A Content Secondary Science Newsletter from the
Southern Nevada Regional Professional Development Program

Science Dissected

Genetically Modified Foods
Model-Evidence Link Diagram (MEL)

Gregor Mendel chronicled the selective breeding of traits in pea plants in the 1800's. The significance of his work was not recognized until farmers implemented crossbreeding practices to produce offspring with the most desirable characteristics.

Genetically modified foods are products of our biotechnological advances. New genes are added to an organism and those genes consequently distribute programming instructions for a new specific characteristic. From crops like corn, cotton, and potatoes to the Canadian trademarked "Enviropig," genetic engineering is producing a wide variety of foods that appear in the grocery aisle.

This issue of Science Dissected provides an instructional resource for teachers to present students with the opportunity to examine several pieces of evidence compiled about genetically modified foods and critically evaluate two competing models of genetically modified foods, their impact on the food supply and their impact on populations.

Model A: Genetically modified food is impacting the quantity and quality of the food supply.

Model B: Genetically modified food is impacting the health of the human population, native species, and the ecosystem

Evidence #1: The data gathered during the Millennium Ecosystem Assessment shows that genetically modified foods contribute to global resources.

Evidence #2: According to the Green Revolution, we know that the world's food supply problem, as well as the health of the population and the ecosystem, can be addressed by the creation of genetically modified foods.

Evidence #3: Some genetically modified foods preserve biodiversity.

Evidence #4: The advances in biotechnology are leading to further investigation related to the effects of genetically modified foods on populations and the ecosystem.

Evidence #5: Many scientists support the development of genetically modified foods as a means to address biodiversity.

The following is a suggestion for using this MEL with students:

1. Hand out the Genetically Modified Foods Model Evidence Link Diagram (page 1). Instruct students to read the directions, descriptions of Model A and Model B, and the five evidence texts presented.
2. Handout the five evidence text pages (pages 4-12).
3. Instruct students to carefully review the Evidence #1 text page (page 3), then construct two lines from Evidence #1; one to Model A and one to Model B. Remind students that the shape of the arrow they draw indicates their plausibility judgment (potential truthfulness) connection to the model.
4. Repeat for Evidence #2-5 (pages 4-12).
5. Handout page 2 for the students to critically evaluate their links and construct understanding.

Once students have completed page 2, they can then engage in collaborative argumentation as they compare their links and explanations with that of their peers. Students should be given the opportunity to revise the link weighting during the collaborative argumentation exercise. If time permits, have students reflect on their understanding of genetically modified foods and create questions that they might explore in the future.

Archived Issues of Science Dissected, http://www.rpdp.net/link.news.php?type=sciencedis. Instructional Resource resulting from Plausibility, It's All About Connecting the Models Workshop co-sponsored by CPDD and SNRPDP Science March 6, 2012

Written by: Judy Kraus

Name:____ ____________________ **Period:**________________

Directions: draw two arrows from each evidence box. One to each model. You will draw a total of 10 arrows.

Key:

- The evidence **supports** the model
- The evidence **STRONGLY supports** the model
- The evidence **contradicts** the model (shows its wrong)
- The evidence has **nothing to do with** the model

Standard: L.8.B.

Evidence #1
The data gathered during the Millennium Ecosystem Assessment shows that genetically modified foods contribute to global resources.

Evidence #2
According to the Green Revolution, we know that the world’s food supply problem, as well as the health of the population and the ecosystem, can be addressed by the creation of genetically modified foods.

Model A
Genetically modified food is impacting the quantity and quality of the food supply.

Model B
Genetically modified food is impacting the health of the human population, native species, and the ecosystem.

Evidence #3
Some genetically modified foods preserve biodiversity.

Evidence #4
The advances in biotechnology are leading to further investigation related to the effects of genetically modified foods on populations and the ecosystem.

Evidence #5
Many scientists support the development of genetically modified foods as a means to address biodiversity.

