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Safety and Socio-Economic Issues Raised by Modern Biotechnology

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Abstract

Modern new biotechnology has the potential to provide major economic and other benefits, but at the same time it poses potential hazards for human health, the environment, the 'natural' biological order and can have adverse socio-economic consequences. The application of such technology frequently violates traditional ethical, moral and religious values. This paper after outlining possible benefits of modern new biotechnologies, discusses the type of biosafety risks which they pose, their possible adverse consequences for the sustainability of biodiversity and agriculture and their potential impacts on socioeconomic welfare and traditional cultures. Particular concern is expressed about the possible consequences of such technologies for developing countries and the practice in some developed countries of issuing patents conferring very broad rights over the use of genetically engineered material. Because these rights are so broad in some cases they have the potential to establish powerful multinational monopolies in the hands of private companies. Global debate about these issues suggest that more emphasis should be given globally to the socio-economic consequences of such technology than in the past. The need for this is highlighted by the North-South divide. Developing countries lag considerably in this new technological field, are placed in a dependant position and have weak institutional structures to control the application of such technology.

Keywords: biotechnology, socio-economic policy, genetic engineering, biodiversity, biosafety, patents

Introduction: Biotechnology is a modern advanced technology based scientific fields such as on molecular biology, biochemistry, cell biology. It adopts many new techniques such as cell and tissue cultivation, cell fusion, gene recombination, microbal fermentation, so as to duplicate and recombine the organisms at the level of cell, chromosome, and gene, and create the best state of organisms according to human desires, and to produce new products and breed new fine varieties with novel traits of high productivity and stress resistance. Modern biotechnology is composed of four technological systems. They are genetic engineering, cell engineering, enzyme engineering and fermentation engineering, of which genetic engineering and cell engineering are the most recent advanced biotechnologies.

Modern biotechnology can not only produce great social and economic benefits, but can also do harm to human health, environment, and result in many socioeconomic problems, such as destroying original social and economic pattern, posing threats to biodiversity and traditional crop varieties, injuring country's or a community's socioeconomic welfare, violating traditional ethical, moral and religious value. In

order to enable biotechnology contribute major benefits to human beings at and to so safety, international society has paid great attention to the biosafety of living modified organisms (LMOs) produced by biotechnology.

1. Social and economic benefits of modern biotechnology

Biotechnologies are being used widely in such fields as medicine and hygiene, agriculture, forestry, raising, fisheries, energy and chemical industries, metallurgical and mining industries, food and light industries, environmental protection. Modern biotechnology has gradually demonstrated its huge potential contribution to productivity, though it has a short history of only tens of years so far. Modern biotechnology will become powerful means to reduce the world's constraints in the fields of food, health, energy, resources and environment. The development and application of modern biotechnology will, over a long period of time, affect human beings and society deeply. Biotechnological industries are likely to become the leading industries in the 21st century. For example, crop varieties, produced by biotechnology, with novel traits of high productivity and stress resistance (aridity, coldness, high salt, etc) are expected not only to increase grain productivity, but also decrease the use of agricultural chemicals (such as pesticide, herbicide and fertilizer), which will be beneficial to environment. In the respect of medicine and hygiene, many drugs such as DNA vaccines, protein engineering medicine, monoclonal antibodies, antisense RNA drugs have been developed by biotechnology. Transgenic animals and plants producing some kinds of medicines (such as vaccines and hormone) may help to reduce illness in the process of everyday diet. Human Genome Project (HGP) and the research into some disease genes will discover the genetic reasons for some illnesses. Environmental pollution is getting worse at present, but biological transformation reactors created by biotechnology promise to absorb pollutants or wastes and decompose them into materials of low or no toxicity.

Therefore, in the present society characterized by knowledge-intensive industries, countries all over the world, especially the industrialized countries, take biotechnology seriously. Large quantities of manpower and financial resources are allocated R & D of biotechnology. Relevant development strategies and policies are drawn up and support mechanisms created to stimulate the development of biotechnology.

