (1.9.2000)

Agenda 21 (1992), Earth Summit 1992 – The United Nations Conference on Environment and Development, Rio de Janeiro 1992

Download: United Nations Division for Sustainable Development:
http://www.un.org/esa/sustdev/agenda21.htm (30.6.2000)

Agriculture Directorate-General (2000), Agriculture Directorate General 2000 Overview,
Download: European Union Homepage: http://europa.eu.int/comm/dgs/agriculture/index_en.htm
(31.8.2000)

AIT (2000), *An Overview of Biotechnology*, American Resource Center 2000
Download: American Institute in Taiwan: http://ait.org.tw/ait/BG/bg0002e.htm (14.06.2000)

Albovias A.S. (1999), *Biosafety in the European Union: Current trends & legislation*, Final Project of European postgraduate programme in environmental management 1998/99, European Association of Management Education (EAEME)

Altieri M.A. and Rossett P. (1999(2)), *Ten reasons why biotechnology will not ensure food security, protect the environment and reduce poverty in the developing world*, Food First, Institute for Food and Development Policy October 1999
Download: Food First: http://www.fooodfirst.org/resources/biotech/altieri-11-99.html (15.7.2000)

Altieri M.A. and Rossett P. (1999), *Ten reasons why biotechnology will not ensure food security, protect the environment and reduce poverty in the developing world*, Food First, Institute for Food and Development Policy October 1999

Download: Food First: http://www.fooodfirst.org/resources/biotech/altieri-11-99.html (15.7.2000)

Original reference: Krimsky S. and Wrubel R.P. (1996), *Agricultural Biotechnology and the Environment: science, policy and social issues*, University of Illinois Press, Urbana

Amman K.et al. (1999), *6/6 Konzept und praktische Lösungsansätze zur ökologischen Begleitforschung, TA-Projekt Nachhaltige Landwirtschaft 1997 – 99*, Agency for Biosafety Research and Assessment of Technology Impacts of the Swiss Priority Programme Biotechnology (BATS), Basel 1999

Ammann K. (2000), *Towards precision biotechnology*, Botanical Garden, Univerity of Bern, Switzerland, Homepage Center for International Development at Harvard University

Download: Center for International Development at Harvard University (CID): http://www.cid.havard.edu/cidbiotech/comments/comments38.htm (10.7.2000)

Ammann K. and Papazov Ammann B. (1999), *Genetically Engineered Crops: How Could We Overcome the Present Day Obstacles in Europe?,* Background Paper, Forum - The Significance of Transgenic Plants for Developing Countries, Basel 1999

Anderson C.E. (2000), *Genetic Engineering:*, The Futurist, March - April 2000, pp. 20-25

Bahrling, D. et al. (1999), *The social aspects of food biotechnology: A European View*, Environmental Toxicology and Pharmacology 7, pp.85-93

Betts K.S. (1999), *Growing evidence of widespread GMO contamination*, Environmental News 33, Issue 23, pp.484-5

Bossel H. (1999), *Indicators for Sustainable Development: Theory, Method, Applications*, A Report to the Balaton Group, International Institute for Sustainable Development (IISD), Canada 1999

Download: The International institute for Sustainable Development (IISD): http://iisd.ca/about/prodcat/perfrep.htm#balaton (20.6.200)

Boulter D. (1995), *Plant Biotechnology: Facts and Public Perception*, Phytochemistry 40:1, pp. 1-9

Business Week (1999), *The Next Bottom Line - Agenda for the 21st century*, Special Advertising Section, Business Week May 3, 1999

Business Week (2000), *"Rocky Grounds for Monsanto",* Business Week June 12, 2000
Download: AG Biotech Infonet: http://www.biotech-info.net/decades.html (15.6.2000)

Carta Nova Novartis (2000), Novartis Crop Protection Homepage
Download: Novartis: http://www.cp.novartis.com (8.6.2000)

CEC (1997b), *The Europeans and modern biotechnology*, Eurobarometer 46.1, European Commission, Luxembourg 1997

CEC (2000), *The Europeans and Biotechnology*, Eurobarometer 52.1, Directorate General for Research Directorate B – Quality of Life and Management of Living Resources Programme, Luxembourg 2000

COM (1999, 22 final), *Directions towards Sustainable Agriculture*, Communication from the Commission to the Council; the European Parliament and the Economic and Social Committee and the Committee of the Regions, Commission of the European Communities, Brussels 1999
Download: European Union Homepage: http://europa.eu.int/comm/dgs/agriculture/index_en.htm (15.8.2000)

