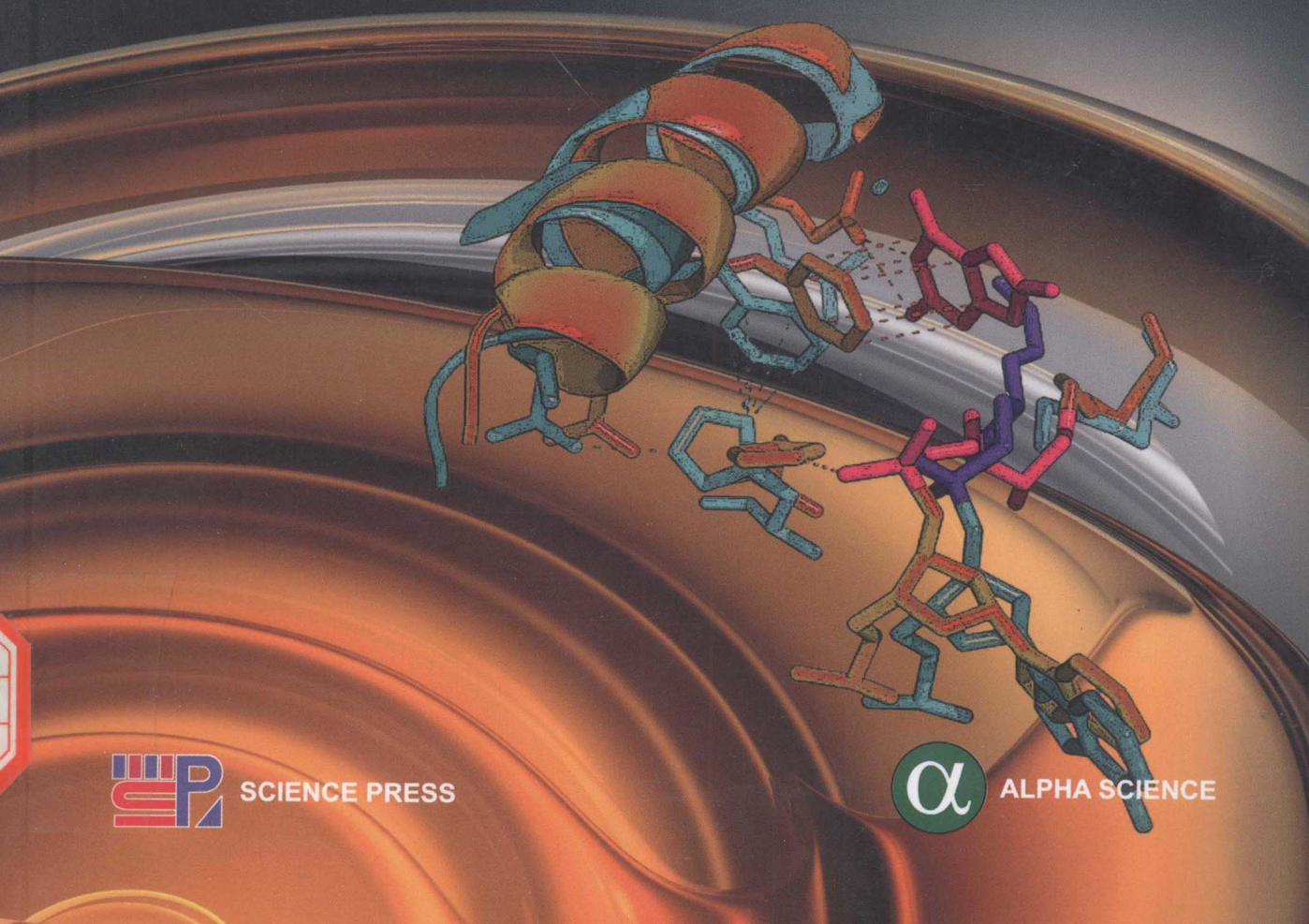
Biosafety and Regulation for Genetically Modified Organisms

Xue Dayuan



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Preface

Population, resources and environment have always been the triple fundamental problems facing the survival as well as development of human beings, and technological revolutions suppose to have the answer to which. Ever since 1980s, along with the development and application of gene recombination and transformation, biotechnology has evolved into the modern stage, tremendous economic benefits have been produced which signals that modern biotechnology industry with genetic engineering as its core is rising and growing dramatically.

