Environmentally sound management of biotechnology

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In 1990, concerns over possible safety and environmental risks raised by biotechnology prompted WHO, UNEP and UNIDO to identify and study the various safety issues involved. As a result, an Ad Hoc Working Group on Biosafety was formed by UNIDO, UNEP, WHO and FAO to work out practical guidelines through a series of consultations with international experts and scientists from developing countries. In 1991, the Working Group produced a Voluntary Code of Conduct for the Release of Organisms into the Environment. The International Centre for Genetic Engineering and Biotechnology (ICGEB), at that time still operating as a UNIDO project, played a key role in assisting the UNIDO Secretariat to develop the Voluntary Code of Conduct.

Since those early years of existence, the ICGEB has been assisting and training its Member States on issues related to biosafety and risk assessment for the environmental release of genetically modified organisms (GMOs). In 1997, the second year of the Centre as an autonomous intergovernmental organization, the ICGEB Secretariat decided to establish a Biosafety Unit with the task of providing its Member States with scientific, technical, environmental and official information related to GMOs.

The first task of the Biosafety Unit was to collect and analyze scientific articles addressing possible risks in the use of products derived by bio-technology. Since 1998, the 'ICGEB biosafety database' has been available on-line (URL: http://www.icgeb.trieste.it/biosafety/) and updated monthly. It contains to date more than 2,200 scientific articles, published in international peer-reviewed journals since 1990, indexed on a functional classification produced by the ICGEB and named 'Topics of Concern related to the environmental release of genetically modified organisms (GMOs)'.

Topics of concern

During negotiations on the recently approved Biosafety Protocol, both environmentalist movements and biotech associations produced extensive lists of eminent scientists for or against the use of GMOs. The same conflict is evident in the scientific literature contained in the ICGEB biosafety database.

Although there is much data supporting the safety of specific GMOs, nevertheless many uncertainties have been expressed, and many scientists have pointed out the lack of experimental data that would be useful, if not essential, in any assessment of the risk factor of these new products.

It would be useful in this context to bring to light some specific anxieties expressed by scientists referring to the potential risks of the two main traits inserted in the GM crops made available in the market in the past years: insect resistance and herbicide tolerance.

Insect resistance (use of Bt toxin gene)

Selection of resistant genes: The selection of resistant genes in a target population, as widely supported by scientific evidence, would compromise not only the utility of the technology but also the use of Bt spores utilized today as a biological pesticide. In fact, such a selection would force farmers to rapidly abandon one powerful method of bio-control and go back to the use of pollutant chemicals. Organic farmers claim that Bt spores could have been used much longer without the intensive selective pressure caused by the expression of the Bt toxin in every single cell of the transgenic crop. The long-term advantages of Bt transgenic crops are not certain and a more elaborate risk-benefit and a case-by-case analysis is being requested by many sectors in order to evaluate possible future limitations to the present agronomic practices and/or lack of an environmentally sound management of biotechnology by competent national authorities.

Susceptibility of non-target organisms: The long discussed case of the Monarch butterfly[1] has focussed public attention on a single case of a susceptible insect. The possible susceptibility of non-target insects, as well as the non-target microbial population, has to be fully examined for the whole ecosystem that could come in contact through leaves, roots or root essudates with the new molecules expressed by the transgene. Recent findings show that the Bt toxin binds rapidly to surface-active soil particles, and that the bound toxin retains its larvicidal activity and is protected by this binding against biodegradation.[2]

Allergenicity: In 1999, a scientific study claimed that exposure to Bt sprays may lead to allergenic skin sensitization and induction of IgE and IgG antibodies.[3] It is felt that an assessment of the allergenic potential of Bt toxin should be constantly carried out and constantly monitored especially in populations exposed to the presence of Bt toxin in food.

Herbicide tolerance (use of glyphosate or gluphosinate resistant genes)

Increased use of chemicals in agriculture: Although herbicide resistance was initially presented as an eco-compatible innovation, many critical opinions have been raised accusing this category of GM products of enhancing the volume of chemicals polluting the agricultural environment. On the one hand there is a tendency to increase the use of chemicals in agricultural practices; on the other, society at large demands an environmental role from biotechnology.