COM (2000, 20 final), *Indicators for the Integration of Environmental Concerns into the Common Agricultural Policy*, Communication from the Commission to the Council and the European Parliament, Brussels 2000
Download: European Union Homepage: http://europa.eu.int/comm/dgs/agriculture/index_en.htm (15.8.2000)

Commandeur P. et al. (1996), *Public debate and regulation of biotechnology in Europe*, Biotechnology and Development Monitor 26, pp. 2-9

Council for Biotechnology Information (2000), Homepage – *World Food Supply*
Download: Council for Biotechnology Information: http://www.whybiotech.com/main.html (6.5.2000)

Der Standard (2000), *Fast 40% des weltweiten Ackerbodens sind ausg*elaugt, Der Standard, May 5, 2000

DG Agriculture (2000), *A Synthesis - Economic Impacts of Genetically Modified Crops on the Agri-Food Sector*, Working Document, Directorate-General for Agriculture, 2000
Download: European Union Homepage: http://europa.eu.int/comm/dgs/agriculture/index_en.htm (31.8.2000)

DG Health and Consumer Protection (2000), *Facts on GMOs in the EU*, MEMO 00/43, Health and Consumer Protection Directorate-General, European Commission, Brussels 2000
Download: European union Homepage:
http://europa.eu.int/comm/dgs/health_consumer/library/press/press63_en.pdf (10.9.2000)

DG XI Environment - Nuclear Safety and Civil Protection (1999), *What do the Europeans think about the environment*, The main results of survey carried out in the context of Eurobarometer 51.1, European Commission

Dickson D. (1999), *GM crops a 'moral imperative' for Third World*, Nature World Conference on Science, Nature 1999, June 3, 1999

Douma W.T. and Matthee M. (1999), *Towards new EC rules on the Release of Genetically Modified Organisms, Genetically Modified organisms in the EC*, Volume 8, Issue 2, 1999, pp. 152-9

Duffy M. (1999), *Does planting GMO seed boost farmers' profits?,* Publication of Leopold Center
Download: Iowa farm business (copy from the Fall Publication of The Leopold Center Letter (Leopold Center: http://www.leopold.iastate.edu/)):
http://www.iowafarmbusiness.org/Articles/Current/Mike%20Duffy.htm (4.5.2000)

E*TRADE (2000), *Key ratios and statistics*, Profile Novo Nordisk and Novartis, last update 06/17/00
Download: E*TRADE:
http://www.etrade.com/cgi-bin/gx.cgi/AppLogic+ResearchStock (21.06.2000)

EFB (1997) *How can biotechnology benefit the environment?*, The report of a European Federation Task Group on Public Perceptions of Biotechnology/ the Green Alliance Workshop, 13th January 1997, London.

Egger P. (1998), *Nachhaltigkeit in Landwirtschaftlichen Entwicklungsprogrammen*, Proceedings Basler Forum Technik & Gesellschaft – Nachhaltigkeit – Ein Konzept ohne Inhalt?, Agency for Biosafety Research and Assessment of Technology Impacts of the Swiss Priority Programme Biotechnology (BATS), Basel 1998
Original Reference: CGIAR, Conway G. et al. (1994), Sustainable Agriculture for a Food Secure World

Embargo (2000), *Global study reveals new warning signals: degraded agricultural lands threaten world's food production capacity*, Embargo May 21, 2000

ERS (2000), *Biotech Corn and Soybeans: Changing Markets and the Government's Role, Economic Research Center*, 12th April 2000, United States Department of Agriculture

European Commission (2000), *Agenda 2000 - Strengthening the Union and preparing enlargement*, European Commission, 2000
Download: European Union Homepage: http://europa.eu.int/comm/agenda2000/index_en.htm (30.8.2000)

FAO (2000(1)), *FAO Statement on Biotechnology*, Homepage Food and Agriculture Organization (FAO) of the United Nations, 2000
Download: Food and Agriculture Organization: http://www.fao.org/biotech/statement (30.8.2000)

FAO (2000(2)), *FAO stresses potential of biotechnology but calls for caution*, Press Release 00/17, Food and Agriculture Organization (FAO) of the United Nations, 2000
Download: Food and Agriculture Organization:
http://www.fao.org/WAICENT/OIS/PRESS_NE/PRESSENG/2000/pren0017.htm (30.8.2000)

FOE (2000), *Legislation covering GMOs*, Friends of the Earth 2000
Download: Friends of the Earth: http://www.foeeurope.org/halt-gmo-pollution/90220/legislation.htm (16.6.2000)

Fortune (2000), *"Is Monsanto's biotech worth less than a hill of beans?"*, Fortune 141- 4, February 21, 2000
Download: AG Biotech Infonet: http://www.biotech-info.net/decades.html (15.6.2000)

