# Handbook of Plant Biotechnology, 2 Volume Set

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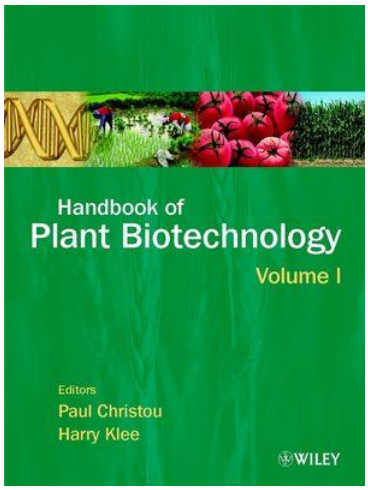


This important reference is the first work on Plant Biotechnology. Written by an international team of experienced researchers and professionals from both academia and industry, it will bring together the principles and practice of contemporary plant biotechnology to include:
* the techniques of plant genetic modification - applications of plant biotechnology, crop improvement in agriculture and a production system for pharmaceutical proteins
* ethics and safety issues - public perception, public relations, scale-up and testing, and legislation within the business of plant biotechnology.

## Part Nine: Risk Assessment of Transgenic Crops

# Factors Influencing Public Policy Development in Agricultural Biotechnology.

## The Way out of the Deadlock in the Biotechnology Debate

Klaus Ammann, Botanic Garden, University of Bern, and Biljana Papazova Ammann, Bern, Switzerland, Version with renewed original citations, all with full text links and with a new active contents list.

> ***Integral****: the word means to integrate, to bring together, to join, to link, to embrace. Not in the sense of uniformity, and not in the sense of ironing out all the wonderful differences, colors, zigs and zags of a rainbow-hued humanity, but in the sense of unity-in-diversity, shared commonalities along with our wonderful differences: replacing rancor with mutual recognition, hostility with respect, inviting everybody into the tent of mutual understanding. Not that I have to agree with everything you say, but I should attempt at least to understand it, for the opposite of mutual understanding is, quite simply, war. Wilber 2002, Boomeritis p. 15*

**Spanish translation by Maria Wright:**

http://www.ask-force.org/web/Wiley/Ammann-Factores-Influenc-2004.PDF with the old citations.

# Contents

# 1. The wider picture

Public Policy, a complex term, a complex situation - since public policy is influenced by so many different 'majorities' and 'minorities', is embedded in the development of human culture, science and art. We have to realize that public policy is influenced by a multitude of factors, with all its temporal and spacial complexity.

Let us commence with a statement: Biotechnology, developed by rapidly up-surging molecular sciences, has become a major factor in everybody's life. Biology, not long ago still the romantic science of rare animals and beautiful plants, has now definitely lost its innocence and needs to be looked at with concerned eyes, but also with a spirit of believing in the great potential in understanding life. This is why the problems connected with a technology derived from a not so innocent biology tend to be complex and are often embracing social components.

If we want to work for a positive social trend and for a transition from global inequity towards a humane world, we ultimately need to enhance the dialogue between knowledge, science and society in a world with its growing conflict potential. Knowledge is understood here as value laden and well experienced long term dimensions of cultural and social knowledge, which we will call from now on knowledge in a wider sence, knowledge sensu lato, short knowledge s.l.

It is obvious, that agricultural biotechnology is one of the centerpoints of the recent biotechnology debate. If we focus on one of the most neuralgic points, it is genetic engineering as a tool for modern plant breeding. It is clear that lay people have a fine-tuned anxiety on the new developments, and it is not only ignorance which makes them fearful. There is a big divide between lay people and scientists and between politicians and citizens, to name just two major divides. The important question is, how can we overcome divides of this dimension and what do we want to set as new policy goals in the appropriate time scales? Divides of this magnitude need resolution and new kinds of mediation, the reasons are important:

Recent developments have clearly shown, that between economics and conflict resolution there are tight connections. Terrorism as an element, which has often been present before 9/11 (you just have to recall the time of some libertarian anarchist's closeness to terror 150 years ago, http://flag.blackened.net/liberty/libertarians.html) has now become a global problem, since technology of logistics have facilitated new organizational structures, and – alas – also structures of new forms of violence on both sides. The third world war will be fought without frontiers, and it is not sure, whether it has already begun or not. Opinions about this are numerous and each one has its own rights, but here we want to look forward in a constructive way.

