ENVIRONMENTALLY SOUND MANAGEMENT OF BIOTECHNOLOGY

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Contents

Summary

The release of transgenic crops on a commercial scale has developed rapidly in recent years. Laboratory experiments and field trials on biosafety have been rather few, however. Evidence exists that living modified organisms (LMO) have had affects on biodiversity and transgene have been transferred to wild related species via gene flow. On the other hand, more and more people are adopting a sceptical attitude to whether or not transgenic foods affect the health of humanity. Biosafety must become one of the most important issues requiring attention, worldwide. The essential steps in environmentally sound management of biotechnology are legislation and scientific research.

l. Introduction

Scientists have been worried about the potential risks of the DNA recombination technology from its early stages in the early 1970s. Endless debates have accompanied the development of this technology. Transgenic crops were released on a commercial scale before the "United Nations Conference on Environment and Development" held in Rio de Janeiro, Brazil, in June l992. These included tobacco mosaic virus (TMV) and cucumber mosaic virus (CMV) resistant transgenic tobacco, which were planted on 8600 hectares in Henan Province, China. Many transgenic cultivars of crops had been tested in field trials over many years and were on the eve of release on a commercial scale in USA and other countries. At least 2 articles of the "Convention on Biological Diversity", which was signed by the heads of states or governments, were specifically concerned with living modified organisms (LMOs), because of the increasingly strident calls for regulating, managing or controlling the risks associated with their use. Article 8, item (g) of the Convention, "*in situ* conservation", reads: "Establish or maintain means to regulate, manage or control the risks associated with the use and release of living modified organisms resulting from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking also into account the risks to human health". Article l9 of the convention "Handling of biotechnology and distribution of its benefits", states: "The Parties shall consider the need for and modalities of a protocol setting out appropriate procedures, including, in particular, advance informal agreement, in the field of the safe transfer, handling and use of any living modified organism resulting from biotechnology that may have adverse effect on the conservation and sustainable use of biological diversity". The resolution by the first conference of the Parties held in Bahamas in November l994 stipulated that it was necessary to set up a special group on biosafety, to comprise l5 experts nominated by states or governments. The task of the group was to submit the documents for consideration by an "Open Ended *ad hoc* Working Group on Biosafety". The sixth conference of this expert group was held in January l999, but, to date, agreement has not been reached on a series of issues related to the protocol.

2. Potential risks of LMOs released to environment

Should the ecological risks be deemed to require it, the elimination of LMOs released on a commercial scale would be extremely expensive, and impossible in most cases. The following ecological risks maybe occur.

2.1 The wild related species of transgenic crops become weeds

Many species related to crops do not exist as weeds in nature, under most conditions, owing to natural forms of control. But these wild-related species may become weeds, once the natural balance is disrupted. These related species may grow vigorously and propagate rapidly when they acquire resistant transgenes from transgenic crops via gene flow. This has been verified by studies carried out by Mikkelsen et al that demonstrated the introduction of transgenes of *Brassica napus* to the wild related species *B. campestris*. The chromosome number of *B. napus* is 2n=38, while the latter is 2n=20. Interspecific hybrids can be obtained after hybridization between glufosinate tolerant transgenic *B. napus* and *B. campestris.* Similar in morphology and highly fertile glufosinate *B. campestris,* the chromosome of which is 2n=20, was discovered in the first generation of backcross. It was confirmed that the transgene of *B. napus* can be rapidly spread to *B. campestris*.

2.2 Transgenic crops themselves can become weeds

Some kinds of cultivated crops have a dual nature, such as some species in *Sorghum*. They are cultivated as crop in normal conditions, but they themselves can also act as weeds under specified conditions. Some crops, which were normal under conditions of natural balance, may tend towards weediness when the insecticide resistant gene or herbicide resistant gene, etc, is inserted or obtained from the escaped transgenes. Other crops, such as, sugar cane, potato, rapeseed and oat, all have close related species with weedy traits, and could become weeds after genetic modification.