Toxicity: The application of sistemic herbicide in post-emergency of GM crops has resulted in a more complex issue than was initially considered. In fact, the novel application of long used chemicals can create a false feeling of familiarity with products never used directly on food. The herbicide gluphosinate ammonium, for example, when applied to herbicide-resistant transgenic plants is converted in its metabolite N-acetyl-L-gluphosinate, which is supposed to be non toxic in mammals. However, a fraction of the same metabolite is known to be reconverted into the original herbicide by gut micro-organisms of the digestive tract of warm-blooded animals. The GMO producer claims that this reconversion is unlikely to have harmful results in mammals. But many objections have been raised about the safety of this category of GMOs intended for food or feed and a full-risk assessment is still to be made on this particular aspect.

Horizontal transfer: Like many other traits inserted in GMOs, the risk of horizontal transfer for herbicide tolerance is cause for concern. The main worry is the potential for invasiveness and persistence of the GMO acting like a weed or a super-weed. In support of such concerns recent studies suggest that transgenic glufosinate resistance is capable of introgressing into *B. campestris* populations and persisting, even in the absence of selection due to herbicide application.[4]

Precautionary approach

Uncertainties about the wide diffusion of new products, especially when they are to be released freely into the environment, stem from a lack of scientific data (or existing contradictory data) about complex environmental interactions. Although scientific data are available for the first generation of GMOs approved for the market, many new concerns have been raised within the scientific community, mainly referring to the need to monitor, for a long period, the interactions between the “approved” GMOs and the environment where they have been released. The media have very often amplified the extreme positions of this debate and contributed to the confusion in public opinion. On the other hand, scientific debate is slowly beginning to focus on a much more interesting case-by-case analysis rather than basing itself on generic *a priori* statements on biotechnology usefulness.

Society has often moved through situations of scientific uncertainty, especially during the pioneering stages of the wide application of new scientific findings. In 1992, at the United Nations Conference on Environment and Development (UNCED), the Governments of the World, recalling their commitment to use the earth resources in a sustainable way, adopted in Principle 15 of the Rio Declaration on Environment and Development what has been called a “Precautionary Approach”: *Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation*.

The precautionary approach is a landmark in the area of political decisions related to the environment, and its inclusion in the Cartagena Protocol on Biosafety, adopted in Montreal in January 2000 under the Convention of Biological Diversity (CBD), outlines how to deal with scientific uncertainties related to the environmental release of GMOs.

The need for further development of internationally agreed principles on risk assessment and management of all aspects of biotechnology has been stated already in Agenda 21, a UNCED document that gives a blueprint for action for global sustainable development into the 21st century. The ICGEB efforts focus on promoting this development in order to allow society to derive maximum benefit from biotechnology and be in a much better position to accept its potential risks.

References

1. ICGEB/bsf-ID: 2106, 'Transgenic pollen harms monarch larvae', Losey JE, Rayor LS, Carter ME,1999. *Nature,* London, vol. 399 (6733): p.214.
2. ICGEB/bsf-ID: 2203, 'Insecticidal toxin in root exudates from Bt corn', Saxena D, Flores S, Stotzky G, 1999. *Nature,* London, vol. 402 (6761): p.480.
3. ICGEB/bsf-ID: 2285, 'Immune responses in farm workers after exposure to *Bacillus thuringiensis* pesticides', Bernstein IL, Bernstein JA, Miller M, Tierzieva S, Bernstein DI, Lummus Z, Selgrade MK, Doerfler DL, Seligy VL, 1999. *Environ Health Perspect*, July 1999,107(7):575-82.
4. ICGEB/bsf-ID: 2076, 'Fitness costs associated with transgenic glufosinate tolerance introgressed from *Brassica napus ssp. oleifera* (oilseed rape) into weedy Brassica rapa, Snow AA, Jorgensen RB, 1999. Conference Title: Gene flow and agriculture: relevance for transgenic crops. Proceedings of a symposium held at Keele, UK on 12-14 April 1999, pp.137-142. BCPC Symposium Proceedings No.72, Publisher: British Crop Protection Council. Farnham, UK. ❑