## 1. 1. Science and the public trust: the present state of error and the way out

The divide between science and morality (including e.g. public trust, value laden knowledge) is growing dramatically, there seems to be no control over the process any more. There is no way

to continue in scientific education of the public with the old and naïve didactics of the anonymous and depersonalized “IT-language” of science Wilber (1998). It is naïve to assume that “if the lay people would know more, they would not be afraid of future technological developments”. Resistance does not primarily come from the (lay)public’s unwillingness to learn, it stems from people’s uneasiness of experiencing science as the sole explanation ideology in modern life. Many people have the definite feeling that biotechnology will intrude into all sectors of their personal life and fear that nobody is going to ask them whether they accept it or not. The debate about transgenic food is a classic example: people feel threatened by the fact that in many countries they do not have the free choice between GM and non-GM-food, and this might be the major reason for the reluctance to accept the fact, that genetic engineering is taking over in modern breeding all-together. There is actually no inherent scientific reason why modern plant breeding should not make maximum profit from all kinds of molecular methods, including genetic engineering. But with this uneasiness entrenched in everybody’s thinking, people are all too easily convinced that there might be something wrong with GM food, although the facts tell us the contrary. The problem here is that many people correctly sense that scientific facts are not the sole element in the debate. Indeed, facts alone, that is, without their social and cultural context, cannot be the ultimate convincing argument; besides this, facts can be filtered and manipulated. When it comes to finding solutions, it would be wise if we all obeyed the rule of the ‘symmetry of ignorance’ Fischer (2001, Fischer, Ehn, et al. (2002), Rittel and Webber (1973, 2005) and especially to take into account emotions and interests. Real world design problems transcend the knowledge of individuals and specific groups. All participants who have a stake in the design activity should be able to contribute their knowledge. Symmetry of ignorance can also be defined the opposite way as asymmetry of knowledge.

How dare we pretend that experts know more than lay people involved in such debates, when those experts are imprisoned in their IT-language cage? This is the moment to realize and admit our common ‘symmetry of ignorance’ when we tackle social issues.

If scientists do not learn to respect the realms of non-scientific knowledge, they will indirectly build up public resistance to the very science that they are preaching; the irony of this situation is somehow hilarious and tragic at the same time. A dialogue between incompatible languages in the spheres of science and morality in modern and postmodern times needs to start from a well-defined base as concerns some important issues:

In order to bridge these various languages we have to attempt to integrate truth (science) and meaning (morality) in society. At the same time, we have to understand both the good and the bad news of modernity and postmodernity if we want to use the crutches of the social history of the last two centuries. We should be conscious, that equating truth to science and morality to society is a very problematic issue ever since philosophers such as Hans-Georg Gadamer, historians of science such as Thomas Kuhn, or the various authors that write within the broad field of the ‘sociology of science’ or ‘science, technology and society’ (Bruno Latour, Harry Collins, etc.) have shown the entanglements of science in society (that is, science is not free of passions and interests, just as morality is informed by the accoutrements of science, personal communication G. Verschoor).

The good news of modernity are liberal democracies, emancipation, democratization of knowledge, higher living standards, steadily growing life expectancy due to a highly successful fight against diseases. The bad news is the widespread loss of meaning in social and personal life Spretnak and Collins (2002?), a growing loss of life quality in social and cultural sectors, a brutalization of daily life, the loss of family love, growing drug problems, or all the ingredients leading to neglect through affluence (German Wohlstands-Verwahrlosung).

The good news of postmodernity indicates the new importance of the role of interpretation in human understanding, a renaissance of the we-language developed in art and now hopefully instrumentalized in social structures, engaging in help for developing countries, etc. But careful: the bad news is that there is nothing else but interpretation, and thus we can dispense with the objective component of truth altogether, science is questioned routinely, often with the cheap excuse of an exaggerated principle of precaution, and people feel more and more reluctant to accept progress in technologies stemming from modern sciences.

If we really want to bridge those growing gaps of understanding and acting, we must try to initiate a considered and constructive debate in decision-making processes which do not mix the language of science and morality, but bring them together with a new procedural language described below.

It is fruitless to debate in an atmosphere where opponents clash in a “dialogue” where they refuse to accept that a common platform has still to be developed. The deplorable alternative would be parallel preaching, fights and accusations, a match without winners and no creative fun – all too often the sad reality….

## 1. 2. Towards a new common platform among opponents

A new ‘common language’ between those spheres must be found step by step, without mixing factual and deontic knowledge in the context of planning. Planning knowledge is bridging theory with reality in a particular context. There is no third and miraculous pathway leading to problem solutions. What we need is the development of new ways of coexistence through a reconciliatory process that aims at developing a new ‘common language’. The ‘new common language’ is the metaphor for a procedural language that gives us the chance to reconciliate contrasts in culture and interests. Latour (1996).

We must make clear, right from beginning, that polarity in debates often stems from the wrong use of language. For example, patenting (or protection of knowledge) has a different background in various cultures. Intellectual Property Rights (IPRs) in the first world has its own legislation language, and shamans in developing countries try to protect their knowledge with all-together ways and means which are ultimately reflected in language. An excellent example is the different kinds of plant taxonomic nomenclatures used by Amazon Indians that are based on the medicinal and spiritual use, while the nomenclatures of western, scientific taxonomists are based on morphology and genetics. We need a successful attempt to find some common goals in a world with inevitably growing global visions for common survival begins with learning

about, and acknowledging, existing differences and proceeding to choose a common platform intended to take decisions and find solutions.

There is a need to conduct a debate about inequalities, with a view to generate new knowledge (and hence new intellectual property). We have to accept that these issues belong to the domain of inequities in human capabilities.

