Intrinsic Value and Integrity of Plants in the Context of Genetic Engineering

A multidimensional approach including perspectives from philosophy and biology, legal and social aspects, as well as viewpoints from plant breeders, food producers and processors

Wednesday evening 9th to Friday afternoon 11th May 2001
The Goetheanum, Dornach (Switzerland)

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Speakers and Abstracts or Papers

Dignity of Plants and Perception

Christoph Rehmann-Sutter, Lecturer in philosophy, University of Basel (CH), President of the Swiss Society for Biomedical Ethics

For seeing the dignity of plants a special perceptive attitude is required. When we relate ourselves to living beings in an appreciative way, they can appear as autonomous "spaces of meaning".

Dignity of man v. dignity of creatures

Klaus Peter Rippe, Research Assistant at the Dept. of Philosophy, University of Zurich, Managing Director of the Ethics Centre, University of Zurich (CH)

There are two reasons to ascribe all living beings with an inherent value. Such an ascription rests (i) on the rejection of a purely subjective conception of welfare. If, however, not only the subjective sensations count, there exists (ii) no reason to ascribe moral status to only those living beings, which are capable of having sensations. The possibility of a dignity of creatures seems to come from the position that we are to be morally accountable for creatures for their own good. A violation of the creature dignity is then present, if the own good of plants or animals is infringed. If a violation of an individual good is present, it is to be asked in every case, if this violation can be justified by other morally relevant factors. The idea of a dignity of creatures does not prohibit the balancing of goods; this is an important difference to the concept of human dignity.

Intrinsic value of animals. Implementation in Dutch governmental regulation and its implication for plants

Henk Verhoog, *If*gene Co-ordinator NL, biologist specializing in philosophy of biology and bio-ethics, former lecturer at the University of Leiden (NL) in "biology & society"

The concept of the intrinsic value of animals was first mentioned in 1981. Now it is incorporated in the Dutch Animal Experimentation Law which has a zoocentric background: vertebrate animals that can suffer have intrinsic value. There is another Law on the Health and Welfare of Animals which, among others, deals with transgenic animals. The making of transgenic animals is monitored by an ethical committee which advises the Dutch Ministry of Agriculture. This committee not only looks at health and animal welfare, but also at the integrity of the animal. The policy with respect to transgenic animals is called a 'no, unless' policy: i.e. no genetic modification of animals unless the scientists can show that it is for a substantial goal, which cannot be reached by alternative means. The concept of animal integrity is related to the species-specific 'nature' of animals. The integrity concept fits very well into a biocentric and even ecocentric bio-ethical theory applying to all living beings, thus plants as well. The step from animals to the integrity and intrinsic value of plants has not yet been taken in the Netherlands, but the crisis about transgenic food may change this. Also internationally we see an increasing willingness to take so-called 'intrinsic consumer concerns' more seriously. These concerns go beyond the risks for health and environment. They deal with the perceived unnaturalness of genetic engineering, the lack of respect for the integrity (and inherent worth) of life, playing God, etc.

Dignity of man and Intrinsic value of the creature – conflicting or interdependent legal concepts?

Hanspeter Schmidt, Attorney-at-law at the OLG in Karlsruhe and at the LG Freiburg (GE), certified expert in Administrative Law

Copies of Hanspeter Schmidt's paper will be distributed at the workshop

Shamans and scientists

Jeremy Narby, anthropologist with Swiss NGO “Nouvelle Planète” author of “The Cosmic Serpent, DNA and the Origins of Knowledge”

In 1999, three molecular biologists travelled to the Peruvian Amazon to see whether they could obtain bio-molecular information in the visions they had in sessions orchestrated by an indigenous shaman. They had no previous experience of ayahuasca shamanism or of the Amazon, though they did have an interest in alternative healing traditions and shamanism. Their age ranged from the late-30s to mid-60s. One worked as a scientist in an American genomics company. Another was a professor at a French University and a member of the National Center for Scientific Research (CNRS). The third taught in a Swiss University and was a director of a research laboratory.

None of the scientists spoke Spanish, and the indigenous ayahuasquero did not speak English or French, so I translated for them. The first thing to report is that the scientists and the shaman had many long conversations. They did not cease to have things to say to one another. The shaman had been studying plants, as an ayahuasquero, for 37 years. He answered the biologists' questions for days on end. He also conducted night-time ayahuasca sessions, in which the biologists took part. They saw many things in their visions, including DNA molecules and chromosomes.