Provide a reason for three of the arrows you have drawn. **Write your reasons for the three most interesting or important arrows.**

A. Write the number of the evidence you are writing about.
B. Circle the appropriate descriptor (**strongly supports | supports | contradicts | has nothing to do with**).
C. Write the letter of the model you are writing about.
D. Then write your reason.

1. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

2. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

3. Evidence # ____ strongly supports | supports | contradicts | has nothing to do with Model _____ because:

4. Circle the plausibility of each model. [Make two circles. One for each model.]

	Greatly implausible (or even impossible)									Highly Plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10

5. Circle the model which you think is correct. [Only circle one choice below.]

Very certain that Model A is correct	Somewhat certain that Model A is correct	Uncertain if Model A or B is correct	Somewhat certain that Model B is correct	Very certain that Model B is correct

Evidence #1
The data gathered during the Millennium Ecosystem Assessment shows that genetically modified foods contribute to global resources.

Excerpt from:
http://science.salempress.com/doi/abs/10.3331/glor_1144?prevSearch=genetically+modified+food&queryHash=3bf903f8b3eec316ac09407e65235097

Encyclopedia of Global Resources

Ecosystem services

Category: Ecological resources

Ecosystem services are the means by which societal benefits and support are provided by ecosystems. Such benefits and support are also known as natural capital. They include climate regulation, water availability, the maintenance of wildlife and their habitats, fodder, and the production of raw materials such as wood, fiber, medicines, and a range of foods. All are fundamental components in people-environment relationships, given their necessity for human well-being, and all contribute to the provision and/or maintenance of global resources.

Background

Ecosystem services are closely linked with biogeochemical cycles and energy transfer. In biogeochemical cycles nutrients are continuously transferred between the constituent parts of the Earth's surface: rocks, soils, water (freshwater and marine), plants, animals, and the atmosphere. These processes are vital in energy transfers within food chains and webs. The spatial and temporal distribution of these processes is determined to a large extent by climatic characteristics but also influences global climate via the carbon cycle. Such processes affect the quality of the "commons" (air, water, oceans), the maintenance of which is essential to human well-being. These processes also control the natural capital that accrues within all ecosystems and that is used for society's needs. ecosystem services underpin all human activity through the continuous generation of resources and the environmental processes that are essential to that generation. Inevitably, ecosystem services are complex, are under pressure from a growing global population, and require careful management. The *Millennium Ecosystem Assessment* (*MEA*), compiled as a collaborative effort by 1,360 scientists worldwide between 2001 and 2005, summarizes the state of and major trends in global ecosystems and their services under the four headings used below.

Supporting Services

The primary supporting services are nutrient cycling, soil formation, and primary production. Nutrient, or biogeochemical, cycling involves the transfer of elements and compounds within and between the biosphere (organisms and their environment), atmosphere, and pedosphere (soils). They consist of pools or stores between which fluxes occur..

Primary production is the amount of organic matter produced per unit area per unit time by organisms that can photosynthesize (green plants on land and algae in the oceans). These organisms have the ability to absorb solar energy and convert it to chemical energy through the generation of complex organic compounds such as sugars and carbohydrates. Although less than 1 percent of the solar energy that reaches Earth is used in photosynthesis, this small amount fuels the biosphere. Primary production is the first stage in energy transfer through ecosystems and is thus the basis of all food chains and webs. Nutrient cycling, soil formation, and primary production are vital for the ecosystem services described below.

Provisioning Services

Provisioning services encompass food, wood, fiber, genetic resources, fuel, and fresh water. Primary production on land and in the oceans underpins the generation and replenishment of many resources on which humanity depends.

Global food production is a vast enterprise that essentially processes carbon and is a major generator of wealth. It involves crop and animal agriculture at various scales (subsistent or commercial); may have a fossil-fuel subsidy, as in the case of "industrialized" agriculture; and requires a reliable supply of fresh water. An indication of the magnitude of this production is reflected in the Food and Agriculture Organization's (FAO's) 2006 data for the major staple crops: 695 million metric tons of maize, 634 million metric tons of rice, and 605 million metric tons of wheat. A proportion of this is used as animal feed to create secondary productivity such as meat and milk products. These and other crops, including cotton fiber, are produced on about 15 million square kilometers of cropland.