The industrialization of biotechnology promotes the trade in biotechnological products worldwide, especially with respect to development and application of biotechnological agricultural products. Transgenic crops grown with the traits of insect-resistant and herbicide-tolerant have already been commercialized in some American and Asian countries as far back as 1990s, and the products have been sold to other countries continuously. Nevertheless, the process has been very fast, as the approval for large-scale commercialization of genetically modified organisms' only dates back to 15 years.

Commercialization of transgenic tomatoes back in 1994 signaled the start of using genetically modified organisms. The planting area of transgenic crops in 1996 was 1.70 million hectares, with an increasing rate of 13%; 114.3 million hectares in 2007 and was 65 times higher as that of 1996. There were totally 23 countries planting transgenic crops back in 2007, including 12 developing countries and 11 developed countries, and genetically modified crops were predominantly grown in six countries, namely, the U.S., Canada, Argentina, Brazil, India and China.

In China, transgenic Bt cottons are the main crops approved for commercially planting, and the planting area accounts for approximately 2/3 of the total planting area of cotton, which distributed in the regions around Yellow River, Yangzi River and Xinjiang province as well. Although the approval for commercially planting of genetically modified food products is not yet in place in China, several genetic engineering researches with regard to rice, wheat, maize, rape, soybean and other crops have been carried out already. In the past dozens of years, soybeans with quite large quantity have been imported for producing cooking oil and other products. 70% of soybeans that imported mainly from the U.S., Argentina and Brazil are transgenic types, and the importation rate is increasing in the meanwhile. None of us could ever be immune from transgenic food products as genetic engineering soybean oil has been used quite widely for cooking.

Notwithstanding, genetically modified organisms are characterized as scientifically uncertainty, certain risks regarding to commercialization and large-scale application are therefore inevitable. How to address the issues concerning risks assessment and management is of crucial importance for scientific management and sustainable development.

Release of GMOs into the environment could be harmful to humans and to other organisms as well.

Biotechnological products may have environmental risks over the course of packaging, transportation, storage and application, potential risks posed by living modified organisms that consumed by human and animals as food or feed are relatively high. With the development of industrialization of biotechnology products, biosafety issues concerning biotechnology therefore have emerged as the common concern of international community as a whole and each government as well. Issues with regard to biosafety have also been one of the hot topics in the areas of environmental protection cooperation among nations, especially for the developing countries which are obviously lack of capacity building in dealing with the environmental risks posed by biotechnological products. These countries expect to put in place an international agreement on import of GMOs, and could be supported financially and technologically by international community in terms of capacity building, while on the basis of current international trade in GMOs, several developed countries have expressed great concern with regard to such agreement,. All these driven factors lead to the emergence of the Cartagena Protocol on Biosafety.

Issues concerning biosafety of GMOs encompass quite a wide range, including genetic engineering technology, biosafety and risk assessment of transgenic food, ecological risks and evaluation of such potential risks, detection and monitoring of GMOs, risk management, socio-economic impacts, international biosafety law, the domestic regulations and management systems and public education and participation. That is to say, biosafety issues regarding to GMOs can not only be addressed within scientific framework alone, but also have to be scrutinized under social framework as well. With respect to scientific research, risks assessment should be carried out so as to provide data for management; in the meanwhile, great emphasizes should also be attached to social aspect of GMOs, so as to reaffirm the those objectives set by scientific studies.

