MOURNING THE INCREASING LOSS OF BIO-DIVERSITY

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ABSTRACT

Thousands of genetically distinct varieties of our major food crops owe their existence to years of evolution and to careful selection and improvement by our farmer ancestors. Maintaining distinct strains of agricultural crops is important because these strains may contain genes useful in the continuing fight against pests, drought, and diseases, and even those strains with overall characteristics that may not be attractive economically. In this paper the concerns associated with the increasing emergence of genetically engineered crops and foodstuffs is examined.

PART 1

INTRODUCTION

Our planet's essential goods and services depend on the variety and variability of genes, species, populations, and ecosystems. Biological resources feed and clothe us and provide housing, medicine and spiritual nourishment. The natural ecosystems of forests, pastures, range lands, deserts, rivers, lakes and seas contain most of the Earth's biodiversity. Farmers fields and gardens are also of great importance as repositories, while gene banks, botanical gardens, zoos and germ plasma repositories make small but significant contributions. The current decline in biodiversity is largely the result of human activity and causes serious threats to human development.

At the advent of the 21st century, its being loudly proclaimed by many influential entities that genetic engineering will deliver 'designer' food crops capable of greatly improving contemporary agricultural systems. The biotechnology industry and its supporters are holding out the promise of plants that can be engineered to our precise specifications, creating a future of environmentally sustainable agriculture, more flexible crops, and an abundance of food with which to finally bring an end to world hunger. Life science corporations proclaim, with great fanfare, that their new products will make agriculture sustainable, eliminate world hunger, cure disease, and vastly improve public health.

The reality, however, is that through their business practices and political lobbying, the gene engineers have made it clear that they intend to use biotechnology to dominate and monopolize the global market for seeds, foods, fiber, and medical products. It is also true that the genetic engineering of food crops represents a continuation - indeed an intensification - of the techno-industrial approach to agricultural production, and will intensify the social inequalities, concentrations of power and wealth, and ecological problems it has produced. Genetic engineering also creates new avenues for the corporate domination of agriculture, and poses new kinds of environmental threats, introducing an entirely novel form of industrial pollution into our vocabulary and into the world: genetic pollution.

PART 2
BIODIVERSITY

2.1. BACKGROUND:

"Biodiversity" describes the variety of living organisms of all kinds -- animals, plants, fungi, and microorganisms -- that inhabit a particular area. The general public is acquainted with only a small proportion of the 1.7 million species that science has identified. Far more species in the world remain unknown to anyone; most of these in tropical forests and other poorly studied ecosystems. Thousands of different and genetically distinct varieties of our major food crops owe their existence to centuries of evolution and to careful selection and improvement by our farmer ancestors. This diversity protects the crop and helps it adapt to different environments and human needs.

Today, much of this diversity is being lost. Many unique varieties are disappearing and becoming extinct. The FAO estimates that since the beginning of this century, about seventy five percent of the genetic diversity of agricultural crops has been lost.[1] Beyond conserving species, it is also important to conserve genetic diversity within individual species. Genetic diversity within species is particularly important in domesticated plants and animals and their wild relatives. The breeding of new strains of pest-resistant crops and livestock is critically dependent on the continued supply of new genetic varieties.

Humans benefit from biodiversity in many ways. Besides the animals and plants that we use for food, shelter, raw materials, and companionship, there are thousands of species whose natural products are literally life-saving -- nearly 25 percent of the drugs used in the United States originally came from plants. There is strong scientific evidence that we are now in the opening phase of a massive extinction. In almost all cases, humans are the ultimate cause. The most frequent reason for this loss of biodiversity is loss of habitat: species become extinct when the places they live are destroyed. Preserving natural ecosystems is an important way to protect the endangered species within them. But preserving ecosystems has other important benefits. The quality of the water we drink, the air we breathe, and the soil in which we grow our food all depend on the integrity of natural ecosystems. People have long recognized the role of healthy forests, for example, in reducing erosion, preventing flooding, maintaining the purity of the water, and tempering climatic fluctuations. In recent years scientists have come to see that many other ecosystems provide similar benefits.