The American biologist, who normally worked on deciphering the human genome, said she saw a chromosome from the perspective of a protein flying above a long strand of DNA. She saw DNA sequences known as "CpG islands," which she had been puzzling over at work, and which are found upstream of about sixty percent of all human genes. She saw they were structurally distinct from the surrounding DNA and that this structural difference allowed them to be easily accessed and therefore to serve as "landing pads" for transcription proteins, which dock on to the DNA molecule and make copies of precise genetic sequences. She said the idea that CpG island structure enables them to function as landing pads had not crossed her mind previously, and that genomic research would soon be able to verify this hypothesis.

The French professor had been studying the sperm duct of animals for many years, first in lizards, then in mice. When a sperm cell comes out of the testis and enters the sperm duct, it is incapable of fertilizing an egg. It only becomes fertile once it has travelled through the duct, where about fifty different kinds of proteins work on it. The professor and his team had spent years trying to understand which protein makes the sperm cell fertile. Understanding this could have implications for the development of a male contraceptive. He brought three questions to one of the ayahuasca sessions. First, was there a key protein that makes sperm cells fertile? Second, why had it not been possible to find the answer to that question after years of research? And, third, was the mouse the appropriate model for studying fertility in men? He received answers from a voice that spoke in his visions. In reply to the first question, the voice said: "No, it is not a key protein. In this organ, there are no key proteins, just many different ones which have to act together for fertility to be achieved." To the second question, it said: "I already answered that with your first question." To the third question, it said: "This question is not important enough for me to answer. The answer can be found without ayahuasca. Try to work in another direction."

The Swiss scientist wanted to consult the shamanic sphere about the ethics of modifying plant genomes. She wanted to know if it was appropriate to add genes to plants to make them resistant to diseases. It so happens that tobacco is an important plant for both genetic engineers and Amazonian shamans. Shamans from many different indigenous societies say they speak in their visions with the "mother of tobacco," or the essence of the plant. The biologist reported that she spoke during an ayahuasca-influenced meditation with an entity that the shaman subsequently identified as the mother of tobacco. This entity informed her that tobacco's fundamental role was to serve all living beings. It also informed her that manipulating tobacco's genome was not a problem in itself, so long as the plant could play its fundamental role in an adequate environment, and so long as it was in keeping with that environment. The biologist saw, in a vision, a resplendent plant growing in a desert thanks to an extra gene which allowed it to resist drought. She came away from this experience with the understanding that genetic manipulations were best gauged case by case, in a way that takes into consideration the scientist's intention as well as the way in which the modified plants will be used by society.

In interviews conducted in their respective laboratories four months after the Amazonian experience, the three biologists agreed on a number of points. All three said the experience of ayahuasca shamanism changed their way of looking at themselves and at the world, as well as their appreciation of the capacities of the human mind. They all expressed great respect for the shaman's skill and knowledge. They all received information and advice about paths of research they were on. The two women reported contact with "plant teachers," which they experienced as independent entities; they both said that contacting a plant teacher had shifted their way of understanding reality. The man said that all the things he saw and learned in his visions were somehow already in his mind, but that ayahuasca had helped him see into his mind and put them together. He did not think he had experienced contact with an independent intelligence, but he did think ayahuasca was a powerful tool for exploring the mind.

The scientific information and imagery accessed in ayahuasca visions by the three biologists were certainly related to the information and images already in their minds. They did not have any big revelations. "Ayahuasca is not a shortcut to the Nobel prize," the French professor remarked. They all said that ayahuasca shamanism was a harder path to knowledge than science, and as scientists, they found specific difficulties with it. For example, getting knowledge from an ayahuasca experience involves a highly emotional, subjective experience that is not reproducible. One cannot have the same ayahuasca experience twice, nor can somebody else have the same ayahuasca experience as oneself. This makes it almost contrary to the method of science, which consists of designing objective experiments that can be repeated by anyone, anywhere, anytime.

The scientists said that more research was needed; and that this would require preparing questions carefully, and working with qualified shamans in well-defined conditions. And they are all planning to return to the Amazon at some point to continue working on this.

They conducted this preliminary experiment over two weeks. Afterward they visited a school for bilingual, intercultural education, where young women and men from fourteen indigenous societies are learning to teach indigenous knowledge and science, in their mother tongue and in Spanish. They are Aguaruna, Shipibo, Huitoto, Ashaninca and so on. The school's goal is to train indigenous primary school teachers. Each people has elected an old "indigenous specialist" to work at the school as the keeper and teacher of its knowledge, language and lore.