2 Biosafety issues of modern biotechnology

Inappropriate application of biotechnology can result in many risks/hazards, just as other advanced technologies such as nuclear technology. Has done. For examples, the new genes in crop produced by genetic engineering can result in allergic reactions. Organism fed with genetically manipulated food for a long period of time may develop fatal diseases such as cancers. Being given the traits of pest-resistance, herbicide-resistance or stress-resistance, transgenic plants may escape from agricultural cultivation systems to evolve into vicious weeds. The resistance genes in transgenic plants may also be transferred to their wild weedy relatives, and the latter's fitness might be improved to become "super" weeds which will make them more difficult to control. Large-scale environmental releases of transgenic pest-resistance

crops will create huge selection pressures to accelerate the resistance of target pests. The foreign virus genes inserted and the proteins coded within transgenic virus-resistance plants may recombine with genetic materials of other viruses and proteins to form new types of viruses with higher toxicity. Being not able to kill the target pests and pathogens selectively, the transgenic pest-and-disease resistance crops may poison other organisms simultaneously. Moreover, the pest-and-pathogen-killing material in transgenic plants not only can influence the target organisms, but also may have adverse effects through food chains on other organisms, which include beneficial insects, birds, and mammals and microbes (Andersson, et al. 1992). What is more, many biotechnological products are live organisms that can move automatically and reproduce themselves. Once these organisms are released into the environment are found harmful, it is probably going to be impossible to withdraw them, and the harm created by them may expand gradually and become more serious as time goes by. Therefore, environmental releases of transgenic plants in large-scale may damage the natural ecological balance over a very long period and deeply, therefore, the risks/hazards of modern biotechnology may be even greater than that of nuclear techniques.

Biosafety concerns have hindered the R & D of biotechnology. The public in many countries has expressed its feelings of dislike, abhorrence, even fear, about biotechnological products. This has been expressed by holding parades and demonstrations, destroying trial fields crops, forbidding the import of biotechnological products, and refusing to purchase biotechnological products (Williams, 1998). As a result, biosafety issues are high on the agenda of many countries and the international societies. Regulations or laws on biosafety have been formulated in many countries. The necessity or importance of settling biosafety issues have featured in many international documents and treaties such as Agenda 21 and The Convention on Biological Diversity. In addition, the document of International Technical Guidelines for Safety in Biotechnology was issued by United Nations Environment Program (UNEP) in 1996. Also an important decision to formulate an "International Biosafety Protocol" was adopted in the Second Conference of Parties to "The Convention on Biological Diversity", held in Jakarta, Nov. 1995, in order to ensure the safety of development, application, exchange and transfer of biotechnology and its products (Liu and Xue, 1998a).

3. Potential adverse impacts of modern biotechnology on socioeconomics

Modern biotechnology may also have many unfavorable impacts on society and economic conditions as discussed below.

3.1 Impacts on social and economic pattern

Driven by perceived enormous economic profit, many famous international conglomerates have invested much capital in the R & D of biotechnology, and are altering step by step the world's previous social and economic framework. For instance, Monsanto was traditionally a US-based chemical company. Starting in 1985, it began selling many of its core chemical factories, and invested in

biotechnological industrials. Consequently, Monsanto became a major conglomerate engaged in the R & D of bio-science (Enriquez, 1998). In 1998, about 20 million hectares of fields were planted with Monsanto's genetically engineered seeds all over the world. To further exploit the international market for its crop seeds, Monsanto purchased the International Seeds Company of Cargill at the price of $140 millions in 1998, for the purpose of making a completely integrated system for selling its own genetic engineering seeds (such as herbicide-resistanct transgenic soybean) and its agricultural chemicals (herbicides, for instance). Monsanto thus is able to control a large part of the complete food chain of human beings using its genetically engineered seeds to gain enormous profits. The world's economy is becoming more integration and globalized. It is possible in the future few multinational corporations may decide our food consumption. Once toxic or allergic materials are found in the food chain engineered by them, it could be a catastrophe for the health of human beings.