An increasing proportion of crop production—notably that of corn, soybean, and canola—is used to generate biofuels, while several crops are grown specifically as biofuels. However, the value of growing materials to use as biofuels is controversial because the crops take up land that could be used for food production. An additional roughly 28 million square kilometers of pasture support a large proportion of the world's cattle and sheep. Cotton is the world's major fiber; about 25 million metric tons were produced in 2005.

The organisms in the world's ecosystems contain a wealth of genetic resources with vast potential. biodiversity prospecting is the term given to programs designed to tap this resource by identifying species and screening them for useful properties such as crop protection chemicals and pharmaceuticals. About 25 percent of prescription medicines are plant based, including the widely used aspirin, while the bacterium *Bacillus thuringiensis* is the basis of insect pest control in a range of crops. The bacterium itself is produced as a commercial spray, but the gene component responsible for insect mortality has been identified and inserted into a number of crops, notably cotton and maize, so that these genetically modified varieties produce their own insecticide. As further advances in biotechnology and genetic modification ensue, further opportunities to harness genetic resources will arise.

Future Context

Global population is estimated to increase to 8 billion by 2030. This will compound pressure on already stretched ecosystem services and require an increase in food production by at least 25 percent. According to the *MEA*, humans have altered global ecosystems more substantially since the mid-twentieth century than at any other time in history. This happened because of a threefold growth in population, rapid conversion of forests and grasslands to agricultural land, technologies such as automobiles requiring fossil fuels, and rising standards of living that encompass increased resource use. More than half of the services provided are being degraded mostly at the expense of the poorest people. One aspect of this degradation is the high rate of plant and animal extinction such as the loss of genetic resources, a process that, unlike many other environmental problems, is irreversible. Unsustainable practices and resulting inequity require immediate attention from local, national, and international political and environmental institutions. Each requires the inventory and valuation of ecosystem services, monitoring, investment in management, education programs, and cooperation at all scales.

A. M. Mannion

Evidence # 2
According to the Green Revolution, we know that the world's food supply problem, as well as the health of the population and the ecosystem, can be addressed by the creation of genetically modified foods.

Excerpt from:
http://science.salempress.com/doi/full/10.3331/GloR_1228?prevSearch=genetically%2Bmodified%2Bfood&searchHistoryKey=&queryHash=3bf903f8b3eec316ac09407e65235097

Encyclopedia of Global Resources

Green Revolution

Categories: Environment, conservation, and resource management; historical events and movements

Impending famine in the 1960's in the underdeveloped countries of Asia, Africa, and Latin America was averted by the Green Revolution, which was made possible by the introduction of hybrid "miracle grains" of wheat and rice.

Background

From 1960 to 1965 a number of poor countries in the world could not produce enough food for their growing populations. The Earth's population had almost doubled to 3.7 billion people in fifty years, with more than 900 million people not getting adequate nourishment to lead productive lives. Famine had been avoided during the post-World War II period of history only because production was high for American farmers and surplus grains were shipped overseas as food aid.

In this 1970 photograph, Norman Borlaug, considered the father of the Green Revolution, studies grains that he helped develop.

(AP/Wide World Photos)

In 1966 and 1967, the Indo-Pakistan subcontinent suffered two consecutive crop failures because of monsoons. The United States shipped one-fifth of its wheat reserves to India and sustained sixty million persons in India for a two-year period on American food shipments. It became obvious, as populations continued to grow, that the United States would not be able to continue to supply enough food to feed the world's growing population adequately. In the mid-1960's, American policy began to change from giving poor countries direct food aid to educating and helping them to increase their own food production.