In this context, we have initiated a lecture course on GMOs and Biosafety for graduate and undergraduate students in Minzu University of China. After several years of practice, teaching materials and framework have been continuously accumulated and improved accordingly. Afterwards, several active researchers within related areas of expertise were invited to participate in the editing work which was supported by the projects of GTZ/BMZ Biosafety Capacity Construction and UNEP/GEF China Biosafety National Framework; over the course of compilation, some latest research results were included. Apart from the contribution from members of the editor board, other researchers including ZHANG Zhen, WANG Junhui, ZHOU Qiulin, XU Haibin, WANG Xuejun, CAI Xingxing, YANG Jing, CHENG Wenjuan, PAN Feng and others have also provided great support. ZHANG Wenguo and WANG Jie from the Ministry of Environmental Protection and FENG Jinchao and ZHOU Yijun from Minzu University of China have also been of great help during the compilation of this book.

We hope that this book can be of help and reference for researchers, students and others who are interested in issues concerning GMOs and biosafety. Any comments as well as criticisms are appreciated.

Xue Dayuan
In Beijing
March 2014

Contents

Introduction

The 21st century is the century of biology, and fruitful achievements and great successes have been gained in various fields of biological research, development, and application. The rapid progress in biotechnological research and its results have been rapidly applied to all fields of life sciences. For example, the use of somatic cell cultural and transgenic technology for genetic improvement of crop varieties; the use of bacterial fermentation technology for biology pharmacy; deciphering of important plant and animal genome; and the breakthrough in animal cloning technologies and the resulted clone sheep, clone cows, and clone pigs, etc.; all of the above have brought enormous opportunities for the improvement of human survival and life quality. Especially since early 1970s, the establishment of recombinant DNA technology and the subsequent rapid development of transgenic technology have played, and will continue to play, a key role in fields of agriculture, forestry, fisheries, medicine, light industry and environmental protection, etc. Many people believe that biotechnology will be one of the ten key-technologies for high-tech development in the next few years. Some even consider the biotechnology, particularly GM technology as key technology to solve the food security problems for developing countries in the 21st century. The great breakthrough and contribution of biotechnology including transgenic technology let people feel that they may solve the problems by themselves, and human have the ability to change the nature!

1. The safety issues of transgenic technology and biosafety conception

1) The safety issues of transgenic technology

As we all know, science is a ruthless "double-edged sword", while human is immersed in the surprises of a series of biological research and extensive great breakthroughs and achievements in the century of biology, there occurs a series of biosafety problems in biology field which alarm human, such as the invasion and madly outburst of alien species; the erosion of biodiversity; the transmission and adverse effects of transnational livestock diseases (such as the avian flu, mad cow disease and aftosa) on human; and the reports on the unsafe possibility of GM crops or GM food, etc. Does biotechnology, especially recombinant DNA and transgenic technology have potential danger? Are genetically modified products safe and reliable? With a variety of lab-research achievements of GM crops released from the laboratory to the environment one after another, conducting field experiment and even large-scale environmental release and commercial production, and finally getting into the commercial markets and onto the family's table, skeptical or even opposite voices on GM crops are arising increasingly around the world. People in many countries and some non-governmental organizations (e.g. Greenpeace) are

extremely dissatisfied with the research, production and commercialization of biotechnology products, and there arise many protests, marches or boycotts on biotechnology products constantly. People are increasingly concerned at biosafety, and biosafety issues become the focus of international contention for a time. Then, what is biosafety? How do biosafety issues come out? What are the main contents that biosafety involved? What is the meaning of understanding of biosafety? These are all questions that very interesting and worthy of clarification.