If bovine growth hormone (BGH) produced by genetic engineering are used in dairy, the milk yield of a dairy cow can increased by 30 percent and 10 per cent of its fodder saved at the same time. There will undoubtedly be major impacts on the dairy industry as a result (Liu and Xue, 1998b).

In addition, many medicines, such as vaccines for treating malaria and cholera, will soon be delivered to patients in the form of new antigens synthesized within common fruits and vegetables bred by modern biotechnology. These foods will make the rates of illness and death in many countries (especially in the developing countries) fall precipitously, with the population growth rates increasing correspondingly. What will be the impacts on already inadequate economics and infrastructures of the concerned countries? Will it represent a benefit or a harm to our Earth burdened with huge populations (Miller,1998)?

3.2 Impacts on biodiversity and sustainable agriculture

Foreign genes from other plants, animals and microbes are contained within many genetic engineering crops. These foreign genes can be transferred to other plants in the nature via the pollens of genetically transformed plants. This will pollute the pool of natural genetic resources. The damage to the environment and human society will be long-term, and the loss is incapable of being measured by money. Furthermore, because the majority of transgenic plants have desired traits such as high productivity, disease-pest resistance, stress resistance, farmers are attracted for economic interests, to grow these plants, rather than traditional crop varieties. Therefore, natural biological species might be ignored or even discarded. Consequently, the traditional crop varieties and natural biological species are likely to be lost and the genetic resource-base narrowed. Furthermore, some technology by encouraging the monoculture of crop varieties in certain areas may further add to loss of biodiversity. In the long term, this erosion of the genetic base may undermine the resistance of plants to diseases and insect pests and this may result in reduced crop yields. Hence, global sustainable development could be put in jeopardy.

For another example, attracted by high financial returns over the last few years, an

unprecedented numbers of farmers in one region of Andhra Pradesh state of India turned to plant a single hybrid cotton seed. Due to the combination of unfortunate weather patterns and a pest outbreaks in one year, the crops of these farmers failed. Farmers, who had borrowed heavily to lease additional land and purchase pesticides, faced unmanageable debts, and over 70 debt-ridden farmers committed suicide. There is now a debate as to whether the imminent commercial release of Bt (*Bacillus thuringiensis*) cotton in India will avert or exacerbate such problems in the future (Crompton and Wakeford, 1998).

Transgenic herbicide and pest resistant crops, produced by genetic engineering technology, are being planted in many countries on a large scale. The herbicide resistant genes in transgenic crops, however, can be transferred to other crops and their wild weedy relatives, and so result in new weeds and "superweeds" and the need for more herbicide use. Consequently, environmental pollution may become worse, and use of herbicides less effective (Holden, 1990). Bt *(Bacillus thuringiensis)* is a soil bacterium which is employed to produce an insecticidial toxin within plants. It has been used as a microbial pesticide for many years. The genes coding insecticidal toxins could be transferred to many crops such as cotton, soybean, and rape, to breed pest-resistance crops. But the environmentalists and the Green Peace Corp are concerned that, because these crops produced these insecticidal toxins late in their life cycle, these BT transgenic crops planted on a large scale might increase the resistance of pests to the Bt toxins. This situation would result in greater use of BT-based pesticides and lead to a vicious resistance cycle, with Bt pesticides losing their efficacy and causing heavy economic losses.

In September 1997, the US Environmental Protection Agency (EPA) was sued by a coalition of consumers, environmentalists, and organic farmers for allowing the planting of crops (corn, cotton, tomato) modified genetically to produce an insecticidal Bt toxin. The coalition demanded that EPA revoke 11 registrations which had issued to five companies, cease granting such permissions and complete a statement to analyze the environmental impact of Bt crops approved so far (Wadman, 1997). They called for a prohibition on the introduction of transgenic herbicide-resistance plants into forests and agricultural fields, and urged the UN Food and Agriculture Organization (FAO) to restrict the export of these plants to other countries.