The scientists met with the school's director and with the old indigenous specialists. They spoke positively about their recent experience with an indigenous shaman. But several of the specialists warned them about the abuses that can occur with ayahuasca shamanism. They said that sorcerers worked with ayahuasca and shot darts into people to cause disease. They said ayahuasca was double-edged. "The plant can show you things that will harm you," said one. They emphasized that using ayahuasca required the presence of a well-trained and talented ayahuasquero.

The specialists asked the scientists about science: What was its nature? Where did its center lie? One of the scientists replied that science was fragmented into many disciplines and was practised in many countries. He went on to say that he thought it was very important that young indigenous people learned about science, because it was currently the dominant form of knowledge around the world. In reply, one specialist said he thought this was true, but he also thought that the scientists might consider sending their children to the Amazon to learn about indigenous knowledge. That way, he said, they too would benefit from a complete education.

Once everybody had spoken, the Aguaruna director of the school thanked us for our visit and said: "Here in the Amazon, our knowledge has been taken many times by others, but we have never received any benefits from it. Now we would like to see some returns." He said that an agreement regarding the compensation of indigenous knowledge should be established before any further research was conducted.

This experiment seemed to show that scientists can learn things by working with indigenous Amazonian shamans. Some observers have suggested that shamanism, as classically defined, is reaching its end. But bringing shamans and scientists together seems more like a beginning.

A Goethean view of plants. Unconventional approaches to plants

Jochen Bockemühl, Biologist, former director of the Natural Science Section, Goetheanum, Dornach (CH)

If we try to protect the integrity of a plant, we should know what we mean by this notion. What do we have in mind, when we are speaking of integrity of a plant and its intrinsic value?

With regard to a person it is clear what we have in mind more or less consciously: his or her integrity is the quality of being honest and firm in his moral principles. Meeting a friend we are not so much interested in his physiology or the mechanisms of his body. We might perhaps ask him for his opinion, what the intrinsic value of a plant really is. That is part of *his* intrinsic value. No animal and no plant can give us an answer to this question. We use different ways of thinking when we are speaking of integrity with regard to a human being or with regard to an animal or with regard to a plant.

In general, integrity of something (such as the attributes of a plant or animal), is its state of being united as a whole. How do we experience wholeness? Obviously we have in mind an idea of what we are looking at. We don't mean wholeness in general. The wholeness we are looking for has a definite character. That is its intrinsic value.

Intrinsic means that there are qualities, which are part of the basic nature or character of something. The intrinsic value is valuable – worth protecting –, because of what it *is*, and not because of its connection with other things. What we are trying to protect should be consistent with the basic nature, the specific character. Feeding a dog with substances which came from animals, the character of the food is consistent with the character of the dog. But the same food is not consistent with the basic character of a cow, which is specialised to digest only plants. It is not easy to foresee in a specific way what could happen if plant-eaters are fed with protein of animals. But to know that this is not appropriate is of course possible. We have to develop the faculty to grasp the specific character (inner nature) of the particular being which we wish to respect. The concepts of integrity and intrinsic value have their origin in relation to man. In our normal life we distinguish human beings, animals and plants very well. We feel the differences. But our normal scientific approach does not give us a real grasp for differences perceived in that way.

What we perceive by our senses is never the whole reality – the reality of the wholeness. We always have to complete it (from inside) by our thinking. The visible part of reality has to be completed by the part, which we grasp by our thinking, the spiritual part. Both, the visible part and the spiritual part belong together. They are one. This means that what we see depends on how we are looking at it. This fact is known in phenomenology and is called intentionality.

If we look around and see plants, animals or stones, we have different attitudes of perceiving. They arise in our mind (i.e. in our phantasy) stimulated by our sense-perceptions.

An ambiguous drawing can be used to illustrate intentionality in perception. Normally one uses this phenomenon to show the subjective character of our knowledge. But what the drawing shows is only a picture, not the reality. From this aspect it is not difficult to discover, that we would never reach the whole, the inner nature or the character of the being we are looking for without our intentionality and vice versa.

In perception we anticipate the specific basic nature. It seems strange: if we would like to study a plant, we have to know it beforehand in order to learn to know.

We see it through our experience of life. It forms our view, but transformed into our anticipation. If we keep open our mind, we do not see only what we grasp by our anticipation, but also, what transcends it. Thus our view becomes more and more corrected both by something outside us and something inside. We get more and more familiar with what lies behind (or within) the anticipation: the basic nature or character of the plant.

