BIOTECHNOLOGY AND AGRICULTURE

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Two Differing Attitudes

Not everybody agrees on a definition of biotechnology. Some believe that it originated some ten thousand years ago in Mesopotamia, when humankind, abandoning hunting and gathering, actually invented agriculture and bred the first domesticated animals. These people do not accept any rift in succeeding stages of improvement of agricultural practices, which probably culminated during the 1960's with what was called the "Green Revolution." They further consider that the new biotechnologies, based on astounding knowledge of cellular mechanisms and DNA structure, are an equally simple step, crossing no threshold.

A very similar attitude may be observed among physicians. Considering that the medical ideal is to cure, indeed to eradicate, illnesses or abnormalities, some doctors think that operating on the human genome is nothing more than an extension of the efforts of preceding centuries. H. Tristram Engelhardt (1973) claims that medicine is the art of remodelling humankind, not according to the image provided by nature, but according to its own image. Medical functions follow an implicit idea of what a human being should be. To refuse to intervene in the genome, writes Taguieff (1993) in a paper entitled Les gènes défectueux sont-ils sacrés? (Are bad genes sacred genes?), is to respect the fatal transmission of hereditary defects; is to become party to the endless repetition of human suffering, although it is possible to relieve it. Jean Hamburger (1990) shares that opinion. He believes that to be against all application of the processes of genetics to humanity is to put the chances of possibly curing hereditary diseases at risk.

On the other hand, Hans Jonas (1992) considers that all intervention in the human genome constitutes" essential murder" and that the transformation of a human by a human is a kind of rape; that the remodelling of humans is a crime. The supporters of deep ecology are not very far away from that genomic neo-fundamentalism which claims that our defective genes are part of our heritage.

Jean Dausset (1992), Nobel Prize winner and chairman of the World Council for Scientific Responsibilities, stands between these two extreme points of view. He believes that in science there are acceptable and unacceptable things. "Mastery of life must not necessarily lead," he writes, "at least for the time being, and with our scientific knowledge being what it is, to modification of the human genome. That is unacceptable."

What have the biotechnologies achieved? Even the most enthusiastic (Tait, 1991) has to admit that relatively little has been produced. Furthermore what Tait calls biotechnologies may be considered not much more than simply classic biology and population genetics, for example, micropropagation, resistance to frost and various stresses, improvement in growth in plants. Also included can be control of diseases and reproduction, improvement of nutritional conversion, the quality of cattle-feeding, milk production and so on, among animals.

On the other hand, it seems that creating resistance to pests or herbicides by DNA transfer from one organism, say a bacterium, to a plant, is real biotechnology. The pioneer in this dangerous domain was Professor Baron Marc van Montagu, founder of the Plant Genetic Systems, in Gent (Belgium) (Vaeck et al., 1979). He transferred modified genes of Bacillus thuringiensis, which produces proteins toxic to a large number of insect species, to tobacco plants. These transgenic tobaccos are now protected against the larvae of Manduca sexta, a lepidopteran species. Totally ignoring the potential dangers of releasing GMO (Genetically Modified Organisms) into the environment, van Montagu and his team concluded that the transfer of different chimeric genes to a variety of crops might provide a new and environmentally safer method of controlling destructive insect pests.

Creating transgenic animals constitutes another example of biotechnology. The first announcement of such a manipulation was made more than ten years ago, in 1982. Giant mice had been obtained by injecting the gene responsible for the growth hormone of the rat into mouse ova, just after fecundation. These transgenic mice, twice as heavy as normal ones, transmitted the newly integrated gene to their offspring. Fortunately - or unfortunately - these animals had very unbalanced growth, physiology and morphology.

Hopes! Fears! It seems that the quality of a vast number of plants could be improved. It is not unreasonable to prophesy that the aminoacid content of various proteins could be improved, as well as the content of saturated or non-saturated fatty acids. The number of endogenous toxins could be diminished, decreasing or increasing the starch content, to modify taste and colour. It is not utopian to think that vegetal cells will be able to produce foreign proteins. Today, at the experimental stage, a tobacco plant may produce interferon, human albumin, bacterial á-amylase and even polyesters. However it will probably take a long time to fix nitrogen in non-leguminous plants, such as wheat, corn or rice, whereas twenty years ago it was believed that this could be rapidly accomplished.