3.3 Impacts on socioeconomic welfare of countries and of communities

Application of genetic engineering technology to humans could make it possible, to diagnose and cure genetically-related diseases such as some cancers and haemophilia, etc.. Gene diagnosis, however, may also have adverse impacts on the employment and marriage prospects of human beings. For example, geneticists at Johns Hopkins University recently found that Ashkenazi Jews seemed to double the risk of colon cancer. Such findings have already led to Jewish groups being targeted as a potential market for commercial genetic tests, which might create the perception that Jewish people are unusually susceptible to disease. As a result, anyone with a Jewish-sounding surname could face discrimination in insurance and employment. The

Jewish leaders have been lobbying for laws to forbid genetic discrimination so as to avoid social stigmatization (Lehrman, 1997).

Animals, plants and microbes can be transformed into bio-reactors by genetic engineering technology to produce particular kinds of chemical products as commended. These obligate slave-like biological producers while increasing productive potential can give rise to socioeconomic problems. Suppose a variety of yeast is engineered to produce vanilla in large scale. What kind of impact of this will have on the world's major vanilla producers? In Madagascar, for instance, where vanilla accounts for 10 per cent of the country's exports, what would be the effects on the nation's agriculture, financial infrastructure? Who will be responsible for the influences (Miller, 1998).

3.4 Impacts on traditional culture

Some pious religious persons believe that because modern genetic technology changes, recodes and manipulates Nature that usurps the role of God.. For many gene manipulation involves an immoral (and unwarranted) intervention with God's creation, with the natural order and evolution. Especially concern has been expressed that gene diagnose (which was developed recently) might make descendant selection of human beings possible, and so disturb the evolutionary course of human beings. As a result, it is argued that modern biotechnology should be banned, forbidden or regulated as far as possible. For example, an organization in Europe call Mothers For Natural Law appealed for all genetically modified food be banned immediately, because genetic engineering is not some minor biotech development, but is a radical new technology that violates fundamental laws of nature (Golub, 1997). After the cloned sheep "Dolly" was born in 1997, the issue of "cloned man" has aroused strong reactions all over the world and had huge impacts on the present ethical and moral values. For instance, how do we decide on the relatives of a cloned man? Will human cloning lead to the creation of second-class citizens and even to a revival of slavery (Shapiro, 1997)?

Members of the public have not been silent about ethical and moral issues involved in the granting patents on modern biotechnologies and related property rights. To encourage investing in the R & D of biotechnology, the patent regulations in some countries stipulated that varieties of animal, plant and microbe and their genetic materials and products, as well as production approaches are protected by patent. Since the early 1980s, for example, the United States PTO (Patent and Trademark Office) had awarded hundreds of patents for genetically engineered plants and recombinant DNA approaches to manipulate plants (Stone, 1995a). Most Christians believe that humans and other beings are created by God. Some have argued that granting patents on genes or organisms represents the usurpation of the ownership rights of the Sovereign of the universe. So patenting of genetically engineered animals and human genes, cells, and organs is ethically unacceptable to them (Stone, 1995b).

In addition, to fully protecting the interests of the biotechnological inventors, some countries often approved patent applications much wider breadth from hither to. For

example, in October 1992, the US/PTO (Patent and Trademark Office) awarded a patent to a single company, Agracetus, for the rights to all forms of genetically engineered cotton---no matter what techniques or genes were used to create them.; In March 1994, the European Patent Office (EPO) granted broad rights to Agracetus for all forms of genetically engineered soybean that produced foreign substances. The Roslin Institute of England also applied for the international patent for the cloned sheep "Dolly", and requested that the protected breadth be mammals, include human being. The patent was made known to the public in March 1997 and aroused a panic internationally. These patents with such broad application not only could force smaller companies out of biotechnological business, but also might reduce the biotechnological research activities in certain countries and fields (Stone, 1995a). The width of these patent rights granted has the capacity to create mega-monopolies