Ganguly S. (2000), *From the Bengal Famine to the Green Revolution*, India Onestop
Download: India Onestop: http://www.indiaonestop.com/Greenrevolution.htm (4.7.2000)

Gartland K. and Gartland J. (2000), *The European Debate on GM Food Crop Safety*, Plant Biotechnology Research Group, University of Abertay Dundee, Scotland
Download: Biotrend: http://www.biotrin.cz/enpages/gartland.htm (28.6.2000)

Global Crop Protection Federation (1999), *Sustainable Agriculture – Some Contributions of GCPF member companies and associations*, Global Crop Protection Federation, Brussels 1999

Guardian (1999), *Europe's largest bank warns world's top investors to sell shares*, August 25, 1999

Halweil B. (1999), *The emperor's new crops*, World Watch Institute, Washington 1999
Download: World Watch Institute: http://www.worldwatch.org (10.7.2000)

Halweil B. (2000), *Portrait of an industry in trouble*, Worldwatch News Brief, World Watch Institute, Washington 2000
Download: World Watch Institute: http://www.worldwatch.org/alerts/00217.html (10.7.2000)

Hardi P. and Zdan T. (1997), *Assessing Sustainable Development – Principles in Practice*, International Institute for Sustainable Development (IISD), Canada 1999
Download: The International institute for Sustainable Development (IISD): http://iisd.ca/pdf/Bellagio.pdf (21.4.200)

Holdren J.P. et al. (1995), *The Meaning of Sustainability: Biogeophysical Aspects*, distributed for the United Nations University by The World Bank Washington, D.C., 1995
Original reference:
IUCN (1991), Caring for the Earth: A Strategy for Sustainable Living. With the United Nations Environment Program and the World Wildlife Fund. Gland, Switzerland 1991

Hund A. (1999), *Monsanto: Visionary or Architect of Bioserfdom? A Global Socio-Economic Examination of Genetically Modified Organisms*, 1999

Download: Communications for a Sustainable Future: http://csf.colorado.edu/ecol-econ/99/msg01271.html (24.5.2000)

Hutton W. (2000), *Society bites back*, SustainAbility Monthly Review, March 2000

Download: SustainAbility: http://www.sustainability.co.uk/monthly-review.htm (19.7.2000)

IISD (1999), Workshop report: *Beyond delusions: A science and policy dialogue on designing effective indicators for Sustainable Development*, 26th June draft version, International Institute of Sustainable Development, 1999
Download: International Institute of Sustainable Development: http://iisd.ca/measure/scipol (12.5.2000)

Independent (2000), *Big US firms face investors' revolt over GM food*, Independent February, 15 2000

Irvine R.S. (2000), *'Netwarriors' fight way to top in corporate PR*, O'Dywer's PR Services Report 14:5, May 2000

Download: ePublic Relations™ Ltd.: http://epublicrelations.org/Odwyerarticles.pdf (3.7.2000)

Jessen A.C.(2000), *Regulation of GMOs: Food Safety or Trade Barrier?,* Delegation of the European Commission to the US, Washington DC 2000
Download: The European Union Policies and Legislation:
http://www.eurunion.org/legislat/gmoweb.htm (16.6.2000)

Joly P.B. and Lemarié S. (1998), *Industry Consolidation, Public Attitude and the Future of Plant Biotechnology in Europe*, INRA/SERD Université de Grenoble, 1998

Download: Agbioforum: http://www.agbioforum.org/vol1no2/joly.html (30.8.2000)

Kaeppeli O. and Schulte E. (1998), *Bio- und Gentechnologie II*, pp. 69-71, vdf Hochschulverlag AG an der ETH Zürich, Zürich 1998

Kaeppeli O.(2000), *Technology Assessment in the Business community and for the Business Community: A international comparison*, Draft, will be published in Länderstudie Schweiz, 2000

Krishnakumar A. (1999), *A scientific conundrum – The controversy surrounding genetically modified organisms gathers monumentum*, Frontline 16:3. January, 30 – February, 12 1999

Legg, W. (1999), *Sustainable Agriculture: An economic perspective*, Policies and Environment Division, Agriculture Directorate, OECD
Download: OECD: http://www.oecd.org//agr/News/cont-8.htm (12.5.2000)

Levidow L. et al. (1996), *Library: Environmental risk disharmonies of European biotechnology regulation*, Centre for Technology Strategy, Open University, Milton Keynes MK7 6AA, UK
Download: Biosafety Information Network and Advisory Service (BINAS):
http://www.bdt.org.br/binas/Library/cabi/levidow.html (20.05.2000)