According to the United States Department of Agriculture there were, in May 1993, nineteen plants which had been modified by the technique of recombinant DNA. The most highly modified plant was the potato, which became resistant to some highly specific herbicides, to some viruses and to some insects. Starch content had also been increased. More interestingly, a transgenic potato was obtained which produced chicken lysozyme. Transgenic corn and tomato plants resist a certain number of herbicides, viruses and insects. The ripening time of the tomato was slowed down, and the first tomatoes modified in that way were introduced on the American market in June 1994. In the United States, by May 1993, more than three hundred essays in the field had been compiled in 35 states. According to EBIS, the European Biotechnology Information Service, in June 1994 in Europe, there were currently over 250 research and development releases. These releases were in Belgium (60), Denmark (11), Germany (10), Spain (8), France (78), Italy (18), The Netherlands (32), Portugal (4) and the United Kingdom (35). These releases have so far been cleared under the 90/220/EEC Directive of the 8th of May, 1992, which introduced some rules concerning the voluntary release of GMO into the environment.

The Voluntary Release of GMO's

To obtain authorisation for the voluntary release of a GMO, the applicant firm must provide its national, or regional, authorities with answers to a great number of questions stemming from the 90/220/EEC Directive. The authors of that very full questionnaire seem to have only superficial knowledge of what a living being is and, more importantly, of the complexity of interactions between living beings and the environment. Finally, they are probably unaware of the extent of our ignorance of ecology. Some examples illustrate this: what is the probability, after release, of selection leading to the expression of unexpected and/or undesirable traits in the GMO? Describe the ecosystems in which the GMO could propagate. What is the possibility of excessive proliferation of the GMO in the environment? After release, what is the probability of alteration of the biological interactions of the GMO? It is hard to believe that such questions are being asked.

In France recently, a request for the voluntary release of a transgenic rapeseed - resistant to a specific herbicide - was made to the CGB (Commission du Génie Biomoléculaire). It is amazing that a representative of the agronomic world could declare, at a meeting organised by the French Minister of Environment (Disémination d'organismes génétiquement modifiés: la prudence est-elle possible? Paris, May 25-27, 1994), that the world of agriculture absolutely did not need such a transgenic rape! It should be pointed out, however, that if the authorisation for voluntary release is refused by one of the member states of the European Union, the United States or Japan, it will always be possible, and easy, to obtain such an authorisation from a wide number of countries such as China, the former members of the Soviet Union, South America, Africa, and so on. To what extent will scientists be forced, very soon, to speak of ecological interference, just as we talk today about humanitarian interference. GMO's ignore national borders.

The main characteristic of the numerous essays produced in the world during the last few years is that their first concern has been to discover whether the agronomic performance of the transgenic plant was high. There was very little concern about the possibility of the GMO becoming a pest (Karerva, 1993). The only exception is a study on rapeseed (Brassica napus oleifera), carried out in the United Kingdom over three consecutive years in twelve different environments (Crawly et al., 1993). The main characteristic measured was the possibility of invasiveness in the transgenic rapeseed. In all twelve environments a large number of ecological items was observed: presence or absence of mammals and herbivorous insects, presence or absence of pathogenic fungi, presence or absence of adventices, cultivated or not. The results of that study are perfectly clear: in all cases the growth of the transgenic rapeseed is rigorously similar to that of the non modified plant. Yet, one swallow does not make a summer.

It is clear that the remarkable experiment of Crawly and his co-workers does not provide definite and exhaustive answers to the problems raised by the GMO Indeed it is well known that a vegetal or animal pest may survive miserably for a while, to become virulent afterwards. Furthermore, invasiveness is not the sole problem; new genes transmitted by pollen-grains may be quite successful in sister-weeds and may give rise in the latter to a catastrophic heterosis (hybrid vigour). Finally we have no idea about the effects of the new agricultural practices which will be generated by the transgenic plants. An increasing use of herbicides and pesticides may have dramatic consequences on the balance of ecosystems.

Exotic Plants and Animals

What can be learned from the past? The voluntary, or involuntary, introduction of plants or animals foreign to a country is considered by some as a model applicable to the dissemination of GMO's. If this were true, it would be worrying. Pimentel et al., (1989), a surveyed of the fate of various animals and vegetables introduced into the United States for agricultural, horticultural or ornamental purposes, for hunting for sport, or as pet-animals. There were 5,800 vegetal species introduced; 128 became pests. Ten out of the 20 mammals introduced are creating great difficulties. The same is true for 9 out of the 20 mammal and bird species imported for hunting purposes. Yet only 5 out of the 2,000 species of fishes introduced became a nuisance.

