Part II
The Two Sides of the Same Coin

Biotechnology has been described as "Janus-faced." This implies that there are two sides. On one, techniques allow DNA to be manipulated to move genes from one organism to another. On the other, it involves relatively new technologies whose consequences are untested and should be met with caution. Many traditional biotechnologies are uncontroversial, such as the fermentation of microorganisms to produce wine, beer, and cheese. But genetic engineering, a powerful new technology that involves the artificial transfer of genes across species lines, has provoked intense public interest and scrutiny. Despite its many benefits, genetic engineering has caused concern among some people.

2.1. The good side:

Governments, businesses and some farm organizations are claiming that genetic engineering will help create a more sustainable agriculture, by reducing pesticide use and agricultural pollution, and increasing agricultural productivity and profitability. Some of the most significant scientific advances in biotechnology are predicted for agriculture, and there can be no doubt that biotechnology could possibly have a positive impact on pest management. Biotechnology, it is felt by many has the potential to be a technology which could contribute to more environmentally sensitive agriculture.

It is now widely recognized that biotechnology can play an essential role in fostering the economic and social development of both developed and developing countries, if properly managed. Biotechnology development and applications, have continued to grow at a very rapid rate, leading to an expanding range of products and processes across several sectors. What began with pharmaceuticals and health care, was extended to agriculture and, more recently, to the environment.

In the area of health, many biotechnological products, such as insulin, diagnostics and vaccines, have already been placed on the market and products such as recombinant-derived hepatitis B vaccine have gained widespread international use. Two new biotechnology - based cholera vaccines have recently been licensed in some countries. Currently, more than 2,000 clinical trials of biotechnology-related products are in progress, mainly in the more biotechnologically advanced countries. [4]

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[4]Biosafety Information Network and Advisory Service (BINAS). [Available at: http://www.binas.unido.org/binas/Library/agenda21/data/ch3-intr.html]. (BINAS is a service of the United Nations Industrial Development Organization).

Figure 5: What began with pharmaceuticals and health care has extended to agriculture

In agriculture, products such as diagnostics, biopesticides and bovine growth hormone are now in commercial use. Other products and technologies being developed include improved seeds, new vaccines, novel food ingredients, biotechnology-based techniques for the rapid detection and identification of toxic materials, and several bioprocessing technologies. Developed countries, having increasingly privatized biotechnology research and development, continue to forge rapidly ahead in many sectors. From a global perspective, it has been forecast that major impacts can be expected on health, pharmaceuticals, agriculture, food and the environment within the next 20 years. [5]

According to the report of 'A European Federation of Biotechnology Task Force Group on Public Perceptions of Biotechnology/ The Green Alliance Workshop,'[6] this may be both by improving the efficiency with which non-renewable resources such as agricultural lands and fossil fuels are used and by protecting and remediating the environment, including:

1. Reducing food losses due to pests (diseases, insects and weeds) thus reducing wastage and spoilage and preserving land, fossil fuels, irrigation water, fertilizers, etc.,
2. Reducing the application of fertilizers, fungicides and insecticides while increasing agricultural productivity,

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5 *Id.*

6 Available at: http://www.bioportfolio.com/efb_conf.htm.

3. Reducing energy inputs, mostly involved in the manufacture of agrochemicals,
4. Reducing water pollution from pesticides and soil erosion associated with current methods of soil tillage for weed control,
5. Converting agricultural waste by-products to energy and substitute foods, feeds and fertilizers,
6. Achieving increase in yields by using increased knowledge of plant development and exploiting hybrid vigor in those food and feed crops in which hybridization is not currently possible,
7. Reducing the effects of climatic stresses (drought, low and high temperatures) on plant productivity,
8. Producing renewable energy sources (e.g., biodiesel), commodities and raw materials for industrial uses (e.g., fibers, biodegradable plastics), and high-value chemicals and pharmaceuticals.

2.2. The other side:

Proponents of new biotechnologies claim how wonderful their benefits will be to agriculture and human health. But scientists and citizen groups are also increasingly concerned about the potential costs and adverse effects of these biotechnologies, especially genetic engineering. Genetic engineering has the potential to solve problems. However, "biotechnology is being shaped within the same social context and value system that led to chemical dependence".[7] It is deeply integrated into the same industrial agricultural economy that has created many current environmental, social and economic problems.

2.2.1. Environmental and ecological consequences of biotechnology:

Industrialized agriculture favors genetic uniformity. Vast areas are typically planted to a single, high-yielding variety or a handful of genetically similar cultivars using capital intensive inputs like irrigation, fertilizer and pesticides to maximize production. A uniform crop is a breeding ground for disaster because it is more vulnerable to epidemics of pests and diseases. A pest or disease that strikes one plant spreads quickly throughout the crop.

It should be borne in mind that bioengineered crops could have unpredictable social, economic, and ecological consequences. Traditional crop breeding programs have relied on the time element to determine if a cultivar will

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[7]Rissler, J., 1991:6. Biotechnology and pest control: quick fix vs. sustainable control. Global Pesticide Campaigner, 1 (2): 1, 6-8 [available at http://www.holisticmed.com/ge/pest.html].

be useful under various environmental conditions such as drought, high rainfall and pest challenges. Biotechnology and the companies pursuing the life sciences are in a race for profits without adequate testing and again the time element prevails. There is a strong possibility that genetically engineered crops could be important to the sustainability of agriculture if they are developed ethically, and for the public good. But that may not be the case if the technology is primarily promoted for short-term economic gain. There are two issues that need consideration in this aspect: (1) who is profiting from the current wave of "biogenic" crops? (2) can there be unintended ecological impacts?