2) The broad conception of biosafety

Biosafety may be one of the most frequent vocabulary related to biology appeared in the modern media. As the name implies biosafety must be related to biology and safety. Then, what is biosafety? Which subjects are biosafety related to? Only when understanding the definition biosafety, we may further understand the content it relates to, and what does it research. Biosafety has broad and narrow definitions, broad biosafety refers to "In a certain time and space, exotic species immigrant because of natural or human activities, and thus change and harm the other local species and ecosystems; human-induced intense changes in the environment and its impact and threat on biodiversity; harmful effects on human health, living environment and social life resulted from scientific research, development, production and application." According to the definition above, biosafety covers a wide range of content and fields, including all of the safety problems caused by natural factors and human activities. Therefore, biosafety includes biotechnology, invasion and outbreak of exotics, natural disasters caused by human activities, spread of pandemic diseases and insecurity factors and adverse effects caused by environmental pollution.

3) The narrow conception of biosafety

The biosafety discussed in this book mainly refers to the safety issues related to GM biological engineering technology and products, which is the narrow conception of biosafety. Although the narrow conception has different definitions, in general, biosafety refers to the problems on human health and ecological safety during the whole process of research, development, production and practical application of GM biotechnology and GM products.

According to the definition by UN/FAO, biosafety refers to "The avoidance of risk to human health and safety, and to the conservation of the environment, as a result of the use for research and commerce of infectious or genetically modified organisms".

Other definition of biosafety is to achieve a goal, in order to ensure that GM plants and other genetically modified organisms and the development and use of products produced by biotechnology will not cause adverse effects on plants, animals, human health and genetic resources and environment.

While the narrow definition of biosafety has various versions, and there are some differences between them, but it is not difficult to make out, that the narrow biosafety emphasizes the probable adverse effects and hazard on plants, animals, human health and safety, genetic resources and the environment caused by GM biotechnology and its genetically modified products in research, production and use processes.

2. Raise of biosafety issues

The worry on biosafety was raised in the early 1970s. The emergence of biosafety issues is closely related to the development of biotechnology, especially recombinant DNA, genetic engineering and transgenic technology. During the raise of GM biosafety issues, there are two very important

conferences: the first is Gordon Conference held in 1973 in New Hampshire, when discussed in nucleic acid issues, many biologists raised the safety issues of genetic engineering, and proposed to set up a particular committee to manage the development of recombinant DNA research and instructive laws and regulations; the second is the international conference held in February 1975 in Asilomar, California, scientists officially proposed the safety issues of GM organisms, and took the safety of GM organisms as the key question to be necessarily considered in the development of genetic engineering.

1) Inauguration of transgenic technology era

In the early 1970s, the molecular experiment done at Stanford University in US created the precedent of genetic engineering, and also brought a general debate on the potential risks of genetic engineering. In the late 1960s, Paul Berg, the professor of biochemistry at Stanford University began a study of simian virus SV40. Professor Berg intended to use the virus of higher animal to bring alien genes into eukaryotic cells, and take them as a kind of better carriers of the prokaryotic genes. Therefore, he tried to connected a fragment of DNA from bacteria to the simian virus SV40's DNA. Through their efforts, Berg and his assistant successfully connected the DNA from different source together, and gained the first recombinant DNA in the world. This great breakthrough makes it possible for human to reconstruct organisms by modifying their DNA.

In June 1971, in a biology conference held at Cold Spring Harbor, Professor Berg reported their work about preparing to transform recombinant DNA into the eukaryotic cell, which raised the attention of some biologists. A microbiologist Robert Pollack, who worked in Cold Spring Harbor Laboratory, reminded Berg, that SV40 they studied is a small animal tumor virus, which can transform the human cells into tumor cells. If some research materials spread to the natural environment, it would become a human carcinogen factor which may lead to a disaster. This problem aroused the high attention of Berg and his assistant, after consulting several related biologists and fully discussing with some specialists on simian virus SV40, Berg accepted the advices of the scientists, and suspended the experiments on cell transfection in the fall of 1971, in order to have a further understanding of the safety issues of recombinant DNA before continuing the experiment.