In Australia the rabbit, which was introduced by the first migrants, who wanted to rely on it for part of their food supply, is a classic example, except that the full story is quite unknown. Rabbits were proliferating and therefore another mammal, the fox, was introduced in order to control the population size of the rabbits. Unfortunately, the foxes rapidly became aware that marsupials were much easier to catch than rabbits. As a result there are currently 20 species of marsupials which have definitely vanished. The rabbit becoming more and more prolific, and so Australia introduced myxomatosis, a highly specific and lethal viral disease. In a matter of months 99% of rabbits were killed. The one surviving percent - resistant to myxomatosis - started to reproduce and the situation today is as bad as, or even worse than, before.

Today Australians wish to use the new biotechnologies to restructure the virus of myxomatosis - one for rabbits - and another one for foxes. It is hoped that by such genetic manipulation both rabbits and foxes will become sterile (Morrell, 1993). Apparently nobody asked the simple question, how the dingo or domestic dog might react to the new viruses. And what would happen if the viruses migrate from Australia? And if one percent of the rabbits - and the foxes - were resistant to the viruses? Biotechnological acrobatics!

Yet the horror stories peddled by those who refuse to accept the new biotechnologies may be poor examples. It is not clear that the introduction of a new species into an ecosystem is comparable to the voluntary dissemination of a GMO. These latter organisms, feebly modified, are generally cultivated for decades, even for centuries. This does not demonstrate that they will behave properly, since nobody knows what impels a plant or an animal to become a pest. In the United States, Pimentel and his co-workers are convinced that accidents, provoked by a GMO, will happen, and that the effects of those accidents will never be eradicated.

The World of the Third Wave

Our present world is full of dangers. The key-words of this endangered world, resulting from the excesses which Alvin Toffler (1980) has called the second wave, and which have accumulated over the last three centuries, are: shortage of resources, pollution, destruction of the forests, acid rain, the greenhouse effect, destruction of the ozone layer, the population explosion, unemployment, ungovernable masses, international debts, destructive nationalism, impoverish-ment of the developing world, over-armament, nuclear death. As Hans Küng said (1991), the Occidental World introduced science, but not the wisdom which should oppose the excesses of scientific research; it brought in new technologies, but not the spiritual strength which should allow us to control the predictable and unpredictable risks of these technologies (still with biotechnology); it brought in industry, but not ecology; it brought in democracy, but not the morality which could act as a counterbalance to humanity's insatiable desire for power.

What will happen in the future? Vaucheret and Tepfer (1993) are of the opinion that the moral and ethical stances, which express themselves through the acceptance or refusal of transgenic plants and animals and the new technologies, will condition the future of, among others, the GMO. This seems to be happening in the United States with regard to the bovine growth hormone (BST Bovine Somatotropine). Clearly, that molecule substantially increased milk-production. Fears about the quality of the milk and, more essentially, sociological criticism (the use of BST will force a good number of farmers to leave their farms) and ethical criticism (dairy cows are exhausted after 3 to 4 years) induced a certain number of people and supermarkets to boycott the BST milk.

Why, then, have the great chemical transnationals systematically been buying up firms for vegetal selection and improvement for more than 10 years? The answer lies in lust for power. If you produce a quality total herbicide, plus improved wheat, corn or rice, manipulated for resistance to your specific herbicide, you will become king of the market.

How to React?

How should we react? And if we do react, will it be of any use? How should scientists react? For a good number of scientists two attitudes appear possible. The first, the more common, is blind acceptance - conscious or unconscious - of the dynamic in which we live. The other one is partial, or total, refusal to apply the new technologies. Such is, for instance, the attitude of the French biologist Jacques Testard (1992), and the German theologian Hans Jonas (1992). Testard is a scientist who resigned twice from his post. The first time was at the INRA (Institut National de la Recherche Agronomique) where he was currently working on a milk-production improvement programme. He became aware that as he was increasing milk-production he was automatically guaranteeing the disappearance of some small farmers. The second time was at the INSERM (Institut National pour la Santé et la Recherche Médicale) where he developed the new in vitro fertilisation techniques - he was the "father" of Amandine, the first French baby conceived in vitro. There, he became aware of the possible directions in which these new technologies were heading, and indeed which we can now observe everyday. He resigned again.

On the other hand, Gilbert Hottois, (1990) is of the opinion that there are three possible attitudes to the development of new technologies. The first is to test all techno-scientific potentials. It was Teller, one of the "fathers" of the A-bomb, who said that Technological Man has to produce everything which is possible, and has to apply the knowledge acquired by all means (quoted by Lenk, 1984). The second attitude is the choice of total renunciation and the preservation of the human-nature relationship. As Francois Gros said: "we are the administrators of our biosphere, not the owners." (quoted by Hottois, 1990). Now it is obvious that the technical imperative will result in the disappearance of ethics, while pure preservation will result in the disappearance of science and technology. According to Hottois, there is a third possible attitude: the decision to try certain techno-scientific possibilities as a function of criteria to be determined.