In our normal consciousness of our own self, we are more united with the world than we suppose. But we cannot have this kind of consciousness without perceiving something outside of us. Every phenomenon we discover appears along with a certain kind of self-awareness. Otherwise we will not recognise it as something being there. With the first impression something presents itself, and this perception is based on awareness of oneself, which appears at the same time. The intentional aspect of this first given perception can be called the intuitive anticipation of a specific kind of wholeness.

If we encounter an animal or a plant, the first perception directs our attitude to it. In meeting a dog, without reflection we do not expect it to be standing at a certain place growing in relation to its environment like a plant. In the same way we do not expect the plant to bark like a dog. Often we forget all this and suppose it to belong to the object which has seemingly nothing to do with us.

Although our intentionality is guided by earlier personal experiences and therefore preliminary, it opens our view for the nature of the specific being.

How can we approach the basic nature of a plant? We need several attitudes for coming closer to it step by step. We can see the plant as a **physical object**: it has roots, leaves, the flower and so on. But how does the seed fit into this picture? With it we imply the thought of the plant's development, life etc. **Life-processes** cannot be mechanical, because the plant appears and disappears. What we see of the plant at one time is different from what we observe at another time. Along with the transformation of the visible part, the (invisible) spiritual part is always changing. Life carries on in the rhythmic breathing-process of coming into appearance for our senses and fading away. Coming to appearance in a new way shows an image of the basic character with regard to the specific influence of the environment. Fading goes along with getting back the whole capacity of growing under new circumstances in a new way. The basic nature of a plant is the specific kind of going through this process.

In my opinion respect for the dignity of a plant can only be developed with regard to its basic nature. These considerations will be further explored with respect to the understanding of the context in which genetic manipulations of plants take place.

Does gene transfer harm the integrity of a plant?

Michael Haring, Plant molecular biologist, professor for plant physiology, University of Amsterdam (NL), member of *If*gene NL

One of the most intriguing observations in the process of making transgenic plants is the high percentage of failures. While the plant is trying to re-organize itself from scratch, many forces are at work: plant hormones that stimulate plant growth and development; antibiotics that kill the cell unless it takes up the gene fragment offered. The plant is disoriented and therefore it is a miracle that it can eventually restore its form and can cope with the new properties that have been forced upon it. Not rarely, this results in metabolic changes that are totally unexpected. Every transgenic plant line is a new individual, which has responded differently to the challenge of transgenesis. Therefore one should ask the question what does the whole process of genetic manipulation mean to the essence of a plant.

Ethical plant breeding techniques from an organic point of view

Edith Lammerts van Bueren, agronomist, leader of the plant breeding section at the Louis Bolk Institute in Driebergen (NL), director of the Dutch Foundation Zaadgoed for organic plant breeding, member of *If*gene NL

Abstract: Until now, organic farmers have largely depended on varieties developed in the conventional breeding system. Because of the development of gene technology in conventional breeding and the requirement that organic agriculture cannot use GMO's, it was necessary to develop a vision of organic plant breeding. In this contribution, criteria to assess the suitability of breeding and propagation techniques for organic agriculture will be discussed based on the organic concept of plant health and the organic position on food chain relationships.

Introduction: Organic farming[1] is being recognised as a growing economic activity and one that meets many of society's current demands on agriculture such as sustainability, biodiversity, regional development, multifunctionality and respect for the intrinsic values of plant and animals. However, as this method of farming expands, plant breeding is becoming a major bottleneck.
Currently, organic farmers largely depend on varieties supplied by conventional plant breeders, even though organic farming conditions demand varieties with different characteristics from conventional varieties. Another problem is that conventional breeders are increasingly using gene technology to produce new, genetically modified varieties which are neither desired nor allowed in organic farming. Continued dependence on conventional breeding systems is therefore undesirable.
In order to present a GMO-free plant breeding system for organic agriculture ('organic plant breeding') as an alternative to breeding with gene technology, the organic sector must do more than explain why it is against the use of GMOs. It will have to explain what approach to breeding it does want if it is to do justice to the intrinsic value of plants from an organic point of view.

Towards a Sustainable Plant Breeding: The Louis Bolk Institute, an independent research institute in the field of organic farming, published a discussion paper and a final report on the organic sector's ideas and preconditions for a professional plant breeding system without gene technology (Lammerts van Bueren et al, 1998 and 1999)[2]. Organic breeding is not the same as propagating varieties that have been produced by the conventional system and selling these on the organic market. Organic farmers have different requirements for variety characteristics (products) and for the manner in which the product comes about (process). Guiding principles for a breeding system for organic farming must encompass both ecological and socio-economic aspects.