In the spring of 1972, Boyer Laboratory at University of California isolated a new endonuclease from *E. coli*, named *Eco*R Ⅰ, which can cut the DNA in its specific location, and then the cutting-off DNA fragments can also be re-connected, this new endonuclease is called restriction endonuclease. Since then, biologists obtained a "biological knife", which can be used to carry out various operations on genetic material of organisms to change their genetic characteristics. Later, a variety of restriction endonucleases were discovered, which allowed biologists to easily manipulate the genetic materials of various organisms. These series of findings and research progresses deeply made more and more people concern at the potential hazards of recombinant DNA.

2) Early warning in Gordon Conference

On June 13th, 1973, a nucleic acid seminar named Gordon Conference was held in New Hampshire in the U.S., in the conference the role of bacterial restriction endonuclease in DNA operation was discussed, after Boyer introduced his work cooperated with Professor Cohen about cutting the genes from different sources and splicing a gene heterozygote, many scientists participating in the conference felt excited, but also expressed concern about the future operation on genetic engineering. Under the suggestion of scientists participating in the conference, the conference committee specially organized a seminar on the biological risk on recombinant DNA, and then made a decision to address to National

Academy of Sciences (NAS) and the National Drug Research Institute (NIM), calling on them to found a special committee on managing the research on recombination, enacting appropriate instructive laws and regulations, fully guaranteeing the safety in the research of genetic engineering. Philip Handler, President of NAS received the letter, then after a Council discussion, he agreed to found a committee to deal with the safety issues of recombinant DNA technology.

In January 1974, Berg was entrusted the work of this committed and began to prepare a small seminar, which held in April at MIT. The scholars including Watson, Nathans and other Nobel Prize winners, attended the conference, and then proposed a report that summed up the developments on recombinant DNA technology since Gordon Conference, and also pointed out that it would bring biosafety problems without restriction and guidance. The committee proposed the following four recommendations:

(1) Forbid to carry out two types of experiments temporarily. The first is the experiments on constructing novel, self-replication plasmid with potential hazards, because this plasmid may transform the resistance to antibiotics into other microorganism, or bring the virulence into avirulent one; the second is experiments on connecting the cancer genes or other animal viruses with plasmid or other virus genes. Scientist around the world should obey it consciously, until an appropriate method came out to evaluate and control the potential hazards.

(2) Take the experiments on connecting animal DNA with plasmid or phage DNA into serious consideration.

(3) Call on US institutes of Health (NIH) to found an advisory committee to manage the risk assessment of recombinant DNA, look for ways to reduce this risk, and set up criteria to guide the research on recombinant DNA.

(4) Hold an international conference in 1975, scientists engaged in this area would discuss together how to deal with the potential hazards of recombinant DNA.

3) Contention in Asilomar Conference

On December 24th - 27th, 1975, after active preparation by Berg and other American distinguished biologists, an international conference on the biosafety of recombinant DNA was held in Asilomar in California. 150 representatives from US and other 12 countries attended the conference, and they were all the elite in molecular biology of the time. In the conference the representatives expressed their views, each showed that the manipulation of genes had risks of hazard or did not have safety problems by a large amount of experimental evidences. In this view, for the safety of genetic engineering, there had always been two completely different views and perspectives. These two opposites had their own advocates, who carried out intense and wide-ranging discussion, even contention from the beginning of the conference. Professor Sydney Brenner at Biology Laboratory in Cambridge pointed out that the risk of biosafety was not only a term in the laboratory, but also a comprehensive, long-term effect; it might bring some potential, indirect effects to organisms and their environment, or might not bring effects in the future, but came out the hazard after a long incubation period. He believed that Asilomar Conference was the first formal discussion on biosafety held by the world's pioneers of molecular biology, and biologists should look further ahead, take integrated approaches, and be not just limited to the immediate point of contention.