## 1. 3. Motivations, Drivers and Incentives for tackling Science and Technology problems in the future

It is very important to review, with due respect, the motivations of major players in this global debate. It is also indispensable to invite major interested parties which do professional work initiated by their own motivations. Government representatives (regulators, legislators and executives), professional representatives of the civil society sector and scientists, all having a direct interest to get together and debate on the topic of IPRs should be ready to go through an iterative process, trying to find common ground in innovative processes leading to new solutions. We need to develop a common understanding of the differences in power systems in the developing world, indigenous populations and the western world, power systems which are reflected in differences between healing systems, to give just one example. It are precisely the range of healing strategies, the various medicinal philosophies and the different technologies behind all this which need to be respected – and from there we will be able to build a common ground, a common world view and a common world picture with enough room for human, cultural and spiritual diversity and values.

## 1. 4. Can we direct Science and Technology Development in order to create a better world where a new IPR concept can play a new and important role?

The real issue is hidden in the inequalities of the use of existing information, especially where such information is under IPR protection. Here there are two issues. The first relates to capabilities for using available knowledge (whether protected or not); the second relates to access to patented knowledge under conditions that do not compromise the incentives provided to promote the creation of intellectual property.

If we want to come to new solutions about IPRs we need to question scientific progress and the institutions producing it.

With the above steps 1.1 to 1.4 there is no room for a division or fruitless debate about dependent or independent research, a concept which reminds one of old-fashioned, stalinist views where scientists have been judged along their membership in the communist party. We should concentrate on the question whether or not such research is of high

quality and useful for reaching the goals envisaged - goals which will be defined in the process of decision-making, and which might result in real surprises. Is it really true that research supported by the private sector is less creative, more linked to short-sighted goals, and under heavy commercial constraints? And what about the present-day system of scientific publication: does it guarantee quality in scientific research?

Can we still allow basic research to be absolutely free - and completely separate in its outcome, from societal needs and ethics? Do we need novel public and private financing concepts? For many successful scientists patenting is not the solution, as there are other mechanisms at work to measure scientific merits and which lead to better positions within science. Patenting in the life sciences needs to be adapted to the facts of life, its genetics and unique ability to reproduce and particularly to its dynamic evolutionary status.

How can the needs of developing countries be included in the development of new technologies? What about IPRs and the absolute need to feed additional billions of people in a few decades?

This is the crucial part of any debate, where we need to build common ground, which will hopefully evolve into the idea of IPR clearing houses, such as various civil society groups propose in accordance with large life science companies.

# 2. Some insights into the public and scientific debate

After having seen the general picture we need to delve deeper into the details of the debate on GM crops and agriculture. We need to have a close look at some of the more important players participating:

## 2.1. The Scientists

Scientists still tend to see the world through the glasses of facts alone. This is understandable since they are dependent on high quality publications in order to start and maintain a good scientific carreer. It is a world of facts they live in and this world has been quite successful in producing progress and fancy new technologies. It is also a world of reductionism and experiments, clean conclusions and automatically there are only a few thoughts given to follow ups and social responsibility. It is usually a world of lab experiments, and field ecology only recently caught up with computer models, strict statistical discipline and quantitative analysis. It is good to know what Karl Popper said about scientific data: he takes *falsifiability* as his criterion for demarcating science from non-science Popper (1972, Popper (1994). In the fight for scientific truth with opponents who often indulge into unscientific, populist slogans, scientists tend to focus on rectifying facts in fighting for the good cause. This leads in a deplorable way to a strong belief in scientific facts alone, or worse: it is difficult to keep the balance and admit the lacunes of knowledge. We should anyway distinguish between Science as a final product of scientific endeavour and research (the activity which leads to those results and which is very sensitive to all sorts of political and economic questions – access to funding being only one example.

## 2.2. The Corporations

Industry representatives and scientists working within companies often live in an euphemistic atmosphere, believing in the good cause of their product development. It is a world of deontic knowledge (planning knowledge, the knowledge what ought to be) and there is little space for other kinds of knowledge, other than theirs. This can lead in the best scenario to a clash with business oriented colleagues which have to deal with the shareholders and need to keep the company on an economic course which promises future development. Industrial scientists are in conflict with their desire for both scientific and deontic knowledge, because this may be at odds with the stratagems of the companies they work for. A clash helps to recognize contrasts and this might be very helpful for future creative processes. It is also true that there is a certain stress in developing products with a market potential but, as in academic science, sustainability

in its own work quality is the best guarantee for long-term success. The suggestion that corporate scientists are forced to produce certain opinions which do not necessarily match with good science is too simplistic: in both academic and corporate realms it may happen that scientists develop eroded ethics and produce flawed results on purpose. Career (and money) pressure of all kinds may be the reason in both cases. It is certainly better to distinguish between good and bad science and to have a certain, but limited confidence in the peer review process. But this is itself also a questionable concept, since if one goes for non-Popperian definitions of a scientific protocol as Paul Feyerabend, Ilya Prigogine and Isabelle Stengers suggest, then the divide between 'good' and 'bad' becomes rather blurred. After all, there exists no overall ruling concept, which would allow us to be in any way the dictatorial stewards of the scientific truth.