Macilwain C. (1999), *Developing countries look for guidance in GM crops debate...*, Nature 401, pp.831-2

Maeschli, C. (1998), *Fachstudie Das Leitbild Nachhaltigkeit – Eine Einführung*, TA – Projekt Nachhaltige Landwirtschaft, Agency for Biosafety Research and Assessment of Technology Impacts of the Swiss Priority Programme Biotechnology (BATS), Basel 1998

Mathew D. (1998), *The new business case for profit with principles*, Director New Academy of Business, Bristol, UK 1998
Download: New Academy of Business: http://194.207.162.41/pages/9-2c.asp (27.4. 2000)

Maxeiner D. and Miersch M. (2000), *Lexikon der Öko-Irrtümer – Fakten statt Umweltmythen*, Chapter Landwirtschaft, pp. 211-237, Piper Verlag GmbH, München, 2. Edition

Maxeiner D. and Miersch M. (2000, 2), *Lexikon der Öko-Irrtümer – Fakten statt Umweltmythen*, Chapter Gentechnik, pp. 57-74, Piper Verlag GmbH, München, 2. Edition

McIntosh M. et al. (1998), *Corporate Citizenship*, pp. 83-183, Financial Times Pitman Publishing, Great Britain 1998

Meadows D. (1998), *Indicators and Information Systems for Sustainable Development*, A Report to the Balaton Group, The Sustainability Institute, September 1998

Download: The International institute for Sustainable Development (IISD): http://iisd.ca/about/prodcat/perfrep.htm#donella (15.5.200)

Millstone E. et al. (1999), *Beyond 'substantial equivalence'*, Nature 401, pp. 525-6

Mitsch F.J. and Mitchell J.S. (1999), *DuPont, Ag Biotech: Thanks, but no thanks*, Deutsche Bank June 12, 1999

Montague P. (1999), *"More on the natural step",* Rachels Environment and Health Weekly September 16, 1999

Download: AG Biotech Infonet: http://www.biotech-info.net/decades.html (15.6.2000)

Multinational Monitor (2000), *Biotech Futures - The View from Wall Street*, Volume 21, Number 1 & 2, January/February 2000

Download: WWW.Essential.Org: http://essential.org/monitor/mm2000/mm0001.07.html (30.6.2000)

Murphy S. (1999), Market Power in Agricultural Markets: Some issues for developing countries, South Centre, Geneva, 1999

Download: South Centre: http://www.southcentre.org/publications/ (30.6.2000)

Nafziger E.D. (1999), Questions and Answers about GMOs, Crop production Extension Department of Crop Sciences, University of Illinois, 1999

Download: Kentucky American Seeds, Inc.: http://www.kentuckyamerican.com/kyamerican/GMO.htm (29.6.2000)

NGO Steering Committee (2000, 1), *World Trade, Food production and the Diverse Roles of Agriculture*, NGO Background Paper, A Discussion Paper for the Attention of Delegates to the Intersessional Meeting of the Commission for Sustainable Development (CSD8), NGO Steering Committee to the United Nations Commission on Sustainable Development, 2000

Download: NGO Steering Committee to the United Nations Commission on Sustainable Development: http://www.igc.org/csdngo/ (13.8.2000)

NGO Steering Committee (2000, 2), *Is it worth defending the concept of multifunctionality in agriculture?*, NGO Background Paper, Contribution of Solagral to the Intersession of the Commission for Sustainable Development (CSD8), NGO Steering Committee to the United Nations Commission on Sustainable Development, 2000
Download: NGO Steering Committee to the United Nations Commission on Sustainable Development: http://www.igc.org/csdngo/ (13.8.2000)

Novartis (2000), Novartis Homepage, Who we are
Download: Novartis Info: http://www.info.novartis.com/weare/index.html (14.5.2000)

Novartis Foundation (2000), *Das Engagement von Novartis für Nachhaltige Entwicklung*, Novartis Stiftung für Nachhaltige Entwicklung (NSNE), 2000
Download: Novartis Foundation for Sustainable Development: http://www.foundation.novartis.com/german/novartis_nachhaltige_entwicklung.htm (3.6.2000)

Novartis Foundation Mission (2000), Welcome to the Novartis Foundation for Sustainable Development Online, Novartis
Download: Novartis Foundation: http://www.foundation.novartis.com/nfhome.htm (27.6.2000)

Novartis Report (1998), *Health, Safety and Envrionment Report 1997*, Corporate HSE, Novartis International AG, Basel, Switzerland
Download: Novartis Info: http://www.info.novartis.com/hse/dialog/publications.htm (27.5.2000)