2.3 Effect of transgenic crops on biodiversity

The effect of transgenic crops on biodiversity or non-target organisms has been confirmed by the results of many recent experiments. Transgenic crops have been released on a commercial scale for only a few years and it can be predicted that evidence will increase rapidly through the passage of time. Two case studies, one of which was a laboratory experiment and the other a large-scale field trial, will be described in this article.

2.3.1 Pollen of transgenic maize harms the larva of the monarch butterfly

The toxic protein from the CrylA(b) gene in insect resistant maize is also expressed in maize pollen. A very simple but tremendously influential experiment on a laboratory scale was completed by Losey et al. The only source of food for caterpillars of the monarch butterfly *(Danaus plexippus)* is species of *Asclepias*, including *Asclepias curassavia*. Monarch larvae were fed with leaves of *A. curassavia*, on the surface of which there was a layer of pollen from transgenic *Bt* maize, with a density similar to the dusted pollen under natural conditions. More than l0% of larvae died on the second day and 44% died 4 days later, but all larvae of the two controls survived. The two controls consisted of no pollens on the leaves of *A. curassavia* and normal pollen on the leaves. The consumption rate of leaves clearly varied. The largest consumption rate occurred on leaves with no pollen on the surface. The consumption rate was very much less on leaves with *Bt* pollen, leading to a decrease in growth of larvae. Their weight was only half of those of one of the controls (no pollen) at the end of the experiment.

2.3.2 Transgenic *Bt* cotton seriously harms the dominant parasitic natural enemies

Monitoring has been carried out by Xia Jing-yuan et al. after release of transgenic *Bt* cotton on a commercial scale. Results illustrated that dominant parasitic natural enemies of the cotton bollworm were seriously harmed by transgenic *Bt* cotton. The numbers of larvae of the parasitic natural enemies *Campoletis chlorideae* and *Microptitis sp*. per hundred bollworm larvae in *Bt* cotton, decreased by 79.2% and 88.9% respectively, in comparison with the control (normal cotton). The parasitic rate and emergence rate of *Campoletis chlorideae* parasitizing bollworm fed with transgenic *Bt* cotton decreased

9l.4% and 37.5% respectively, as compared with those fed with normal cotton. The weight of cocoons and individuals of *Campoletis chlorideae* decreased 54.0% and ll.l%, respectively in comparison with the control. The parasitic rate of *Microptitis sp*. decreased 57.l% in comparison with the control; the weight of individuals decreased 44.2%, and all the cocoons were dead, no individuals emerging from them. It can be concluded, therefore, that transgenic *Bt* cotton seriously harmed the rate of parasitism, the hatching rate and the cocoon quality of the dominant natural enemies of bollworm larvae.

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Biographical Sketch

Qian Yingqian was born in Zhejiang Province China on 28 December, l932. He graduated from Department of Biology, Fudan University, Shanghai and graduated from Department of Biology, Nanjing Univerisity, Nanjing, but there was no degree system at that time in China. He has been working in the Institute of Botany, Chinese Academy of Sciences (CAS) since l959, and has been a research professor since l986.

He has studied plant cell biology since the late l950s. His main contribution in the early l960s was studies on the behavior of somatic nuclei and reproductive nuclei in corn pollens germinated artificially, and he found the wall-like material around the sperm for the first time in the world by using electron microscopy. Protoplast culture, somatic hybridization and related issues on plant cell biology were studied since the early l970s. In cooperation with his colleagues, whole plants of corn, trititrigia and kiwifruit were regenerated from protoplasts; all of these regenerated plants were the first record in the world. *Nicotiana tobacum* and *Glycine max* hybrid cell line were obtained via somatic hybridization. First and second prize of natural sciences award of CAS and third prize of natural science award of the State were achieved owing to the achievements mentioned above in the late l980s and early 1990s.

He has studied the field of biodiversity since the early l990s, and was one of the first scientists involved in biodiversity and biosafety in China. More than ten papers on biosafety were published in professional journals and popular science magazines.

He has been the Deputy Director, Director of Institute of Botany, CAS (l98l-l986), Director of Bio-Sciences & Biotechnology, CAS (l987-l992), President of Guangxi Academy of Sciences (l992-l994) and Editor-in-Chief of the Journal, *Chinese Biodiversity*.