## 2.3. The NGO's

The Non-Governmental Organisations, or as they are called today: civil society representatives, play an important role in our risk-minded society. It is not widely known that the big NGO's are powerful organisations of a global scale, well organized and also supported by numerous members. NGO's still play the card of the 'David' image against the Goliaths of global companies, which is certainly not true anymore if one compares the PR budgets. There is nothing, though, to bring in against the power of NGO's. In fact, we need to have powerful organisations of this type in the debate, but certain details should not be overlooked: firstly, these organizations do not have a direct democratic legitimation; secondly, they are often not structured in a democratic way (both points also true for industry corporations); thirdly (and worse), they seem to be more interested in making more money (and members) through populist slogans, and are less keen in solving problems through hard field work. This is of course not true for all NGO's, and dozens of important ones indeed carry out plenty of professional projects with a problem-solving strategy - often learning the hard way, just as corporations, scientists and governments.

## 2.4. The Regulators in Governments

Regulators are the supposedly neutral stakeholders who care for public health and wellbeing. In order to be prepared for regulatory activity, they must be excellent scientists, always keeping up with progress in technologies about to be implemented. This is an extremely difficult task, since they must keep the middle line in the debates, and should listen to all arguments. This is all-the more difficult as debates drift into emotive realms and thus strongly influence opinion-making and the making of new regulatory structures. It is a sad fact that, in Europe, regulatory offices are notoriously understaffed and not supported by strong regulatory rules. But what is even worse is

that politics strongly and often inadvertently influences and thus hampers their work considerably, especially since the dramatic drop in trust in European governments as a result of the dubious treatment of scandals like the one on HIV blood contamination, BSE and other grave incidences. Consequently, the public and also many politicians believe that, in the case of the GM debate, corporations and scientists developing those promising technologies come up with just another lie. It is not easy for regulators to work in this climate of mistrust and fight for the truth (whatever this may be...). Regulators need more harmonization, more biosafety research documentation, and certainly more support in all regards.

## 2.5. The Journalists

Journalists serve the public in conveying impartial reports, networks of facts, interpretations and, if at all possible, in the face of their daily competition for headlines and articles which must fill the columns, with extensive documentations that, in the best case, show both sides of the medal.
Good journalism attempts to separate documentation, opinion and comments, but increasingly one sees articles that mix up mall three. And we all know that sensationalism is an important marketing tool for all newspapers, and it is often camouflaged with terms like ‘good stories’, ‘lively reports’, etc. The monarch butterfly story is a typical one: the first sensationalist publication in Nature Losey (1999) obtained broad coverage and was making its world tour within  days, but when six extensive publications in the Proceedings of the National Academy of Science appeared some months later, it was no news and reported only in a few newspapers, probably because the publications provided no story about the killing of innocent butterflies by the evil, toxic plants of global corporations Sears (2000, Sears, Hellmich, et al. (2001).
But this is only part of the story: today we have to cope with an unfortunate, media-driven public mix of anti-global, anti-corporate, anti-business and anti-technology attitudes, which is a great problem as far as the GM debate is concerned because it tends to polarize positions and inhibits the possibility to engage in creative dialogue.

## 2.6. The Population

It is difficult for the lay people to survive in this debate and to peer through the fog of false, filtered and – alas - true arguments. It is difficult to make a choice on whom to believe, and often the choice is an emotional one. And it is also true that the public has a fine-tuned sense of anxiety and that many have realized – maybe even earlier than the researchers - that biology resulting into new technologies has lost its innocence. This should be a strong motivation to delve deeper into the matter, to get educated, but one often encounters a contrary attitude: many people just run away or prematurely take an

entrenched position instead of getting involved in this historic debate. It is baffling to see that people are ready to learn swiftly and seriously about computing, about many other technologies – as-long as it is related to self-serving mobility and communication. But life itself seems still not to be so interesting as to really indulge into studying. This is deplorable and has to be reversed: we need to invest heavily into science communication of the best kind and, in addition, to enhance the trust in the ability of the public to learn and to argue about the difficult and complex issues and benefits.

# 3. The Way Out

The solution will not be easy. We must find a way to influence the various factors in this public debate. This will be a long and arduous process. It needs a 'New Approach'. This 'New Approach' provides a paradigm for the treatment of socio-ecological systems. For this purpose, the method of teaching must be given equal weight alongside the type of decision making. Its conceptual framework has five kinds of questions corresponding to fivefold knowledge. This new framework helps the individual to develop self-respect and, through a better appreciation of his own strengths and limitations, to recognize false theories Papazova Ammann (1991, Papazova Biliyana (1986).

This process needs to be adapted to the problems and solutions envisaged and needs also professional moderation. Here an example is given of how to handle the precautionary approach. This chapter is mainly based on the writings and thoughts of two authors: Horst Rittel: Rittel (1972) and Frank West Churchman Churchman (1979, 1984): See also the extensive account published within UNED: Hemmati Minu and Dodds Felix (2012, Hemmati Minu, Dodds Felix, et al. (2002)

The thesis of this part is to demonstrate that a static use of a sole, generally accepted definition of the PA will be extremely difficult, since it does not meet the real needs of a principle as an important legislative tool introduced in many important conventions with the goal to protect biodiversity.