Novartis Report (2000), *Innovation and Accountability - 1999 Health, Safety and Environment Report*, Corporate HSE, Novartis International AG
Download: Novartis Info: http://www.info.novartis.com/hse/dialog/publications.htm (27.5.2000)

Novo Nordisk (2000), Homepage
Download: Novo Nordisk: http://www.novo.dk (20.06.2000)

Novo Nordisk Report (2000), *Putting Values Into Action - Environmental and Social Report 1999*, Stakeholder Relation Department, Novo Nordisk
Download: Novo Nordisk: http://www.novo.dk (27.5.2000)

Nuffield Council on Bioethics (1999*), Genetically modified crops: the ethical and social issues*, Nuffield Foundation 1999
Download: Nuffield Foundation:
http://www.nuffieldfoundation.org/bioethics/publication/modifiedcrops/ (16.6.2000)

OECD (1993), *Environmental Indicators: Basic Concept and Terminology,* Background Paper Number 1, Paris: Group on the State of the Environment, Environment Directorate, Organization for Economic Co-operation and Development, Paris 1993

OECD (1997), *Environmental Indicators for Agriculture*, Organization for Economic Co-operation and Development, Paris 1997

OECD (2000), *Frameworks to Measure Sustainable Development,* An OECD Workshop, OECD Proceedings, Organization for Economic Co-operation and Development, Paris 2000

Overseas Development Administration (1995), *Guidance note on how to do stakeholder analysis of aid projects and programmes*, Overseas Development Administration, Social Development Department, 1995
Download: Oneworld: http://www.oneworld.org/euforic/gb/stake1.htm (14.05.200)

Parida A. (1999), *Issues and Perspectives of Transgenic Crops in the Asia-Pacific Region*, Background Paper, Forum - The Significance of Transgenic Plants for Developing Countries, Basel 1999

Raps A. et al. (1998), *2/6 Konzept und praktische Lösungsansätze zur anbaubegleitenden Forschung bei Einsatz transgener Kulturarten*, TA-Projekt Nachhaltige Landwirtschaft 1997 – 99, Agency for Biosafety Research and Assessment of Technology Impacts of the Swiss Priority Programme Biotechnology (BATS), Basel 1998

Reeves T.G. (1998), *Sustainable Intensification of Agriculture*, International Maize and Wheat Improvement Center (CIMMYT)
Download: CIMMYT: http://www.cimmyt.cgiar.org/about/SustInt.htm (1.7.2000)

Reuters (1999) *Du Pont/Monsanto could dominate farming for decades*, Reuters March 8, 1999
Download: AG Biotech Infonet: http://www.biotech-info.net/decades.html (15.6.2000)

Reuters (2000), *FOCUS-EU keeps moratorium on new GM crops,* Reuters World Report March, 9 2000

Rosset P. et al. (2000), *Lessons from the Green Revolution - Do We Need New Technology to End Hunger?*, Tikkun Magazine, March/Aril 2000
Download: Institute for Food and Development Policy:
http://www.foodfirst.org/media/opeds/2000/4-greenrev.html (4.7.2000)

Saad M.B. (1999), *Position Papers: Sustainable Agriculture - Food Security for Food-Insecure: New challenges and Renewed Commitments*, Centre for Development Studies, University College Dublin, Ireland 1999
Download: Earth Summit 2002: http://csdngo.org/agriculture/agr_paper.htm (7.6.2000)

Savio M. (1999), *The Role of Internal Communication in Defining Sustainable Agricultural Standards*, Final Project of European postgraduate programme in environmental management 1998/99, European Association of Management Education (EAEME)

Schulte E. and Kaeppeli O.(2000), *Nachhaltige Landwirtschaft und grüne Gentechnik*, Ergebnisse zum Forschungsprojekt, pp.51-82, Agency for Biosafety Research and Assessment of Technology Impacts of the Swiss Priority Programme Biotechnology (BATS), Basel 2000

Sehn (1998), The Precautionary Principle, The Science and Environmental Health Network (Sehn)
Download: Sehn: http://www.sehn.org/precaution.html (01.09.2000)

SoE (1995), *State of Environment Report 95*, Environmental Protection Authority New South Wales
Download: Environmental Protection Authority New South Wales:
http://www.epa.nsw.gov.au/soe/95/23_1.htm (10.05.2000)