The patent system can also be used by some countries/individuals to usurp intellectual ownership of "native technologies". For instance, the neem tree, known as the "blessed tree", had been used by Indian farmers as a medicine for centuries. After conducting research on the tree's properties, however, a US company patented a method of extracting and stabilizing azadirachtin, a potent natural pesticide, from the neem tree. The patent could hurt Indian farmers because they could be forced to stop using the technology which they have been using for generations or pay royalties for its use (Wolfgang, 1995).

4. International concerns about biosafety and related socioeconomic issues of biotechnology

Many countries are taking socioeconomic issues arising from new biotechnology very seriously. For example, some member countries of the EU (Austria, Denmark, Sweden, and Finland) believe that the socioeconomic impacts should be specifically taken into account when drawing up biosafety regulations. The Norwegian Gene Technology Act required that, before deciding whether or not to grant a license or patent application, significant emphasis should be placed on whether the deliberate release of Living Modified Organisms (LMOs) represents a benefit to the community and a contribution to sustainable development (Crompton, 1998).

The UNEP's "International Technical Guidelines for Safety in Biotechnology" also draws attention to the importance of assessing the socioeconomic impacts of biotechnology. During the negotiation of the "International Biosafety Protocol", socioeconomic impacts was one of areas given special attention by several participating countries.

In general, developed countries possess a high level of biotechnological expertise, with greater ability to solve biosafety issues than developing countries. They are the exporters and beneficiaries of biotechnological products. Many developed countries involved in negotiations argued that the socioeconomic issues of biotechnologic change were too complex for them to contribute constructivity to the debate because of their relative ignorance, although the issues were important. They agreed there was

an urgent need for socioeconomic issues to be studied exhaustively. It was agreed that it is appropriate for international biosafety legislation to take such issues into consideration, and the socioeconomic issues of biotechnology should be discussed alone in another global forum.

In contrast to developed countries, developing countries have low biotechnological capacities, with little ability to solve biosafety issues. They are the importers of biotechnology and potential victims of the adverse impacts of biotechnological products. As a result, some developing countries, such as India and China, believe that socioeconomic issues raised by modern biotechnology were very important to all countries, especially for the developing countries endowed with rich genetic biodiversity. They insisted that socioeconomic issues taken into account as an essential part of international biosafety legislation, that public safety should be protected through suitable policies and regulations. In addition, measures should be taken to ensure that economic activity and the distribution of income are economic opportunities and are not impaired by monopolization of biotechnologies, and it is needed to control production of genetic material such as seeds and associated chemical and biological substances by some private enterprises. They also requested that the Contracting Parties to The Convention on Biological Diversity who planned to produce with biotechnology a commodity that had been previously imported, should notify in advance the other Parties whose exports would be reduced. The notification should be made sufficiently in advance (at least seven years), to enable the latter to make alternative production plans. When the affected Parties are developing countries, the Parties that replaced the imported products by biotechnological products should provide the affected Parties with financial and technical aid (Liu and Xue, 1998c).

Thus it can be seen that, not only can biotechnology produce enormous social and economic benefits, but it may also result in many serious socioeconomic problems. Those problems are intensified because of the vastly different stages of biotechnological development developed and less developed countries and regions and because of the varied economic and political situation of many countries and regions. Biotechnology policies need to accommodate those differences. Because of divergent development and social status of countries, it will be difficult to obtain global consensus in the short term on biotechnology policies and the socioeconomic issues which should be taken into account in such policies. It is possible that international disputation about biotechnology policies will continue for a long time. Nevertheless if now biotechnology is to contribute the sustainable development of the world, international society must make concerted efforts via policy formulation to address the possible detrimental socioeconomic impacts of biotechnology, some of which have been highlighted in this contribution.

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