The way out will be a more discursive model, a model that allows for adaptation to local conditions and which enforces solution-oriented procedures.

Discussions around the PA usually concentrate on definitions. PA definitions are plentiful, they depend on the scientific and social background of their authors, and they all contain elements of truth and error. One of the basic problems of PA is that there is no such thing as an overall definition; the application of PA always depends heavily on the context. In my view it is of no use to solve the problems in the application of PA by achieving a generally accepted definition, since it is difficult to sharply define a principle where uncertainty is the main element. Terms and concepts like uncertainty always depend heavily on the scientific, social, cultural and economic background of those who forward them.

Problems in the application of the Precautionary Approach (PA) also have many other roots. The two most important are:

- The lack of knowledge on how the PA has been first defined and where it is coming from.
- The debate on PA is too closely related to factual knowledge alone.

These two reasons also are topics of following paragraphs of this contribution.

Let us first have a look at the most important definitions of the PA.

# 3.1. The roots of the Precautionary Approach and environmental debates

We have to realize that the Precautionary Approach (PA) has been first introduced in the Convention of the Biological Diversity CBD (1992). It was at that time a nearly uncontested, meaningful “approach”, which in Germany later was called “principle”, based on the facticity of a deteriorating environment, an environment which obviously suffered from human activity of all kinds: there was air- water- and soil pollution and, in some restricted regions, alarming damage to natural forests. Heavy-metal pollution was a reality, along with dioxin contamination. Although we have to admit that, in the beginning, environmentalists were often exaggerating, this nonetheless helped to bring the issues to the debating table. However, due to this early ‘factual enhancement’, we now have a credibility gap in Europe, for example in relation to the dying-forest syndrome - whether we accept it or not, the forests just refused to die. During the 1970s, the environmental debates in Europe were derailed. We believe that this happened when activists and corporates started to mix up deontic knowledge (how things ought to be) with factual knowledge (how things actually were).

But in the constructing period of the CBD there was no doubt that factual knowledge had to predominate in order to trigger some decisions.
It is true that some elements of the PRECAUTIONARY APPROACH already contained other kinds of knowledge right from the beginning, but the real nucleus of the PA was always factual. Environmentalists soon brought up deontic knowledge (of how things ought to be in future from their point of view), and very soon also some instrumental knowledge was developed on how to solve the environmental problems targeted. It was kind of a peaceful debate, where everybody was optimistic on how to solve the problems within a few years or, at the most, decades.

This complacency was jolted by Rachel Carson’s Silent Spring Carson (1962 - 2002). This work showed us all that long-term environmental effects could seriously harm bird-life. Indeed, the shock of the disclosure of the harmful side-effects of DDT even made us forget the positive aspects of this particular pesticide, namely that it saved, according to official World Health Organization statistics (see the full account in …), the lives of hundreds of millions of people by killing the malaria-carrying mosquito Anopheles Tren and Bates (2001). Gradually, then, environmentalists started to realise that ecological problems were not simple problems, which could be readily solved, and that remedies for them were going to be difficult to find.

We still remember those difficult days of endless debates about flux, modelling, circulation ecology, interdisciplinary or even transdisciplinary collaboration as the best way to solve research problems and to swiftly find solutions for environmental problems. In the end we all realized that what we called interdisciplinary or even transdisciplinary research too soon just degenerated into multidisciplinary structures, structures which were unavoidable, since research money was limited and had to be divided up logically.

Interdisciplinary work would have at least required some mutual understanding and eventual reaction to what the research partner does, and transdisciplinary work should include a

planning phase in order to fix a common research goal and then try to get the necessary disciplinary groups to work together and, in the end, produce something which would be an amalgamate of all research activities – a dream many scientists still nurture but today begin to understand why it is so very difficult to achieve.

This is all complicated further when we try to expand inter(trans)disciplinary work beyond natural sciences, including social sciences such as sociology, history, philosophy etc. When one does so, one inevitably runs into the trap of statistical and epistemological debates. This is of course a dead end and will never ever lead to solutions with a broad consensus, which is politically important.

The discussion about Precautionary Approach is too closely related to factual knowledge alone. This may seem paradoxical in the light of what we have stated above. We are convinced that the moment we put factual knowledge into proper proportion vis-à-vis all other kinds of knowledge and try to analyse this in a true systems approach, we will easily be able to cut the Gordian knot.

We must realize that the problems in the discussion about the Precautionary Approach are 'wicked problems', which means that linear planning will resolve nothing Rittel and Weber (1973).

A wicked problem is one for which each attempt to create a solution changes the understanding of the problem. Wicked problems cannot be solved in a traditional, linear fashion, because the problem definition evolves as new possible solutions are considered and/or implemented.

Wicked problems always occur in a social context - the wickedness of the problem reflects the diversity of stakeholders who share the problem.

This is why it is virtually impossible to attack the problem of knowledge lacunae in a direct and linear way, it can only be solved through a discursive process, through a second generation management strategy, for more information see Conklin (2003) and citations in there.