The United States had, in the 1950's, responded to an ailing agricultural economy in Mexico by sending scientists from the Rockefeller Foundation to develop a new wheat that yielded twice as much grain as traditional varieties. The project was successful, and in 1962, the Rockefeller Foundation collaborated with the Ford Foundation to establish the International Rice Research Institute at Los Baños, in the Philippines. Two strains of rice, PETA from Indonesia and DGWG from China, were crossbred to produce a high-yield semidwarf variety of rice called IR-8.

Both the new rice and new wheat were developed to have short but strong and stiff stalks to support large heads of grain. Yields from the rice and wheat seeds were two to five times higher than traditional varieties as long as they were grown with large inputs of fertilizer, water, and pesticides.

Seeds were shipped to ailing countries. Asia expanded acreage planted in the new varieties from 81 hectares to 14 million hectares between 1965 and 1969. Pakistan's wheat harvest increased 60 percent between 1967 and 1969. India's production of wheat increased 50 percent, and the Philippines' production of rice was so successful that it stopped importing rice and became an exporter.

Positive Aspects

The new seeds were dependent on irrigation by tube wells (closed cylindrical shafts driven into the ground) and electrical pumps. Irrigation methods were installed in poor countries. This new availability of water made it feasible for farmers to grow crops year-round. The dry season, with its abundant sunlight, had previously been a time when crops could not be grown. With the advent of irrigation, the dry season became an especially productive growing season. Poor countries in tropical and subtropical regions were able to grow two, three, and sometimes four crops a year. Approximately 90 percent of the increase of the world's production of grain in the 1960's, 70 percent in the 1970's, and 80 percent in the 1980's was attributable to the Green Revolution.

The Green Revolution brought to politicians in developing countries the realization that they could not depend permanently on food aid from other nations. Whereas leaders and politicians in these countries had previously concentrated on developing industrial projects, the extreme pressure of overpopulation on their limited food and land supplies caused them to address agricultural problems and give emphasis to programs to encourage production of food supplies. Countries that were affected by, and benefited from, the Green Revolution include India, Pakistan, Sri Lanka, the Philippines, Turkey, Burma (Myanmar), Malaysia, Indonesia, Vietnam, Kenya, the Ivory Coast, Tunisia, Morocco, Algeria, Libya, Brazil, and Paraguay.

Drawbacks and Environmental Impact

Large-scale pesticide application not only is costly but also can have an adverse effect on the environment. Only a small percentage of insecticides used on crops actually reach the target organism. The rest affects the environment by endangering groundwater, aquatic systems, pollinators, various soil-dwelling insects, microbes, birds, and other animals in the food chain. In addition, large water inputs are needed for proper irrigation of crops. Of the farmers who can afford to irrigate in poor countries, many do not do so properly, and thereby cause salinization, alkalization, and waterlogging of soils, rendering them useless for growing crops.

Large-scale application of fertilizers is costly and reaches a point where further applications do not produce the expected increase in yield and begin to cost far more than they are worth. Crop yields also decrease because of increased soil erosion, loss of soil fertility, aquifer depletion, desertification, and pollution of groundwater or surface waters.

The Green Revolution exemplifies monoculture agriculture, the planting of large areas with a single type of seed. This use of monotypes can create multiple environmental problems. In many cases, the widespread use of genetically homogeneous seed caused old varieties with great genetic variability to be abandoned. Crops consisting entirely of genetically homogeneous rice and wheat are more vulnerable to disease and insects, requiring inputs of agrochemicals which can be harmful to both the environment and human health. Planting vast hectares of monotypes has the potential to result in massive crop failure due to destructive fungi or chemical-resistant insects.

Moreover, Green Revolution techniques rely heavily on fossil fuel to run machinery, to produce and apply inorganic fertilizers and pesticides, and to pump water for irrigation. Gasoline is costly and is often in short supply in many of the poor nations. Sociologically, the Green Revolution in poor countries favored wealthier farmers with the capital to pay the considerable costs of irrigation, seeds, fertilizers, pesticides, and fossil fuels. This fact has accentuated the financial gap between the big and small farmers.