2.2. GENETIC ENGINEERING AND THE THREAT TO THE WIDESPREAD ERADICATION OF BIODIVERSITY:

There are currently more than four dozen genetically engineered foods and crops being grown or sold in the U.S. These foods and crops are widely dispersed into the food chain and the environment. Over 70 million acres of GE crops are presently under cultivation in the U.S., while up to 500,000 dairy cows are being injected regularly with Monsanto's recombinant Bovine Growth Hormone (rBGH). Most supermarket processed food items now "test positive" for the presence of GE ingredients. In addition several dozen more GE crops are in the final stages of development and will soon be released into the environment and sold in the marketplace. According to the biotechnology industry almost 100% of U.S. food and fiber will be genetically engineered within the next five to ten years.

The widespread commercial release of genetically engineered plants will continue the process of eroding the diversity of plant varieties that still exist in the world. This is a process begun many decades ago, as the few new industrial seed varieties that were supplied by seed companies began to replace the enormous diversity of varieties within each crop that have been developed by traditional farmers over thousands of years. Much of this plant diversity has already been lost. The industrial manufacture and supply of seeds is creating a level of uniformity of crop varieties that may threaten future food security.

The new biotechnologies further heighten this biological uniformity through the new tissue culture techniques that have been developed for reproducing seeds in factories. These new techniques for the first time allow millions of genetically identical copies of a particular seed variety to be reproduced. But in mass-producing these perfect copies, they introduce an even higher level of uniformity into plant varieties and into farmers' fields. As noted earlier, such highly uniform plant varieties create ever more serious pest problems.

There is also another type of uniformity made possible by genetic engineering. By allowing the transfer of genes across all species boundaries, genetic engineering begins to erase the distinctions and boundaries between species. The genetic structure of all life forms, and the parts that make it up, become interchangeable with every other. One consequence of this erosion of species boundaries will be that we will hardly know any more what it is that we're eating. What looks, feels, smells, and even tastes like an apple or an orange may also contain genes from a capsicum or a pig or a human.

In developing new products, scientists take plant samples from the field to the laboratory, where the simple act of moving a single gene from one spot to another within a cell - whether or not it causes an actual variation in the next generation, creates a "plant variety" deemed sufficiently "new" to qualify as a patentable invention. In most cases, such genetic engineering experiments produce nothing worthwhile. In a few cases, the variations have desirable traits that can be reproduced and marketed. The emphasis on finding and isolating plants with the most marketable traits leads to the decline of other plant species, as only those required to create the new techno-varieties are cultivated. In the U.S. alone, the focus on commercial varieties has already led to the loss of many varieties of plants in seed bank storage. A survey of U.S. seed banks showed that some varieties of non-commercial crops such as chufas, martynia and rampion have been lost entirely.[2]

2.3. BIODIVERSITY AS A MUST:

Diversity within each crop is essential to agriculture, as is the diversity between crops and the genetic diversity among all species on earth. Diversity within crops refers to the multitude of ancestral and domesticated forms. This diversity has two components. First are the close relatives of cultivated crops, such as the many species of wheat—einkorn, emmer, durum, spelt, goatgrass, and common wheat. Second are the different cultivated varieties of each crop, including the breeding lines that are the source of new varieties. Many of the varieties are landraces, which are locally used varieties of the crop developed by farmers for their own use. These landraces harbor most of the crop's genetic diversity. The world wheat collection, stored in dozens of national and international seed banks, includes 125,000 accessions (strains) that are held as an international service by the United States Department of Agriculture (USDA). Most of these strains are landraces. It is genetic diversity that has allowed wheat to be grown successfully around the world, allowing breeders to find varieties with genes that can overcome local problems such as novel diseases, insects, and climate. Genetic diversity has also been essential for maximizing and stabilizing the productivity of a crop in a given region. About half of the year-to-year increases in crop productivity result directly from genetic improvements—superior new crop varieties. The genes that make these varieties unique come from the existing genetic variability of crops, but genetic biotechnology now potentially allows genes to be transferred to crops from any other living species.[3]

Maintaining distinct strains of agricultural crops is important because these strains may contain genes useful in the continuing fight against pests and diseases, even those strains with overall characteristics that may not be attractive economically.[4] Crop genetic diversity is not just a raw material for industrial agriculture; it is the key to food security and sustainable agriculture because it enables farmers to adapt crops suited to their own ecological needs and cultural traditions. Without this diversity, options for long-term sustainability and agricultural self-reliance are lost. The type of seed sown to a large extent determines the farmers's need for fertilizers, pesticides and irrigation.