Stiftung Risiko-Dialog (2000), *Nachhaltigkeit In Landwirtschaft und Ernährung: Differenzierte Standpunkte zum Bt-Mais von Novartis*, Zusammenfassender Bericht des Dialogprojekts und der Anwendung der Methode Product Sustainability Assessment, pp. 1-46, Stiftung Risiko Dialog, St. Gallen 2000

Sustain (2000), *European Indicators, Results of a Project Seminar*, Sustain – The alliance for better food and farming, 2000

Download: Sustain: http://www.sustainweb.org/indicators/fir3.htm (10.6.2000)

The Campaign (2000), *News Updates*, The Campaign to Label Genetically Engineered Foods, 2000

Download: The Campaign to Label Genetically Engineered Foods: http://www.thecampaign.org/ (03.05.2000)

The Leasing Forum (2000), *Bt Corn Decisions*, January, 18 2000, University of Illinois

Download: The Leasing Forum: http://www.urbanext.uiuc.edu/champaign/leasing/2000_01.html (04.05.2000)

The Scotsman (1999), *GM firms top of ethical investors' black list*, The Scotsman, August, 31 1999

Thelen K.D.(2000), *Transgenic Crops*, Crop & Soil Sciences, Michigan State University Extension, 2000

Download: Michigan State University Extension: http://www.msue.msu.edu/valueadded/gmo's.htm (25.05.2000)

TransGen (1999), *Europäische Union: Zulassungsstop für gentechnisch veränderte Pflanzen*, Transparenz für Gentechnik bei Lebensmitteln. Das Online Informationssystem der Verbraucher Initiative, 1999

Download: TransGen: http://www.transgen.de/index2.html (16.6.2000)

UC Sustainable Agriculture Research and Education (2000), *What is Sustainable Agriculture?*, University of California, 2000

Download: University of California - Sustainable Agriculture Research and Education Program: http://www.sarep.ucdavis.edu/concept.htm (20.5.2000)

UNEP (1999), *Global Environmental Outlook 2000*, Division of Environmental Information, Assessment and Early Warning (DEIA&EW),United Nations Environment Programme

Download: GEO: http://www.grida.no/geo2000/index.htm (5.5.2000)

Wafula J.S. (1999), *Perspectives on Transgenic Crops Development and Use in Africa*, Background Paper, Forum - The Significance of Transgenic Plants for Developing Countries, Basel 1999

Wambugu F. (1999), *Why Africa needs agricultural biotech*, Nature 400, pp. 15-16

Washington Post (1999), *"Monsanto admits mistakes",* Washington Post, November 1, 1999
Download: AG Biotech Infonet: http://www.biotech-info.net/decades.html (15.6.2000)

WBCSD (1997), *Signals of Change - Business Progress Towards Sustainable Development*, World Business Council for Sustainable Development, Geneva 1997
Download: World Business Council for Sustainable Development:
http://www.wbcsd.ch/publications/signals.htm (23.4.2000)

WBCSD (2000), *Corporate Social Responsibility – making good business sense*, World Business Council for Sustainable Development, Geneva 2000
Download: World Business Council for Sustainable Development:
http://www.wbcsd.ch/publications/csr2000.htm (23.4.2000)

Werner A. et al. (2000), *4/6 Abschätzung der Auswirkungen transgener Sorten auf Umweltqualitätsziele*, TA-Projekt Nachhaltige Landwirtschaft 1997 – 99, Agency for Biosafety Research and Assessment of Technology Impacts of the Swiss Priority Programme Biotechnology (BATS), Basel 2000

WHO Food Safety Programme (2000), *Genetically Modified Foods in the 53rd World Health Assembly*, Food Safety Programme, Department of Protection of the Human Environment, Cluster on Sustainable Development and Healthy Environments (FOS/PHE/SDE),World health organization (WHO) 2000
Download: WHO: http://www.who.int/fsf/Gmfood/105thEB.htm (1.9.2000)

Wolfson R. (1998), *US Patent on New Genetic Technology Will Prevent Farmers From Seed Saving*, GENOTYPES, March 11, 1998
Download: Genetically Modified Food News 5.April 1998:
http://home.intekom.com/tn_info/rw80405.htm (2.8.2000)

World Commission on Environment and Development (1987), *Our Common Future*, Oxford University Press, Oxford, UK 1987

World Resource Institute (2000), *Disappearing Land: Soil degradation*, Sustainable Development Information Service (SDIS), World Resource Institute (WRI), 2000

1.2. Key Sources

1.2.1. Assessing Sustainable Development and Indicator Development

Blanchet C. (1999), *Les Indicateurs de Développement Durable (IDD),* Texte support de cours – Formation EAEME, Module : Environnement – Société – Développement : Concepts, principes, outils & méthodes, EPF Lausanne