Ecological Aspects: Organic farmers want a production level that is economically sound and viable from a sustainable farm management view. The demand on natural sources in and around the farm should not exceed the carrying capacity. Farm management is aimed at supporting the self-regulating ability of the soil, the plants and the animals on the farm. In particular, soil fertility must be prevented from deterioration or even enhanced. The use of synthetic chemical fertilisers, pesticides and herbicides is not allowed.
Because of the use of compost, organic farmers are more exposed to natural variability in farm conditions. That is why organic farmers need varieties that adapt well to specific soil situations on each farm and that grow well at low fertility levels. More than conventional farmers, organic farmers greatly value variety characteristics that contribute substantially to weed reduction, that contribute to a broad resistance to diseases and pests and a high product quality, for example taste.
To find basic, ecological principles for a breeding method for organic agriculture we have translated the basic principles from the farm level which involve a closed cycle, self-regulation and diversity to the plant level which requires respect for 1) self-reproducibility, 2) autonomous adaptability and 3) species barriers and species-specific characteristics. These principles characterise the specific nature of plants, in other words the intrinsic values and integrity of plants.

1. Self-reproducibility: According to the ecological principles of organic agriculture, a crop must be able to complete its life cycle in natural, organic soil circumstances. This ensures that the crop maintains its developmental potential in different growing conditions and guarantees sustainable use in the breeding system. Some modern hybrid varieties have lost their reproductive ability. Apart from losing their uniformity in the next generation, parent lines of some hybrids can only be maintained with propagation

[1]Organic agriculture is understood to be that section of agribusiness which operates in accordance with Council Regulation (EU) no.2092/91 on organic production.

[2] The discussion paper is part one of the project 'Towards sustainable organic plant breeding' funded by the Dutch Ministry of Agriculture, Nature Management and Fisheries (Department of Science and Knowledge Dissemination), which ran from September 1997 to April 1999. The aim of this project was to draw up a vision and statements on the possiblities for a plant breeding based on organic values (part one), to guide the discussion between various organisations connected with the organic sector (part two), and to draw up a policy plan for development of a plant breeding system for organic agriculture (part three). After the discussion paper of 1998 a final report was published in 1999.

by tissue culture. Another issue is cytoplasmic male sterility (CMS). This technique makes the propagation of hybrids easier by ensuring that female lines and progeny are male sterile. Sterility may be restored with a restorer line, which is not always available. From an organic point of view production of sterile varieties (including the latest method of seed termination) is ethically unsound as they result in an unsustainable use of plants, which are the result of centuries of cultivation. The proposal is to allow the use of hybrids in organic farming only if the vigour of the parent line has not declined to the extent that natural propagation is no longer possible and if F1 progeny can still be used for reproduction (i.e. is not male sterile using CMS without a restorer line).

2. Autonomous adaptability: Central to the ecological standpoint is the view that plants or crops should be studied in their interaction with the environment, in other words as a whole. Thus in situ selection is more important than selection based on individual, genetic traits alone. It is therefore important that breeding activities are carried out in organic circumstances, at the regional level.
Supporting autonomous adaptability to natural variation in environmental factors means increasing the genetic variation in and among the varieties of each crop and striving for durable levels of polygenetic resistance to diseases and pests rather than absolute, monogenetic resistance, as is the case with the use of the current genetic modification techniques.

3. Species barriers: Another question often posed in discussion is to what extent crosses between species should be allowed. Organic agricultural principles aim to respect natural species authenticity. Cross-breeding may be allowed to increase variation, for example to transfer the resistance characteristics of a wild plant to its cultivated equivalent, provided the cultivar maintains its ability to have the fertilisation taking place on the plant itself (and not in vitro).
In addition to respecting natural species authenticity, plant breeding from an organic perspective should retain or improve the quality aspects of a plant, such as taste, keeping properties and nutritional value. Desired aspects are subject to regional differences (diversification).

Socio-economic Aspects: From an organic agricultural perspective, a successful plant breeding programme is not only based on a close plant-environment interaction, but also on a close cooperation between farmers and breeders, optimising the use of mutual knowledge and experience. A more participatory plant breeding approach should be developed.
Modern plant breeding becomes more and more dependent on legislation measurements. Current legislation on the authorisation of new varieties is a bottleneck in the marketing of varieties with greater genetic diversity, suitable for organic farming. These laws need to be amended. The organic sector agrees that breeders' rights should be maintained, but demand more consideration for organic farmers' needs. This will require several changes such as a new funding structure for organic breeding.