And it is certainly true what Laurence J. Peter has said:  Some problems are so complex that you have to be highly intelligent and well informed just to be undecided about them Sawyer (2003).

## 3.2. How can we go from knowledge to action?

Some years ago, the introduction of genetically engineered crops into the environment or the international trading of Living Modified Organisms (LMO's)  would have been seen as tame problems to be solved in some sessions among executives who would then hand over a plan to professional PR people who would then have solved everything within a few months. It would just have been a matter of presenting some comprehensive scientific data, and the solution would have been automatically defined.

But, unfortunately, planning problems in the field of green biotechnology have now evolved into wicked problems with complex structures and no obvious causal chains. This applies also to

the Precautionary Approach. These problems cannot be determined totally in a quantitative and scientific way, there are no existing solutions in the sense of definitive and objective answers only.

Unfortunately, wicked problems have been treated mainly in two directions:

- through formalised (linear) methods which are suitable only for the solution of tame problems.
- Often, solutions have been found empirically, through trial and error acceptable solutions can be found, and gifted planners or regulators often develop good intuition and take into account socio-economic factors as well. But, deplorably, too often a systems approach that works properly for tame problems ends up in a fiasco when it tackles wicked problems.

## 3.3. Systems approach of the first and second generation

Much hope has been placed in the systems approach of the first generation, which certainly had its merits (linear planning models with a clearcut goal to achieve, such as the NASA missions, toll bridges, defence systems, designing a new crop for a undisputed, certain purpose etc.). Planning goals were “clearly” defined, and all decisions where oriented towards these goals.

In general, it can be said that the systems approach of the first generation has been followed by an era of disappointment, since it has not yielded what was expected of it: a number of large and complex projects such as urban renewal, improving the environment, tackling the nutrition problems of mankind etc. can only be considered as failures or partial failures such as the “green revolution”.

The main reason for this is the fact that the classic paradigm of (rational) Science and Technology is not applicable to the problems of open ecological and/or societal systems. It is very important to realise that problems in biotechnology are not solely problems of science, but also problems of society. This does not mean that risk assessment should not be science based, on the contrary. It would be a big mistake to assume that the involvement of open structures in ecology and human society would provide cheap excuses to deviate from the path of science when it comes to questions of safety and regulation. Or, even worse, to abuse scientific language in order to achieve an ideologically stamped agenda as certain members of the newly grown (protest or biotech) industry are doing.

Professional management tools which are based on a ‘systems approach of the second generation’ should not be mixed up with “future workshops”, with their frequent and inconsiderate use of pin walls when activist groups start their “planning”. Those actions have rarely led to sustainable results, and too often future-workshops (German “Zukunftswerkstätten”) start with a fulminating brainstorming and lots of enthusiasm that quickly wanes as the participants go home to live their normal lives and forget about their big

declarations. If these workshops would be properly carried through according to the original recipes results would be certainly be better Jungk Robert and Mullert Norbert (1996).

We should also note the difference between management tools and 'collaborative learning workshops' - which can be very enjoyable and, at least in the heads of the participants, successful. However, these events - even if they have an effect on attendees' subsequent decisions - rarely achieve sustainable results. They lack the process of collaborative decision-making. It is important to avoid a misunderstanding here. In its basic structure, decision-making is not a democratic process involving mass voting; rather, it is a process where the people participating are genuinely involved. To be even more explicit, participants in the decision-making process should have their own genuine interest in the cause, this avoids the danger of manipulation by clever PR exponents, utilising populist or, worse, fundamentalist arguments.

Consensus conferences and also citizens' conferences are extremely helpful in cases of public conflicts, but here again it is difficult to see how the processes that are criticised will change for the better, or how negative trends will be turned around definitively. Let's face the difficulties: How on earth can you expect a citizens' group to learn about the complexity of solutions necessary within a few days of intensive briefing?

Another kind of internal consensus conference is designed by the promoters of the "Syntegrity approach" which brings together corporate people in-order to analyse internal dynamics and processes and to discern negative effects. This approach seems especially appropriate in crisis management and cannot resolve the big societal debates. Hagelstedt and Persson (2000).

Despite the fact, that there is a lot of effort becoming evident to design new planning and management methods, negative results are predominant and are in fact part of a planning crisis that stems from the seventies and which continues today.

## 3.4. What is the "Systems approach of the second generation"?

It is primarily the paradox of rationality that has been severely underestimated in the systems approach of the first generation.

The more questions we ask, the more answers are possible and vice versa. Limitations of technological solutions are always hidden in open ecological and social systems: just compare the infamous case of DDT sprayings in the past (see 3.1). Constraints in possible secondary effects in ecology should be examined carefully: this has been well demonstrated in the case of the Monarch larvae being killed by Bt-Maize pollen - the result of a sophisticated laboratory study Losey (1999) where press coverage was out of proportion – even though the author himself warned about a too far going interpretation. Would one have asked the farmers, they would have been able to say that feeding time of the larvae rarely overlaps with pollination, and studies have later demonstrated, that the larvae show avoidance strategies towards Bt pollen, and many other factors let us now explain why most non-target insects in Bt crop fields are not harmed Gatehouse, Ferry, et al. (2002), on the contrary, the reduced pesticide spraying is beneficial for the non-target insect populations Candolfi, Brown, et al. (2003) and Sears,

Hellmich, et al. (2001). The big irony is that farmers do not like Milkweeds, treat them as nasty weeds and try to get rid of them with Roundup Ready herbicide recipes.