Asilomar Conference is an important conference concerning transgenic biosafety, and is the first conference officially held in the world about genetic engineering biosafety. In the conference, there was

a heated discussion on a series of biosafety issues, and there were more wide discussions about more comprehensive and long-term biosafety, problems that recombinant DNA might escape to environment, bio-security and details in transgenic laboratory, researches in virus and *E. Coli* as well as diseases they might cause, and the development of biology and biosafety issues that the public concerned and participated in. It was important that most biologists advocated that experiments in genetic engineering should be continued, and that biology should develop and move forward, but we should take security measures according to the risk and biosafety problems of genetic engineering, to prevent and avoid potential risk as much as possible instead of holding up the progress of genetic engineering. National Institute of Health published the interim report of Asilomar Conference, and it served as the policy paper of public laboratories in the US. Moreover, Asilomar Conference also became a conference that had great historic significance in transgenic safety and management in human society.

4) Arousing public concern

After Asilomar Conference, transgenic organism technology had a rapid progress. Under the circumstance that large quantities of transgenic organisms have been successfully created and continuously released to environment, biosafety problem seems more and more notable, and a number of countries have begun to lay down relevant transgenic biosafety management rules and laws, which the following chapters of this book will discuss in detail. And a series of biosafety assessment systems have been laid out, and the details will also be specifically discussed in the following chapters.

Now biosafety is not only limited to few scientists or administrative staff, but has become a great event concerned and discussed by the public. As GM organisms have experienced a large-scale environmental release and commercial production in the world, GM products have been transported across boarder through international trade; GM food has become consumer goods of many common people, so the public have to consider the safety of GM organisms for their own health and environment.

5) Appearance of potential risk

There have been some reports concerning the security problem in consuming and the process of research and development of GM plants. For instance, a kind of GM soybean containing Brazil-nut allergen may cause hypersensitivity of some populations; Pusztai, from Rowett Research Institute in Scotland reported that the weight of body and organs of rats was apparently reduced after fed with Galanthusnivalis agglutinin (GNA) GM potatoes, and that their immune systems were damaged; Losey from Cornell University in US reported that the pollen of *Bt*-GM maize caused growth retardation or even death of the larva of monarch butterfly; the "Terminator" Technology patent applied by USDA and DPL(Delta and Pine Land) has damaged the interests of farmers in developing countries, and it has caused strong reflections in global society since it might lead to biosafety problem when the "terminator" gene escapes to environment via pollination; there were also incidents like GM maize ruined the environment and stealing and burning GM crops, etc. Those reports and events have left more suspicions in consumers and have evoked more contentions on the biosafety of GM food. It has been more than ten years since the wide application of transgenic technology and consummation of GM food up to now, but there are no reports about serious harm caused by using GM organisms. Though, people are not less alert about the risk of GM organisms, but treat them more prudently and rationally.

6) Wide concern in the world

On July 11th, 2000, Chinese Academy of Sciences, the Royal Society, United States National Academy of Sciences, Brazilian Academy of Sciences, Indian Academy of sciences, Mexican Academy

of Sciences and Third World Academy of Sciences issued a joint statement concerning "GM plants and world agriculture", pointing out the irreplaceable importance of transgenic technology in eliminating hunger and poverty in Third World; meanwhile, they considered that studies on the safety of GM organisms should be reinforced to ensure the well development of research and application of GM organisms and to improve the safety in environment and consuming GM food. Moreover, the statement on problems in biotechnology issued by FAO indicated that "Biotechnology provides powerful tools for the sustainable development of agriculture, fisheries and forestry, as well as the food industry... Biotechnology can be of significant assistance in meeting the needs of an expanding and increasingly urbanized population". However, FAO also noticed that people were worried about the risk of biotechnology in some aspects, especially effects on human health and potential hazard to environment. In addition, FAO mentioned that unified culture of few GM cultivars replaced the diversity of traditional landraces, which might compromise the biodiversity of crops. FAO advocated risk assessment system based on science, objectively analyzing the profits and potential risk of each GM organism, evaluating every GM product, technology and program and their probable effects on biodiversity, environmental and food safety, and seriously detecting the effects after application, to guarantee the sustainable safety to human.