Figure 6: Genetic engineering has the potential to solve deadly diseases.

Another issue is that genes for Bt or for herbicide resistance could be passed, via cross-pollination, to related weed species. Such cross-pollination is a normal mechanism in plant evolution. Many plant species produce fertile hybrids, and genes have regularly moved between crops and their wild and weedy relatives. Thus resistance to a particular herbicide may appear in some strains of weeds. Furthermore, an engineered organism may produce unanticipated harmful impacts on other species in its new environment.

2.2.2. Possible human impact:

Biodiversity and species integrity are inextricably linked. Transgenic technology transgresses both species integrity and species boundaries, leading to unexpected, systemic effects on the physiology of the transgenic organisms produced as well as the ecological community into which the transgenic organism is introduced. Allergenic and toxic products have arisen in transgenic organisms and recent evidence suggests that transgenic resistance to pests and diseases may be associated with increased allergenicity. Recent evidence also suggests that vectors carrying transgenes may spread horizontally via microorganisms, animals and human beings in an uncontrolled and uncontrollable manner. The teeming microbial populations in the terrestrial and aquatic environments serving as a horizontal gene transfer highway and reservoir, facilitate the multiplication and recombination of vectors and infection of all plant and animals species.[8]

It has already been seen that genetic engineering of crops can backfire. For example, an effort to insert a protein-producing gene from a Brazil nut into soybeans was short-circuited when people who were allergic to the nuts showed an allergic reaction to the beans in skin and blood tests. Yet as more genes are transferred across more species lines, without any requirement for warning labels, such problems could become more common.[9]

Horizontal gene transfer is a runaway process that cannot be regulated. This makes it paramount to control what is released in the first place. Recent statistics are frightening. Infectious diseases were responsible for one-third of the 52 million deaths from all causes in 1995. Multi-drug resistant tuberculosis is now estimated to affect 10 million people each year with 3 million deaths. At least 50 new viruses attacking humans emerged between 1988 and 1996. Between 1986 and 1996, E. coli infections increased in England, Wales, and in Scotland. Vancomycin resistance rose from 3% to 95% in San Francisco hospitals in the four years between 1993 and 1997 and Staphylococcus (toxic shock syndrome) is now invulnerable to all known antibiotics.[10]

2.2.3. Biotechnology in developing countries:

However, the transfer and development of biotechnology in an environmentally sound manner requires a variety of conditions, including capital inputs that, in the case of many developing countries, are not readily available.

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[8] Mae-Wan Ho, & Beatrix Tappeser. *Transgenic Transgression of Species Integrity and Species Boundaries - Implications for Biosafety* [Available at: http://psrast.org/wanho.htm].
[9] http://biz.yahoo.com/prnews/990331/ia_pioneer_1.html.
[10] *Scientists Link Gene Technology to Resurgence of Infectious Diseases.* [Available at http://www.psrast.org/prhortra.htm].

Case studies on biotechnology and sustainable agriculture recently commissioned by the OECD Development Center's AGENDA 21 program[11] for Kenya and Zimbabwe in Africa, India and Thailand in Asia, and Colombia (and Mexico) in Latin America identified common constraints in the diffusion of environmentally sound biotechnologies, especially to small farmers, weak collaboration between the private and the public sectors, and inadequate financial resources as well as mechanisms for the effective exploitation of emerging technologies. In countries where legal frameworks for biosafety and/or intellectual property protection are in place, the operational aspects need further attention.[12]

In African countries, the level of sophistication in biotechnology development is extremely variable, ranging from very traditional applications such as food fermentation of cassava in least developed countries, to monoclonal antibody and diagnostics research and tissue cultures in other countries. In general, biotechnology research and development in Africa evolves around the various international research and development centers.[13]

A number of governments are involved in trying to promote the diffusion of bio-pesticides to reduce dependence on chemicals, and research on bio-pesticides is being supported in public institutions. However, the technical capacity of the public institutions in the developing world to produce bio-pesticides efficiently and to ensure consistent quality is not adequate. This thereby results in a lack of acceptability and effective demand on the part of farmers. The private sectors too are not very interested in producing and commercializing bio-pesticides. The situation is worse in countries where national extension services are shrinking because of decreasing public expenditure and increasing privatization.[14]

As there is inadequate information on the current state of development and on the immediate economic impact of biotechnology in many other developing countries, mainly because in most of the developing countries biotechnology is integrated in the various traditional sectors, the general trend is not fully known.

There is a need for more effective indicators on progress towards

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[11] The Agenda 21 program on the environmentally sound management of biotechnology focuses upon the need for: (a) increasing the availability of food, feed and renewable raw materials, (b) improving human health, (c) enhancing protection of the environment, (d) enhancing safety and developing international mechanisms for cooperation, and (e) establishing enabling mechanisms for the development and the environmentally sound application of biotechnology. [available at: http://www.binas.unido.org/binas/Library/agenda21/data/ch1.html].

[12] http://www.binas.unido.org/binas/Library/agenda21/data/ch3-a1.html.

[13] *Id.*

[14] Brenner, Carliene. *Biotechnology and Technological Change in Developing - County Agriculture: An Overview of OECD Development Center Research.* [Available at: http://www.Idrc.ca/book/focus/789/brenner.html].

sustainable development through biotechnology in the developing countries. The industrial sector and individual entrepreneurs in many of these countries have still to gain confidence in the potential of investing in commercializing results emanating from such research. In addition, the general public is still inadequately informed about the benefits and risks associated with the development and applications of biotechnology, even though science and technology are seen by many as engines of economic progress.[15]

[15] *Id.*