Communities that lose community-bred varieties and indigenous knowledge about them risk losing control of their farming systems and becoming dependent on outside sources of seeds and the inputs needed to grow and protect them. Without an agricultural system adapted to a community and its environment, self-reliance in agriculture is impossible. Diversity may help to decrease risk by decreasing the year-to-year variability of yields. For instance, landraces of wheat often have lower yield variances than many modern varieties. This lower variation in yields likely occurs because individual plants within a genetically variable population differ from each other. The ones favored by particular climatic and soil conditions in a given year can grow well and thus compensate for those that do poorly under those conditions. Similarly, farmers often will grow mixtures of two or more varieties as a hedge against the risk of disease or environmental stress. [5]

These effects of diversity illustrate two general. First, greater diversity leads, on average, to greater productivity. This effect of diversity on productivity should occur whether the diversity comes from growing many different plant species together in a pasture or forest; from growing a mixture of genotypes (a landrace) as a crop; from growing different crops in sequence, as in crop rotation; or from maximizing the genetic diversity within each individual plant, as it occurs in high-yielding crop varieties and commercial hybrids.

The level at which diversity is most important, and the kind of diversity that is needed, varies with the situation. For example, genetically diverse landraces are essential for farmers who must grow their crops in marginal, variable environments and who have no access to outside sources of diversity. These farmers must have plentiful diversity in their crops in the field. In contrast, commercial farmers are highly dependent on diversity in the foundation breeding pools of plant breeders who continually supply diverse new varieties to the commercial farmers, providing them with a kind of sequential diversity that has been called 'diversity in time.' The more heterogeneous the habitat and the more the environmental condition fluctuation during the growing season, the greater the beneficial effects of diversity. Conversely, in a spatially uniform, unchanging habitat in which a single factor always limits growth, a single strain is hypothesized to provide as great a yield as a mixture of several different strains grown together.[6]

Agricultural conditions, especially climate and disease and other pests, rarely are stable and predictable. Perhaps because of this, study of maize yields and years of practical experience lead to the recommendation that a farmer's best policy is to grow several unrelated single cross hybrids with good records for stability of performance as well as high yield. Second, greater diversity leads, on average, to lower year-to-year variability in productivity; that is, to greater stability. The ability of diversity to decrease year-to-year variability in yield means that diversity can act as crop risk insurance. Farmers may plant several different crop varieties as an additional way to decrease risk. Planting several kinds of crops, several varieties of a given crop, or a mixture of varieties as one crop increase the chance that some plants will be resistant to a disease or insect, or will perform well under existing climatic conditions. Greater crop diversity would thus decrease the odds of crop failure and may increase average yields. These features of biodiversity are greatly underutilized and merit further study and application.[7]

Evidence from the Green Revolution leaves no doubt that the spread of modern varieties has been an important cause of genetic erosion, as massive government campaigns encouraged farmers to adopt genetically engineered varieties and to abandon many local varieties. The uniformity caused by increasing areas sown to a smaller number of varieties is a source of increased risk for farmers, as the varieties may be more vulnerable to disease and pest attack and most of them perform poorly in marginal environments.

Field performance of some recently released transgenic crops has shown that increased endeavors in this area may not necessarily lead to success:

1. Bt transgenic cotton - Additional insecticide sprays needed due to Bt cotton failing to control bollworms in 20,000 acres in eastern Texas (Kaiser, 1996[8]).
2. Cotton inserted with Roundup Readgô gene - Bolls deformed and falling off in 4-5 thousand acres in Mississippi Delta (Lappe and Bailey, 1997[9]; Myerson, 1997[10]).
3. Bt corn - 27% yield reduction and lower Cu foliar levels in Beltsville trial (Hornick, 1997[11]).
4. Herbicide resistant oilseed rape - Pollen escaped and fertilized botanically related plants 2.5 km away in Scotland (Scottish Crop Research Institute, 1996[12]).
5. Virus resistant squash - Vertical resistance to two viruses and not to others transmitted by aphids (Rissler, J.[13]).
6. Early FLAVR-SAVR tomato varieties - Did not exhibit acceptable yields and disease resistance performance (Biotech Reporter, 1996[14]).
7. Roundup Ready Canola - Pulled off the market due to contamination with a gene that does not have regulatory approval (James, 1997[15]).
8. Bt potatoes - Aphids sequestered the Bt toxin apparently affecting coccinellid predators in negative ways (Birch et al., 1997[16])