7) Development of the conception of biosafety

Looking back to the origin of transgenic biosafety and the generation and development process of the conception, they have developed to a large extent and have more contents. In Gordon conference, consideration about the biosafety of recombinant DNA was limited to some disease harmful to human in laboratory or limited environment, while now it has cover safety problems in many aspects that transgenic technology and GM products might bring about, such as food security, effects on plants, animals and biodiversity, and social ethics. People's knowledge about the problems of transgenic technology and GM products is deepened step by step: from advocating rigid restriction due to fear at first, to gradually accepted that the negative effects of GM organisms can be reduced by scientific test, evaluation and management.

Safety is a relative conception. Any technology especially new ones could not ensure one-hundred percent safety. Just like plane, train and automobile, which are convenient vehicles widely accepted, do have some security problems, but they have contributed a lot in improving out life standards.

Therefore, many scientists consider transgenic technology an important way to solve global food security problem, which have broad prospects and must be seriously treated and more deeply studied, but security problem brought by the technology should be solved. We believed that as the continuous development and commercialization of transgenic technology, studies on transgenic biodiversity in greater depth, and the establishment and perfection of risk assessment system, people can gradually solve the security problems of transgenic technology and GM organisms.

3. The hotspots of biosafety

1) The safety of biotechnology

There were many viewpoints and severe debates in the concept of biosafety of genetic engineering since its forming. The experiments of DNA recombination were first attempted by Berg as he combined the DNA from bacteria and the DNA from monkey virus SV40 together in 1960s, and then temporally blocked due to biosafety considerations. The success of plant transformation in 1980s and the development of first transgenic tomato variety 'Flavr Savr' in 1994 which were approved for commercialization later, promoted the transgenic biotechnology a lot. Since then, the transgenic

biotechnology prevailed and developed very fast in many countries including developing countries. As the great perspective and potential shown by transgenic biotechnology in developing the society and economic, severe competitions between scientists and companies, including Monsanto (the USA), Hoeches (Germany), Novantis (Swiss), were involved in the race of development of biotechnology and promoted this technology.

2) The biosafety problems by GMOs and their products

The topics on the biosafety of GMOs were first discussed only among the scientists and researchers in molecular biology and genetic engineering. Most of the discussions were about the biosafety problems predicted in theory, which may arise during the process of development and research in genetic engineering. Accompany with the fast development of biotechnology and the environmental release and commercialization of GMOs, more and more people came into contact with GMOs. Consequently, the media draw the attentions onto the biotechnology and its product. Concerns about the food safety and environmental risks caused by GMOs were aroused, and many people paid more attentions on whether the transgenic products would do harm to them. People holding different religions also considered that transgenic biotechnology and its products were 'un-natural' and conflicted with their doctrines, and consequently the GMOs were criticized as 'un-safe' in ethic. Some events related with transgenic biotechnology brought great debates and made the prediction of the un-safety of GMOs like a fact, which was supported on 'scientific experiments'. With the inappropriate of few mass media, some people were scared with transgene and became very opponent to biotechnology.

In 1998, a report by Professor A. Pusztai, a scientist of the Institute Rowett in Scotland, caused great sensations worldwide. In this report, the abnormal growth of organs, weight reduction, and damage in immunity systems were found in mice that ate transgenic potatoes with *GNA* gene. That was the first study that proved the toxicity of transgenic food to animals, and obviously also to human, if it was hold true. However, the Royal Society announced that the experiment by Professor A. Pusztai could not reach the conclusion that the transgenic food was harmful to human health after a serious review in this experiment, because of some obvious problems and defects in its design. Medias like the Reuters reported a lot about this event and the negative impacts continued even as Prime Minister of England and European Union gave speeches in succession to appease the concerns of people on transgenic food.