Outlook

The drawbacks of the Green Revolution have led farmers and scientists to seek safer and more diverse solutions to world food needs. Genetic engineers hope to be able to breed high-yield plant strains that have greater resistance to insects and disease, need less fertilizer, and are capable of making their own nitrogen fertilizer so as not to deplete the soil of nutrients. Proponents of integrated pest management continue to investigate combinations of crop rotation, time of planting, field sanitation, and the use of predators and parasites as ways to control insects without the use of harmful chemicals. Regardless of developments in food production and technology, however, in the long term the most important aspect of addressing world food needs is to control population growth.

Evidence #3
Some genetically modified foods preserve biodiversity.

Excerpt from:
http://science.salempress.com/doi/full/10.3331/GloR_1431?prevSearch=genetically%2Bmodified%2Bfood&searchHistoryKey=&queryHash=3bf903f8b3eec316ac09407e65235097

Encyclopedia of Global Resources

Seed Savers Exchange

Category: Organizations, agencies, and programs

Date: Established 1975

Since its founding, the Seed Savers Exchange has helped preserve the genetic material of more than twenty-five thousand plant species. Modern agriculture practices tend to focus narrowly on an increasingly small number of crops, resulting in the endangerment or extinction of thousands of plant species. However, the Seed Savers Exchange helps maintain genetic diversity over time, which is critical to combating the further loss of species from disease, pestilence, and other environmental factors.

Background

The Seed Savers Exchange was founded in 1975 in Decorah, Iowa, by then husband and wife Kent Whealy and Diane Ott Whealy. The couple had been given the seeds of two garden plants that Diane's grandfather had brought to the United States from Bavaria in the 1870's, a gift that made them recognize the value of preserving not only the genetic but also the cultural and historical heritage of plants. Over time, the nonprofit organization has grown to several full-time employees and occupies 360 hectares, where it maintains more than twenty-five thousand varieties of vegetable, fruit, flower, and herb seeds as well as a small number of endangered cows and poultry.

Seeds are stockpiled in the Svalbard Global Seed Vault on the island of Svalbard near the North Pole. The Seed Savers Exchange's initial contribution to the vault was five hundred seeds.


(AFP/Getty Images)

Impact on Resource Use

The Seed Savers Exchange is a permanent repository of thousands of seeds, including those of many plant species that have otherwise virtually disappeared. Unlike many seed banks, the Seed Savers Exchange not only stores seeds but also actively plants approximately

10 percent of its inventory each year in rotation, allowing seeds to be distributed among members or sold. The wide variety of plants the Seed Savers Exchange grows each year helps combat the existence of monocultures, or the covering of hundreds or thousands of hectares with a single crop. While large commercial food growers routinely deal in monocultures in order to maximize profit, the practice risks crop annihilation if that particular strain is attacked by a disease or pest. In addition, the Seed Savers Exchange's planting activity keeps those species in contact with the larger natural environment, and thus better equipped to survive in the future, rather than "frozen" in storage and unable to react to changing environmental conditions.

The Seed Savers Exchange also promotes the saving and exchange of seeds among members, thus creating community, spreading the impact of its work, and promoting long-term survival of plant species. It also sells seeds via print and online catalogs, which has helped promote the organic farming industry, because commercially available seeds are far more limited in variety. In addition, many commercial seeds are either hybrids that do not reproduce reliably or genetically modified, which is not permitted in the organic food trade.

The Seed Savers Exchange considers education and outreach to be important parts of its mission. In addition to providing seed-saving guidance in its newsletters and on its Web site, the Seed Savers Exchange houses a visitors' center that offers guided tours to individuals and groups. The organization also participates in the global seed preservation community, most notably by contributing almost five hundred seeds for the opening of the Svalbard Global Seed Vault in Norway in 2008. The organization has additional global donations planned. The donations help ensure that some of the Seed Savers Exchange's seed stock will be protected in the event of local disaster in Iowa.

Amy Sisson

Evidence #4
The advances in biotechnology are leading to further investigation related to the effects of genetically modified foods on populations and the ecosystem.