Bossel H. (1999), *Indicators for Sustainable Development: Theory, Method, Applications*, A Report to the Balaton Group, International Institute for Sustainable Development (IISD), Canada 1999
Download: The International institute for Sustainable Development (IISD):
http://iisd.ca/about/prodcat/perfrep.htm#balaton (20.6.200)

Hardi P. and Zdan T. (1997), *Assessing Sustainable Development – Principles in Practice*, International Institute for Sustainable Development (IISD), Canada 1999
Download: The International institute for Sustainable Development (IISD):
http://iisd.ca/pdf/Bellagio.pdf (21.4.200)

Hardi P. et al. (1997), *Measuring Sustainable Development: Review of Current Practice*, Occasional Paper Number 17, International Institute for Sustainable Development (IISD), Canada Industry, Canada 1997
Download: Canada Industry: http://strategis.ic.gc.ca/pics/ra/op17-a.pdf (15.7.2000)

Meadows D. (1998), *Indicators and Information Systems for Sustainable Development*, A Report to the Balaton Group, The Sustainability Institute, September 1998
Download: The International institute for Sustainable Development (IISD):
http://iisd.ca/about/prodcat/perfrep.htm#donella (15.5.200)

1.2.2. Case Study Novartis

Carta Nova Novartis (2000), Novartis Crop Protection Homepage

Download: Novartis: http://www.cp.novartis.com (8.6.2000)

Novartis Report (1998), *Health, Safety and Environment Report 1997*, Corporate HSE, Novartis International AG, Basel, Switzerland
Download: Novartis Info: http://www.info.novartis.com/hse/dialog/publications.htm (27.5.2000)

Novartis Report (2000), *Innovation and Accountability - 1999 Health, Safety and Environment Report*, Corporate HSE, Novartis International AG
Download: Novartis Info: http://www.info.novartis.com/hse/dialog/publications.htm (27.5.2000)

Novo Nordisk Report (2000), *Putting Values Into Action - Environmental and Social Report 1999*, Stakeholder Relation Department, Novo Nordisk
Download: Novo Nordisk: http://www.novo.dk (27.5.2000)

Stiftung Risiko-Dialog (2000), *Nachhaltigkeit In Landwirtschaft und Ernährung: Differenzierte Standpunkte zum Bt-Mais von Novartis*, Zusammenfassender Bericht des Dialogprojekts und der Anwendung der Methode Product Sustainability Assessment, Stiftung Risiko Dialog, St. Gallen 2000

1.2.3. Genetically Modified Organisms

Schulte and Kaeppeli (2000), *Nachhaltige Landwirtschaft und grüne Gentechnik*, Ergebnisse zum Forschungsprojekt, pp.51-82, Agency for Biosafety Research and Assessment of Technology Impacts of the Swiss Priority Programme Biotechnology (BATS), Basel 2000

1.2.4. Sustainable Agriculture

Legg, W. (1999), *Sustainable Agriculture: An economic perspective*, Policies and Environment Division, Agriculture Directorate, OECD, 1999
Download: OECD: http://www.oecd.org//agr/News/cont-8.htm (12.5.2000)

Reeves T.G. (1998), *Sustainable Intensification of Agriculture*, International Maize and Wheat Improvement Center, CIMMYT, 1998
Download: CIMMYT: http://www.cimmyt.cgiar.org/about/SustInt.htm (1.7.2000)

UC Sustainable Agriculture Research and Education (2000), *What is Sustainable Agriculture?*, University of California, 2000
Download: University of California - Sustainable Agriculture Research and Education Program: http://www.sarep.ucdavis.edu/concept.htm (20.5.2000)

1.2.5. Study of European legal and social context

Albovias A.S. (1999), *Biosafety in the European Union: Current trends & legislation*, Final Project of European postgraduate programme in environmental management 1998/99, European Association of Management Education (EAEME)

Bahrling, D. et al. (1999), *The social aspects of food biotechnology: a European View*, Environmental Toxicology and Pharmacology 7, pp.85-93

CEC (1997b), *The Europeans and modern biotechnology*, Eurobarometer 46.1, European Comission, Luxembourg 1997

CEC (2000), *The Europeans and Biotechnology*, Eurobarometer 52.1, Directorate General for Research Directorate B – Quality of Life and Management of Living Resources Programme, Luxembourg 2000

1.2.6. Others

Business Week (1999), *The Next Bottom Line - Agenda for the 21st century*, Special Advertising Section, Business Week May 3, 1999

Halweil B. (1999), *The emperor's new crops*, World Watch Institute, Washington 1999