A paper named "Transgenic pollen harms monarch larvae" was published in *Nature*, one of the top scientific journals in May, 1998. In this article, the authors, J. E. Losey and his group from Cornell University, reported that feeding with *Asclepins crurassavica* containing pollens of *Bt* maize lead 40% mortality of the larva of monarch butterfly (*Danaus plexippus*), compared with non-mortality of the controls (feeding with *Asclepins crurassavica* without pollens of *Bt* cotton). The *Bt* maize occupied 40% total maize field and one question raised: whether the large-scale cultivation of *Bt* maize would cause environmental and ecological hazard? Whether the *Bt* transgenic crop that conferred toxicity and resistance to insects would do harm to non-target organism or even the whole ecosystem? Some of the most important media in the USA. such as the *New York Times*, *Wall Street Journal*, and *USA Today*, reported this news in the front page. Consequently, the transgenic biosafety became one of the most popular topics. However, the later series of experiments revealed that the pollen of *Bt* maize would do little harm to the larva of *Danaus plexippus*, because the pollen of *Bt* maize on leaves of *Asclepins crurassavica* was much rarer in natural conditions than that in Losey's experiment and would slide off due to the smooth surface of the leaves. Studies about the impacts of *Bt* maize on the monarch butterfly,

organized by USDA and published in PNAS later, also confirmed the result that the pollen of *Bt* maize would do little harm to the larva of *Danaus plexippus*.

Generally, from the birth of the concept of biosafety and the events happened later, the biosafety problems were not only discussed in labs among scientists of genetic engineering, but also concerned by the whole society including the companies of transgenic products, their franchisers, and the consumers. People from different groups had different ideas and understandings on life science and biotechnology, and they looked on biotechnology and its products from their own standpoints or interests. Consequently, there were different voices on biosafety events and made the transgenic biosafety become a hotspot in life science and environmental protection. To clarify the confusions in the debates on biosafety and let people have clearer understandings and more objective attitudes towards the transgenic biosafety, it is very necessary to conduct further researches on the biosafety of GMOs. This would be helpful to clarify the facts, make a clear distinction between right and wrong, correct ultra response, and enhance the protective notions to biosafety.

3) Managements of biosafety

Recently, people still could not provide a quantitative conclusion on what kind of un-safety factors and harms would be brought by modern biotechnology to human and nature ecological environment as well as how serious and how wide-ranging these harms and un-safety would be. The biosafety problems have already been seriously regarded in many developed countries, special funds are also appropriated for the biosafety experiment and research, some of the countries even organized committees of experts on biosafety and administrations to manage and authorize experiments referring to transgenic plants, animals, micro-organisms and their applications for environmental release and commercialization. In spite of that, we still cannot make exact and satisfied conclusions on biosafety problems within such a short period, especially on the ecological and environmental impacts, as the concept of biosafety only raised very recently and researches on it were still not enough. The results gained from experiments within a very limited scale, which may have flaws on experimental methods, could only explain partial or local problems, or even lead to wrong conclusions.

Given that there were not enough data from long-term monitoring, research on biosafety and ecological consequence after the large scale environmental release of GMOs, especially their accumulate effects, we should study the potential negative impacts of biotechnology and GMOs on human health and the environment in a more scientific and rigorous way.

4) The interests of companies

Companies of biotechnology may enormously impose on the biosafety researches and the results because of their huge economic powers. The referred researches by Institute Rowett in Scotland and Cornell University in the USA. were re-evaluated and considered unscientific due to their flaws in the design of this experiment. However, the international NGOs (non-governmental organization), considered that there might be some bargaining behind as the company of biosafety cannot bear any denial on their products. In addition, the editors of *Nature* accepted the critical comments from reviewers and announced the article about the detection of transgene in the weedy maize in countryside of Mexico were problematic and unsuitable being published in *Nature*. Someone considered it was very unusual and there might be some powers of biotechnology companies behind.

5) The perspectives of the transgenic biotechnology and GMOs

There are two viewpoints in opposite towards the development and utilization of transgenic