Judging Breeding Techniques: In the above mentioned papers, the possibilities and acceptability of all current breeding techniques for organic farming were assessed on the basis of ecological and socio-economic principles. The techniques can be subdivided according to the level of plant organisation: the level of the crop and the plant, the level of cell (tissue culture) and the molecular level (genetic modification).
Organic plant breeding should be based on selection and crossing techniques at crop and plant level. These techniques address the plant-environment interaction and are better suited to a participatory breeding approach.
The organic sector has its reservations about breeding techniques at the cell level. Although the cell may be defined as the smallest living entity, there is no question of interaction between the organism and the natural organic environment at this level. From an organic point of view the plant is the smallest entity to focus on. Reducing plants to the level of the cell and culturing cells in the laboratory should be seen as an ecological detour, since adaptation to the organic farm situation must occur at a later phase in the breeding process. Many of these techniques are termed 'biotechnology'. Some have been used for years without enough awareness and objection from the organic sector. Sometimes these techniques are necessary when the 'distance' between the wild plant and its cultivated equivalent has grown too far for crossing. Alternatives will need to be developed should the organic sector decide against using such techniques.

EC Regulation 2092/91 on organic production prohibits the use of genetically modified material in organic production. Such a ban is justified on the basis of organic farming principles:

- It is a one dimensional and drastic intervention in a plant’s genetic make-up, which destroys its connection with its natural environment. To insert the desired DNA, the plant is first reduced to cell level and then reconstructed using tissue culture techniques. The (whole) plant x natural growing environment interaction is bypassed.
- There is insufficient knowledge of the risks connected with such reductionist methods; it is not unlikely that unexpected, detrimental effects on the ecosystem and public health will become evident in the long term.
- These capital-intensive breeding methods inevitably lead to patenting practices and the development of multinational breeding corporations, which together restrict the free exchange of genetic material and threaten genetic and cultural diversity.

However, in addition to genetic modification, selection techniques have been developed at the level of DNA, which do not alter a plant's DNA. In this case, such a DNA diagnostic method might supplement, but never replace, other field selection methods in an organic breeding programme.

A specific breeding system for organic agriculture is essential if the sector is to develop its potential and optimise its farming methods. It is important that organic agriculture, in the interests of a free choice in society, remains GMO-free. It is thus unavoidable that the organic sector sets up its own alternative breeding system, which does not exclude participation of or cooperation with conventional seed companies.

The organic sector makes a plea for a plant breeding system that respects the principles and demands of organic farmers and consumers. These principles and demands raise new breeding objectives. An organic breeding system should operate at a high level of plant organisation and should take into account regional differences and the complexity of agro-ecosystems. The scientific challenge to organic agriculture is to develop and optimise crossing and selection techniques at plant and crop level.

Literature

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Solutions of agronomic problems based on “ecological integrity”

Florianne Koechlin, biologist, director of the Blueridge Institute in Munchenstein (CH) member of the Swiss Ethics Committee on Non-Human Gene Technology, co-ordinator of “No patents on life!”

We're in West Kenya in a field station of the International Center for Insect Physiology and Ecology (ICIPE) near Lake Victoria. The small maize field in front of us looks dreadful: the plants are only 1 m high, the leaves yellow and full of holes, and there are almost no cobs at all. Close by, Mrs Ouzo, the farmer of these fields, shows us another maize field – the plants are over 2 m high, with dark green leaves and healthy cobs. It's the same maize variety on both fields, planted on exactly the same day. The difference could not be bigger. The first maize field was destroyed by stem borers and striga (witch weed), the two most important pests of maize and sorghum in all Africa. Stemborers can destroy up to 80% of the crop in no time, the loss of crops due to striga varies from 20 to 80%. If both pests are present at the same time, they can easily destroy the whole crop.

Around the second field, Mrs Ouzo planted 3 rows of Napier grass. "The beauty of this grass is that its odours are attractive to stem borers", says scientist Zeyaur R. Khan. "The grass then produces a gummy substance that traps the pests. Only about 10% of the stem borer larvae survive". Between the maize rows, Mrs Ouzo planted the leguminous Desmodium, a ground-cover plant whose odour repels stem borers.

The stem borer is attracted to Napier grass (*Pennisetum purpureum*) at the outside of the field and repelled by Desmodium (*Desmodium uncinatum*) from the inside of the field. This "push-pull" system was originally developed by ICIPE. The starting point was the knowledge that stem borers must have been indigenous to East Africa long before maize was introduced there (about 100 years ago). Originally its host must have been different kinds of wild grass. Only later on, it specialised on maize which had no resistance against it – but was all the more nutritious. For 4 years Khan and his team selected several species of wild grass with strong stemborer-attracting odours and cultivated them in a garden near the local station. Farmers from the surroundings were invited to choose from the different varieties: they mostly preferred Napier and Sudan grass, which both look very similar to maize and are good fodder. Varieties of wild grass looking more like "weeds" were left aside.