In order to tackle wicked problems, one needs to go through an extensive process of argumentation, also called objectification (which is not to be mixed up with an "objective approach" to the problem.)

During this long process of argumentation we obviously use also our intellectual, but certainly also social talents, but this should not lead us to the misunderstanding, that the planning process is exclusively rational: There is rational planning, but there is no way to start to be rational, one should always start a step earlier, since there are important trends and facts which will make straightforward rational thinking and acting when solving wicked problems pointless. It is not the theory component, but rather the political component of knowledge that determines the vector of the action. This is the 'zero step' so important in the publications of Horst Rittel Rittel (1972). This is also the basis of the understanding of the term "Symmetry of Ignorance".

Cited from Rittel (1972) the major steps of the decision making process:

- *to forget less: if you tell me your version or story, maybe I forget less than I would otherwise.*
- *to stimulate doubt: if you have to tell your story it is likely to stimulate doubt, and this is good because only doubt is a test of plans.*
- *to raise the right issues: objectification will help you identify those questions which are worthwhile , which have the greatest weigh t and where there is the greatest disagreement. If we agree, we do not have to discuss or analyse something. If wo disagree considerably and it is important we have to discuss and analyse it.*
- *to control the delegation of judgement: if I let you plan for me, the n you had better objectify to me how you proceed, because I want to have some control about the delegation of judgement.*
- *the belief that explicitness is helpful which is not so in all matters of life. There are some situations where we had better not be explicit.*

For example: the fact that experts can be wrong and farmers know better in certain situations in agriculture because daily practitioners are often better observers out in the field. After all, agriculture is especially well-suited to the systems approach of the second generation, since agricultural systems include a complex and very dynamic ecology, narrowly connected to a multitude of social and cultural issues, where often wicked problems wait for resolution. Kunz and Rittel (1984, Rittel and Webber (1973, 2005).

The knowledge needed in wicked planning problems is not concentrated in a single head. It is absolutely essential to let all partners be involved in the problem-solution process, which includes part of the population (mainly farmers' organisations and consumer organisations), the Governmental Regulators, the Non-Governmental Organisations, the Life Science Companies and the Scientists. There is no monopoly of knowledge, no one can decide alone on the Precautionary Approach. Having illustrated the difficulties in solving wicked problems, we need

a new approach in problem-solving, in order to avoid the pitfalls of ignoring bottom-up feedback's.

One can only go through a successful decision making process, if one also follows another important rule: all partners in the planning process have to avoid hidden agendas, which is certainly eased by a minimum amount of respect paid to each one of the partners and even more successfully by having a free exchange of information beforehand. Nobody should be criticised for speaking up on behalf of his interest. It is wrong to perpetuate reciprocal accusations of 'abuse of the PA for conducting a trade war', or for denigrating the PA for reasons of global unhindered trade for one's own advantage.

It is obvious in these times of growing difficulties when communicating biotech products, especially in agriculture, that all partners still have a lot of homework to do.

The Biotech Companies are populated with people who are convinced about their own products, since they know precisely about safety standards and regulatory processes. So far so good, but these people live in a World of euphemisms and perfection, and through time they develop a lack of understanding criticism from outside.

The scientists often are naïve enough to stick to factual, instrumental and explanatory knowledge alone. Many miss a very important point. As Hannah Arendt put it: one of the most noble tasks of scientists is to make public opinion out of facts Arendt (2003).

The regulators should find ways and means to cope with the growing speed of new developments. One of the main reasons why things in Europe turn sour is the fact that European regulation is way behind the one of the United States. On the other hand, this is an excellent occasion to see more clearly the geographical differences in regulation.

Some of the NGO's have developed into powerful protest industries and are not interested in a thorough scientific analysis, since this could blur the populist argumentation they need to keep up in order to get more donors, which are in fact their shareholders.

The Public is often lost between the two camps and, surprisingly enough, only a minority feels the need for better education, whatever this would mean according to the two camps described above.

## 3.5. How to Solve Wicked Problems in Biotechnology and the Environment

What we need in these cases is an action-oriented approach. Risk Assessment and Management must be perceived as a planning strategy of the second generation in developing a professional framework for decision-making.

Strategies must be developed to recognise the consequences of our doing on one side, and to specify our knowledge on the other. This knowledge has to be gained step by step and case by case: if we want to clearly distinguish our present state of knowledge (or ignorance as you wish)

from appropriate decisions to be made that are not based on our views and opinions, we need to go through the following steps

- What is the problem ?
- What do we want ?
- What are the alternatives ?
- How do we compare them ?
- How can we reach the solution ?