Excerpt from:
http://science.salempress.com/doi/abs/10.3331/glor_1051?prevSearch=genetically+modified+food&queryHash=3bf903f8b3eec316ac09407e65235097

Encyclopedia of Global Resources

Background

Modern biotechnological advances have provided the ability to tap into a natural resource, the world gene pool, with such great potential that its full magnitude is only beginning to be appreciated. Theoretically, it should be possible to transfer one or more genes from any organism in the world into any other organism. Because genes ultimately control how any organism functions, gene transfer can have a dramatic impact on agricultural resources and human health in the future.

OriginOil cofounder Nicholas Eckelberry stands beside containers of algae that he and his company hope can be used as a biofuel source.


(Reuters/Landov)

Although the term “biotechnology” is relatively new, the practice of biotechnology, according to the foregoing definition, is at least as old as civilization. Civilization did not evolve until humankind learned to produce food crops and domesticate livestock through the controlled breeding of selected plants and animals. Eventually humans began to utilize microorganisms in the production of foods such as cheese and alcoholic beverages. During the twentieth century, the pace of human modification of various organisms accelerated. Because both the speed and scope of this form of biotechnology are so different from what has been historically practiced, it is sometimes referred to as modern biotechnology to discriminate it from traditional biotechnology. Through carefully controlled breeding programs, plant architecture and fruit characteristics of crops have been modified to facilitate mechanical harvesting. Plants have been developed to produce specific drugs or spices, and microorganisms have been selected to produce antibiotics such as penicillin and other useful medicinal or food products.

Developments in Biotechnology

For many years, the methods for selecting desirable traits in living organisms remained unchanged. In the early 1900’s, even with the realization that specific traits are linked with packets of deoxyribonucleic acid (DNA) called genes (the amount of DNA required to encode a single protein), scientists remained constrained to the methods of artificial selection in use throughout history. This changed in the 1970’s, when techniques were developed both to determine the order of the four possible DNA “bases” (which spell out the information found in a gene)—a process called DNA sequencing—and to transfer this gene into another organism. The use of modern biotechnology in crops, livestock, and medicine can be divided into three major stages: identifying a gene of interest, transferring this gene into the organism of interest, and mass-producing the “transgenic” organisms that have taken up this foreign DNA.

Biotechnology in Crop Production

Biotechnology will undoubtedly continue to have a tremendous impact on agriculture in the future. Experts who study human populations predict that the number of human inhabitants on Earth will reach alarming proportions by the mid-twenty-first century. The only way in which civilization can continue to advance, or even maintain a steady state, in the face of this potential disaster will be to increase food production, and biotechnology will most likely play an important role in producing this increase. Increased food production has been dependent on developments such as crop plants that produce higher yields under normal conditions and crops that produce higher yields when grown in marginal environments.

Even under the best of situations, there is a limited amount of land available for crop production, and while the number of people that have to be fed will continue to increase, the amount of good agricultural land will remain the same or decrease. If mass starvation is to be avoided, crops with higher yields will have to be developed and grown on the available land. As human populations continue to grow, good agricultural lands are taken over for industry, housing developments, and parking lots. As nonrenewable sources of energy—notably fossil fuels—are depleted, more land will be diverted to produce cellulosic material devoted to fuel production (the diversion of corn crops for ethanol production in the early twenty-first century is one example). The continuation of this trend will require that crops be grown on marginal lands where soil and growth conditions are less than ideal. The only way to increase crop production is to develop stress-tolerant plants that produce higher yields when grown under these marginal conditions. While the development of these higher-yielding crops could probably be accomplished though traditional breeding programs, the traditional methods are too slow to keep pace with the rapidly increasing population growth. Biotechnology provides a means of developing these higher-yielding crops in a fraction of the time it takes to develop them though traditional plant breeding programs because the genes for the desired characteristics can be inserted directly into the plant without having to go through several generations to establish the trait.