The selection of "repellent plants" was successful, too: The leguminous silverleaf Desmodium is a good stemborer-repellent. Furthermore, it binds nitrogen and thus enriches the soil. It keeps the soil moist and protects it from erosion. But most of all and to everybody's surprise Desmodium is most effective against Striga. Striga is a parasite to maize roots. One single plant produces 20,000 tiny seeds, that disperse easily. In all Africa, problems caused by Striga are increasing.

"Last year, I sold my Napier grass and Desmodium as fodder for 6000 shillings (about 100$, *FK*). With this money, I could afford to pay the school fees for my kids. This year, I am planning to produce Desmodium seed as well because all of my neighbours want to go for this push-pull system. Maybe, I can afford a cow then", says Mrs Ouzo. As one of the first farmers, she was chosen for the project because her fields were most heavily infested by stem borers and Striga. ICIPE plans to establish the push-pull system not only in further areas in Kenya, but also in Ethiopia, Uganda and Tanzania, in close co-operation with the national programmes.

Stemborers and a small wasp: Stemborers have natural enemies, which can be used successfully as well. Five different species of stem borers exist in Africa, the most aggressive one is the spotted stem borer (*Chilo partellus*). It was introduced from India/Pakistan to Africa some 70 years ago. ICIPE scientists went to India to do research in these centres of origin. They found *Chilo partellus* being a harmless pest kept well under control by several natural enemies. One of them is the little wasp *Cotesia flavipes Cameron*: it tracks down the stem borer larvae deep inside the stem and lays its eggs in the pest; these then hatch out and consume the borer from within. After careful testing, this wasp was released on 3 sites in Kenya. By now, the wasps are well established; they not only go for *Chilo partellus*, but for 3 other stem borer varieties too. The latest results show that stem borer infestation could be reduced by 53% in these areas. "Maize only came to East Africa some 100 years ago, and had no resistance against the stem borer. The imported stem borer *Chilo partellus* had no enemies. Any ecological balance that existed between native stem borer and wild grasses was severely disturbed. We try to reintroduce a natural equilibrium into this system", says Bill Overholt. I wanted to know if *Cotesia flavipes* would not harm other insects as well. Overholt confirmed this "The host range of this wasp is limited by its searching behaviour which restricts hosts to stem borer larvae found tunnelling inside the stems of larger grasses. And then it is only certain stem borers, and only the later larvae instars of these which are suitable for the development of the wasp parasites. We made careful evaluations and we did not find one other insect matching all these requirements."

ICIPE is working closely together with national programmes in Kenya, as well as in Uganda, Somalia, Mozambique, Malawi, Ethiopia, Zambia, Zimbabwe and Zanzibar to release the wasp *Cotesia* in all of these countries.

Stemborers and transgenic Bt-maize from Novartis: A third and very different strategy for fighting the stem borer consists of introducing genetically engineered *Bacillus thuringiensis* toxin transgenic maize. The African stem borer species are close relatives to the European corn borer, against which the Bt-maize was constructed. The Swiss company Novartis wants to test and introduce Bt-maize in Kenya. In spring 2000 they started a 5-year $6.2 million program with Bt-maize in co-operation with the Kenyan

Research Institute KARE and the Latin American International Maize and Wheat Improvement Center (CIMMYT) .

This project was presented at a meeting in March in Nairobi, "which turned into one single tribunal against Hans Herren (the director of the ICIPE). They accused him of being an enemy of Africa, and of assuming Africans were incapable of handling biotechnology" (The Tages-Anzeiger, 21.6.00). Klaus Leisinger, director of the Novartis Foundation for Sustainable Development, accused Herren of having gone to the Swiss Development Agency to warn them off GMOs. This is not true. Hans Herren is critical, but he is not a strict enemy of genetic engineering and he told an audience of Swiss government officials about his scepticism: "Possibly, transgenic maize will be part of the solution in the far future. But what about the other problems? The interesting thing about the push-pull system is that it already exists and the farmers use it. It was developed together with the farmers. With the push-pull method, we have an integrated solution for the problems of the stem borer and Striga. We have protein rich fodder, nitrogen fertilizer and good protection against soil erosion. All this within one field. It's a system that's enhancing justice and a sustainable agriculture."