9. Herbicide tolerant crops - Development of resistance by annual ryegrass to Roundup (Gill, 1995[17]).

PART 3
CONCLUSIONS AND SUGGESTIONS

Most scientists agree that the earth's biodiversity is threatened and that steps should be taken to preserve it. Thus the public debate has focused on the costs versus the benefits of such preservation. In addition, groups and individuals supporting unfettered property rights have increasingly viewed government acts to preserve habitat as efforts by an overly powerful federal bureaucracy to restrict individual freedom. Consequently, biodiversity protection has become increasingly controversial. The Convention on Biological Diversity's objectives are "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources." The Convention is thus the first global, comprehensive agreement to address all aspects of biological diversity: genetic resources, species, and ecosystems. It recognizes - for the first time - that the conservation of biological diversity is "a common concern of humankind" and an integral part of the development process. To achieve its objectives, the Convention - in accordance with the spirit of the Rio Declaration on Environment and Development - promotes a renewed partnership among countries. Its provisions on scientific and technical cooperation, access to genetic resources, and the transfer of environmentally sound technologies form the foundations of this partnership.[18]

The Endangered Species Act[19], the programs of the former National Biological Service (now part of the U.S. Geological Survey)[20], and the Convention on Biological Diversity[21] are vehicles for slowing the massive extinction of species currently under way. But resistance from property rights groups has made biodiversity legislation controversial in the United States, and many people continue to focus on the cost instead of the benefits of maintaining the habitats and ecosystems of endangered species.[22]

Widespread recognition and acceptance of the importance and value of conservation and sustainable use of biodiversity is indispensable in order to secure sustainable economic development and to meet public desire for a better environment. The following are some of the many steps we could take to achieve conservation and the sustainable development of biodiversity:

1. Develop a national strategy for biodiversity conservation,
2. Carrying out a national research project for biodiversity,
3. Implementation of a Nationwide Green Network Plan;
4. Strengthening conservation capacity;
5. Effective environmental impact assessments;
6. Establishment of an information management system for biological diversity.

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[18] Convention on Biological Diversity. [Available at: http://www.cast-science.org/biod/biod ch.htm#2
[19] The Endangered Species Act is the United States' principal protection for animal and plant species on the brink of extinction. The act's three main elements are, (1) listing a species as endangered or threatened, (2)developing a recovery plan, and (3) designating the critical habitat. About 950 U.S. species are currently listed as endangered or threatened under the act; about 230 of them are in stabilized or improved condition as a result.The best example of the act's success is the nation's symbol, the bald eagle.
[20] The National Biological Service was the biological research agency originally set up by the U.S. Department of the Interior in 1993 by consolidating the Interior Department's diverse science programs into a coherent unit. Its mission was "to provide the scientific understanding and technology needed to support the sound management and conservation of our nation's biological resources." As a result of the budget deal for fiscal year 1996, the National Biological Service has been disbanded and its programs will be absorbed by the U.S. Geological Survey during fiscal year 1997. The mission of these programs is not expected to change.
[21] The Convention on Biological Diversity is the principal international treaty designed to protect animals and plants from extinction. The Convention has been signed by 165 nations and took effect as international law in December 1993. Over 65 signatories have formally ratified the Convention, although the United States is not one of them. President Clinton signed the Convention for the United States in June 1993, but opposition from some industry and property rights groups blocked Senate action. The Endangered Species Act and similar laws provide stronger protection to biodiversity than required under the Convention. While the Convention will require some countries to adopt stronger laws protecting biodiversity, the obligations of the United States following ratification will, for the most part, be limited to effective enforcement of its current domestic laws.
[22] Union of Concerned Scientists. *Biodiversity*. [Available at: http://www.ucsusa.org/resources/index.html].