Download: World Watch Institute: http://www.worldwatch.org (10.7.2000)

Mitsch F.J. and Mitchell J.S. (1999), *DuPont, Ag Biotech: Thanks, but no thanks*, Deutsche Bank June 12, 1999

WBCSD (2000), *Corporate Social Responsibility – making good business sense*, World Business Council for Sustainable Development, Geneva 2000
Download: World Business Council for Sustainable Development:
http://www.wbcsd.ch/publications/csr2000.htm (23.4.2000)

2. Interviews and informal contacts

- Dr. Georg Diriwächter, Head of Issue Management, Novartis Crop Protection AG
- Dr. Jakob Brassel, Issue Management, Novartis Crop Protection AG
- Dr. Arthur Einsele, Head Public Affairs and Communication, Novartis Seeds AG
- Dr. Erika Ganglberger, Responsible for Pollutants, Gene technology, Agriculture and Renewable Energy, Applied Ecology Institute, Austria

The most important informal contacts have been: Dr. Kaeppeli (Head of BATS), working colleagues of BATS, Dr. Diriwächter (Novartis), Dr. Kaelin (Wintherthur Insurances) and 2 colleagues of the EAEME master course employed at Novartis.

3. Index of Figures

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5. Glossary

“Bacillus thuringiensis (Bt)” (DG Agriculture, 2000)

Bt is a soil bacterium that produces toxins against insects. Bt preparations are used in organic farming as an insecticide.

“Biotechnology” (DG Agriculture, 2000)

According to the draft Protcol on Biosafety, modern biotechnology means the application of:
- In vitro nucleic acid techniques
- Fusion of cells beyond taxonomic family that overcomes natural physiological reproductive or recombination barriers and that are not techniques used in traditional breeding and selection

Biotechnology and genetic engineering are often used interchangeably (see below)

“Bt maize” (DG Agriculture, 2000)

Bt maize is genetically modified to provide protection against the European Corn Borer.

“Cross Pollination” (Kaeppeli and Schulte, 1998)

Spread of genes in plant populations by pollen

“Gene” (Kaeppeli and Schulte, 1998)

Clearly defined hereditary DNA segment of a genome coding for one protein

“Gene Expression” (Kaeppeli and Schulte, 1998)

Transformation of the genetic information in a gene product (protein)

“Genetic Engineering” (DG Agriculture, 2000)

The manipulation of an organism’s genetic endowmnwt by introducing or eliminating specific genes through modern molecular biology techniques. A broad definition of genetic engineering also includes selective breeding and other means of artificial selection

“Genetically Modified (GM) or transgenic plant” (Nafziger, 1999)

GM or transgenic plant is defined as any genetic plant type that has had a gene or genes from a different species transferred into its genetic material using accepted techniques of genetic engineering.

“Genetically Modified Organism” (DG Agriculture, 2000)

An organism produced from genetic engineering techniques that allow the transfer of functional genes from one organism to another, including from one species to another.

“Genome” (Kaeppeli and Schulte, 1998)

The entire genetic material of an organism

“Germplasm” (DG Agriculture, 2000)

Germplasm is living tissue from which new plants can be grown. Germplasm contains the genetic information for the plant’s heredity make-up

“Herbicide Resistant Crops” (DG Agriculture, 2000)

The insertion of a herbicide tolerant gene enables farmers to spray wide-spectrum herbicides on their fields killing all plants. but the herbicide tolerant crops.

Nutraceuticals

Nutraceuticals are crops designed to produce medicines or food supplements within the plant

“Technology Assessment” (Kaeppeli and Schulte, 1998)

Methodology for analysis and evaluation of the impacts of a technology

6. Abbreviations

BATS	Biosafety Research and Assessment of Technology Impacts of The Swiss Priority Programme Biotechnology
Bt toxin	Bacillus Thuringiensis toxin
CAP	Common Agriculture Policy
CSR	Corporate Social Responsibility
DG	Directorate General
DSR Framework	Driving Force – State – Response Framework
FAO	Food and Agriculture Organization
GIS	Geographic Information System
GM crop	Genetically Modified crop
GMO	Genetically Modified Organism
HSE	Health Safety Environment
NGO	Non Governmental Organisation
OECD	Organization for Economic Co-operation and Development
PDS	Product Development Support
PE	Product Evaluation
PR	Public Relations
SA	Sustainability Assessment
SF	Sustainability Forecast
SP	Sustainability Performance
SWOT analysis	Strength – Weaknesses – Opportunities – Threats analysis
TI	Trend Indicator
UV radiation	Ultraviolet radiation
WHO	World Health Organization
WTO	World Trade Organization