A practising horticulturist’s view on the integrity of plants

Christian Hiss, Gardener and plant grower in Eichstetten (GE)

Twentieth century scientific knowledge and its practical implementation in food production has introduced into the history of civilisation a hitherto unprecedented change in the external and internal factors of plant growth.
Externally, 'soil free production' on an artificial substrate, with its computer controlled supply of essential nutrient salts dissolved in water as well as its provision of growing conditions through artificial light and heating, has reached a pinnacle of synthesis of the living conditions of cultivated plants.

Internally, technical modification of the plant's genetic make up has reached beyond the natural capabilities of plant growth. Thus we now exercise an influence on plant growth that has never before been seen. In modern consciousness, cultivated plants have been reduced to numbers and codes readable by machines, thereby rendering them apparently accessible to our complete control. From the producer's economic point of view this development is justified because the yields increased dramatically.

But the question arises as to whether this kind of scientific technical approach to food production leads to a loss of something essential for both people and plants. People lose something through possible changes in food quality and through restricting development of their faculties even to the extent of excluding existential questions about the meaning of existence. Instrumentalising the dialogue with the plant in both production and research limits human perception.

Whether the plant loses something and what that might be is a challenging question if we consider the rising yields and the considerable achievements in plant health of such production methods. The issues we need to address are as follows. Is plant integrity a unity or a multiplicity? How flexible is it in adapting to the surroundings in both laboratory and field? Are the various production methods justifiable in themselves or are there in fact overarching criteria of quality? What alternatives to instrumentalisation can we envisage?

The food plant from the processor’s perspective: The example of the cocoa tree

Craig Sams, Food processor, President of Whole Earth Foods Ltd., Hon. Treasurer of the Soil Association (UK)

Cacao grows wild in only two places, the upper Amazon and in Central America in Guatemala and the Maya Mountains of southern Belize. Cacao is a unique tree with a unique way of capturing nutrients, protecting itself and reproducing in a harsh environment and rearing its offspring in a caring and nurturing way. In the process it produces substances that have a profound attraction to humans, yet these are primarily produced to repel or even poison would-be predators. The cultivation of cacao takes many forms in different regions and some of these have led to the collapse of the cacao industry in large areas as their unsustainability becomes apparent. The most successful long-term cultivation of cacao is that which most closely reproduces the natural environment and functioning of wild cacao. 100 year old disease-free trees are not uncommon using this method, i.e. respecting the goals of the cacao tree.

The cacao tree figures prominently in Maya creation myths, being considered one of the components out of which humanity were created. Dedicated deities embody the spirit of the cacao tree and it features in the Popol Vuh as well as in the Deer Dance. There are parallels with Yggdrasil, the World Ash Tree of Nordic myth.

Making chocolate, with consideration of the unique characteristics of cocoa butter, we see that the characteristics of the tree can be translated into hot drinks and into chocolate confections. The processes of harvest, fermentation, roasting and processing are all most successful when they 'go with the flow' of the natural product and do not seek to change its character.

Genetic engineering of rape seed to produce oils with the same characteristics as cocoa butter will, if successful, lead to the reduction of the cacao tree population of the planet, with consequent negative effects on the forest canopy and forest biodiversity that is inherent to successful and conscientious cacao cultivation.

The success of Maya Gold shows that consumers respond to a processor's commitment to acknowledge the intrinsic value of the cacao plant and sense that there is more than just marketing fluff to the offering of chocolate made with respect for the integrity of the cacao and of the people who share its environment.

Does genetic engineering advance sustainable development?

Miges Baumann, policy analyst, Development Policy Department, SWISSAID, NGO for development co-operation

This contribution asks who in the corporate and public sector is developing what technology. It analyses the three generations of (plant) biotechnology, including the Genetic Use Restriction Technology (GURT). These developments will be measured with the parameters of sustainability (economic, ecological aspects and social equity.)

It will be argued that (in the developing world) patented corporate solutions can in various aspects not compete with existing alternatives in food and agriculture for enhancing a truly sustainable development. Also the promises of an example of public research (golden rice) will be evaluated and compared with existing alternatives.

Plant observation studies

Torsten Arncken, Jochen Bockemühl, Ruth Richter, Research Institute Goetheanum
Margaret Colquhoun, Life Science Trust Pishwanton (UK)

Sensorial encounters with plants comprise several aspects and levels of awareness. In plant observation, certain experiences are conveyed which can be perceived from the various manifestations of the plant in time. This should help us to grasp what we understand by the plant as a whole.

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