All participants need to keep in mind that there are various types of planning knowledge (arranged according to the 5 questions asked above).

The examples given below are lumped together as simple keyword-illustrations, taken out of their context in real planning examples. They cannot be regarded as an example of a realistic situation, as this would be exactly the task of a tedious planning process of the second generation.

### 3.5.1. Factual knowledge is the knowledge of what actually happens (quantitative data or empirical, observational data).

Gene flow species by species / region by region / facts about insect resistance, environmental benefits in agriculture ; Ammann Klaus, Jacot, et al. (2000), Carpenter, Felsot, et al. (2002).

### 3.5.2. Deontic Knowledge, the very important knowledge of what ought to be.

The knowledge about new crops which enhance agricultural production / new agricultural techniques to avoid erosion / new biological approaches to fight insect pests, imports should be segregated for Europe etc. FAO (2002) Pinstrup-Andersen and Pandya-Lorcha (2001). More than 900 people from the public and private sectors and civil society came together in Bonn for three days to discuss goals, solutions, and the actions necessary to end hunger in the next two decades.

### 3.5.3. Explanatory Knowledge explains why things are as they are or why certain effects will happen. Here one already starts to determine the direction of the solution.

The way Bt-proteins are acting on specific pest and beneficial insects / what are the main reasons of unwelcome erosion effects / mechanisms of vertical gene flow / mechanisms of resistance development Sears (2000).

### 3.5.4. Instrumental knowledge on how to steer certain processes, on how to achieve certain goals, knowledge which needs to be balanced against regulation and safety.

How to build Bt and other genes into crops and how to stabilise them / how to avoid vertical gene flow / how to avoid unwelcome soil erosion / how to avoid early upcoming pest resistance Ammann Klaus, Jacot Y., et al. (1999) Traynor Patricia, Westwood James H., et al. (1999), Trevavas (2001).

### 3.5.5. Conceptual knowledge which would allow to avoid conflicts before they pop up. This is the knowledge about complex situations, taking into account all previous kinds of knowledge and also weighting them against arguments coming from open ecological and societal systems.

Concepts about transgenic crops that are compatible with ideas of sustainable agriculture , a thesis defended since decades by .Swaminathan (2001)
Once again: One needs to go through an extensive process of argumentation, also called objectification, not to be mixed up with an “objective approach” to the problem. The hopes of this process are:

- to forget less, to raise the right issue
- to look at the planning process as a sequence of events
- to stimulate doubt by raising questions, to avoid short-sighted explicitness
- to control the delegation of judgement: experts have no absolute power, scientific knowledge is always limited.

## 3.6. There is no scientific planning.

Solving practical problems to develop sustainable transgenic crops cannot be dealt with through a “scientification of planning” which means that planning cannot be steered by scientific facts alone. Dealing with wicked problems is always political because of their deontic premises (which means that one has to involve knowledge of what ought to be). Science only generates factual, instrumental and, in the best case, explanatory knowledge.

The planner (here the regulator who must take decisions in Precautionary Approach) is not primarily an expert, but should act as a “mid-wife of problem solving”, a teacher more than a doctor. Moderate optimism, careful, seasoned respectlessness, and casting doubt is a virtue, not a disadvantage of an action plan manager.

The planning process of wicked problems has to be understood as an argumentative process, it should be seen as a venture (or even adventure) within a conspirative framework, where one cannot anticipate all the consequences of plans.

Systems methods of the second generation are trying to make this deliberation explicit, to support it and to find means with the intention to make this process more powerful and to get it under better control for all participants.

# 4. Outlook

It is beyond logic and present-day knowledge to predict some surprising outcomes in genetic engineering debates designed as above. Still there are some dreams and hints, which should be placed at the end of this contribution:

**"Precision Biotechnology"** could lead to a better design of crop seeds in future. Precision biotechnology would mean that a bag of seeds contains a great variety of different kinds of seeds related to resistance against many pest insects on one side, but all having a precisely designed genome for the quality product to be sold after harvest. Genomic research offers a great future and will greatly speed up modern breeding and add considerably to its precision. Here we also find the key for reintroducing some old concepts of getting modern agriculture closer to biodiversity again. Oosterom and Schenkelaars (1995, Rabbinge, Goode, et al. (1997)

**Organic farming** needs in future to go together with modern breeding methods including genetic engineering. In the eyes of the authors this is an absolute need but also a very difficult thing to achieve, since the transgenic crops of the first generation are either not made for the strategies of organic farming or, worse, they work against such visionary strategies.

Maybe we need some newly designed products that are fit for terms like
**Organo-Transgenic Crops and Organic Precision Biotechnology ?**

This vision would of course break up the present, harsh debate on the Precautionary Approach, and we would at last have the possibility to develop a balanced approach to difficult Precautionary Approach decisions, which needs also a balanced approach to risk assessment, including different kinds of knowledge such as the ones described above.

Under these auspices, we will have at least a chance to make a breakthrough in the present Precautionary Approach debate – but if we continue to fight about factual knowledge alone, we have little hope that we can solve these problems, problems which have an international impact and need to be treated according to the latest insights in management and the systems approach.

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