As a function of criteria to be determined! It is here that the difficulties, indeed the impossibilities exist. Who will determine these criteria? Who will be responsible? Who will be the master? Here again, there are a number of options.

A first option is a definitive retreat, a straight return to the past. Such is the option taken by Veritatis Splendor, the recent encyclical letter of Pope John-Paul II, released on the sixth of August, 1993. There is only one way to behave when confronting actual science and technologies, that is the one given by the Decalogue, the Ten Commandments of the Sinai, the natural law, and so on. The world should behave, with 6 billion inhabitants, just like a small Hebraic tribe wandering in the desert, some 2350 years BC. It must be remembered that the Decalogue was unknown in the Christian tradition up to AD 1246 when, for the first time, it was introduced in a manual created for confessors (Mendenhall, 1965). That return to the sands of the desert is accompanied by a keen distrust of those sciences called human, psychology and social sciences being among the worst offenders. Anthropology, of course, is also a nuisance. Anthropology has observed and described a large variety of customs, habits and institutions. From thereon, according to Rome, universal human values have been negated and the word "moral" has been considered in a relativistic context.

Yet the last fifty years have revealed totally new perspectives to us. It is with Christopher Columbus, in 1492, that the Occidental World very timorously began to discover that the whole world did not live in the same way. Yet it is only in the 18th century, after the great explorers and later on, in the 19th century, as a result of the colonisation of a large part of the world, that the differences between peoples became obvious. However, the Occidental World up to a few years ago was convinced that everybody had to live and to think as it (the Occident) lived and thought. It is a mere fifty years ago that a handful of philosophers, moralists and theologians started to admit that there were values, morals and ethics other than their own.

A synthesis of the entirety of these values is absolutely necessary. It is exactly in this way that Hans Kung (1991) is working. In his latest book Projet d'Ethique Planetaire, he writes that there will be no survival for humanity if there is no global ethos, no global peace without religious peace, no religious peace without dialogue between religions. He believes that - and this will be the fundamental ethical criterion - human beings should not live in a non-human way, on a purely instinctual basis, but rather in a reasonable human way. What will contribute, in a sustainable way, to the successful outcome of human life in all its individual and social aspects, will be ethically good. What will contribute to an optimal blooming of humankind - including drives and feelings - and be beneficial in its relations with nature and society, will be ethically good. Küng, of course, realises perfectly well that the efforts will have to be enormous. Indeed, as Habermas said (1988), we are still far away from that post-metaphysical age and way of thinking.

A Global Marshall Plan

A final attitude, probably the richest one, with regard to "de ces certitudes nouvelles qui mènent à l'incertitude," as given by Edgard Morin and Anne-Brigitte Kern in their remarkable book Terre-Patrie, is the one suggested by Al Gore, current Vice-President of the United States, in his book Earth in the Balance: Forging a New Common Purpose, which he published in 1992, shortly before becoming a candidate for the vice-presidency. His book starts with a precise analysis of all the dangers which threaten humankind at the end of the 20th century. He then proposes a project which he calls a Global Marshall Plan, to be financed by the United States, Europe, Japan and by wealthy, oil-producing states. In Al Gore's view five strategic goals must direct and inform efforts to save the global environment.

The first strategic goal should be the stabilising of world population, with policies designed to create the conditions necessary for a demographic transition in every nation of the world. The second strategic goal should be the rapid creation and development of environmentally appropriate technologies, especially in the fields of energy, transportation, agriculture, building construction and manufacturing, which are capable of accommodating sustainable economic progression without a concurrent degradation of the environment. The third strategic goal should be a comprehensive and universal change in the economic rules by which we measure the impact of our decisions on the environment. The fourth strategic goal should be the negotiation and approval of a new generation of international agreements that will embody the regulatory frameworks, specific prohibitions, enforcement mechanisms, co-operative planning, sharing arrangements, incentives, penalties and mutual obligations which are necessary to make the overall plan a success. The fifth strategic goal should be the establishment of a co-operative plan to educate the world's citizens about our global environment - first by establishing a comprehensive programme to research and monitor changes now taking place in the environment, in a manner that involves people of all nations, especially students; and second, through a massive effort to disseminate information about local, regional and strategic threats to the environment.

The required effort will be enormous, at the same level as the immense injustice which has divided the world into 650 million well-off people and more than 5 billion others. As Morin and Kern said: "La prise de conscience de la communauté du destin terrestre doit être l'événement-clé de la fin du millénaire. Nous sommes solidaires dans et de notre planète. C'est notre Terre-Patrie."

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