Economically, there is often a need or desire to diversify agricultural production in a given area. In many cases, soil and/or climate conditions may severely limit the amount of diversification that can take place. A producer might wish to grow a particular high-value cash crop, but environmental conditions may prevent the producer from doing so. Biotechnology can provide the tools to help facilitate a solution to these types of problems. For example, high-cash-value crops can be developed to grow in areas that heretofore would not have supported such crops. Another approach would be to increase the cash value of a crop by developing plants that can produce novel products such as antibiotics, drugs, hormones, and other pharmaceuticals. Progress toward the production of specific proteins in transgenic plants provides opportunities to produce large quantities of complex pharmaceuticals and other valuable products in traditional farm environments rather than in laboratories. These novel strategies open up routes for production of a broad array of natural or nature-based products, ranging from foodstuffs with enhanced nutritive value to the production of biopharmaceuticals, monoclonal antibodies, industrial proteins, and specialist oils. Crop plants that have been bioengineered to produce novel products may have a much higher cash value than the crop in its natural state.

Biotechnology and the Environment

While there will be a growing pressure for agriculture to produce more food in the future, there will also be increased pressure for crop production to be more friendly to the environment. Biotechnology plays a major role in the development of a long-term, sustainable, environmentally friendly agricultural system. For example, one of the major biotechnical goals is the development of crops with improved resistance to pests such as insects, fungi, and nematodes. The availability of crop varieties with improved pest resistance in turn reduces the reliance on pesticides. In conjunction with the improvements made through biotechnology, improved methods of crop production and harvest with less environmental impact will also have to be developed. Regardless of the technological advancements made in pest resistance, crop production, and harvest, agriculture will continue to have an impact on the environment. Agricultural pollutants will still be present, though perhaps in reduced amounts, and the need to remediate these polluting agents will continue to exist. Hence, biotechnology will play an important role in the development of bioremediation systems for agriculture as well as other industrial pollutants.

Biotechnology in Medicine

While recombinant technology has already had an indirect influence on human well-being through its effects on plants and livestock, it will probably also have a dramatic, direct impact on human health. Recombinant DNA technology can be used to produce a variety of gene products that are utilized in the clinical treatment of diseases. A number of human hormones produced by this methodology have been in use for some time. Human growth hormone (HGH), marketed under the name Protropin, was one of the first recombinant proteins to be approved by the U.S. Food and Drug Administration, in this case to treat a disease called hyposomatotropism. People suffering from this disease do not produce enough growth hormone and without treatment with HGH will not reach normal height. Insulin, a hormone used to treat insulin-dependent diabetics, was the first major success in using a product of recombinant technology. Beginning in 1982, recombinant DNA-produced insulin, marketed under the name Humalin, has been used to treat thousands of diabetic patients. A pituitary hormone, called somatostatin, was another early success of recombinant DNA techniques. This hormone controls the release of insulin and human growth hormone. Some of the interferons, small proteins produced by a cell to combat viral infections, have also been produced using recombinant DNA methodology. The technology could thus be used to produce vaccines against viral diseases. The first of these vaccines, marketed under the name Recombivax HB, was successfully used to vaccinate against hepatitis B, an incurable and sometimes fatal liver disease. A number of other antiviral vaccines were soon developed.

Advances in biotechnology have also enhanced the potential for the future application of gene therapy. Genetic therapy is often defined as any procedure that prevents, reduces, or cures a genetic disease, but for this discussion the term gene therapy will apply only to those procedures that involve the direct manipulation of human genes. The following forms of gene therapy are in development: gene surgery, in which a mutant gene (which may or may not be replaced by its normal counterpart) is excised from the DNA; gene repair, in which the defective DNA is repaired within the cell to restore the genetic code; and gene insertion, in which a normal gene complement is inserted in cells that carry a defective gene.

Ownership Issues

Many difficult ethical and economic issues surrounding the use of modern biotechnology remain. One of the major questions concerns ownership. The U.S. patent laws currently read that ownership of an organism can be granted if the organism has been intentionally genetically altered through the use of recombinant DNA techniques. In addition, processes that utilize genetically altered organisms can be patented. Therefore one biotechnology firm may own the patent to an engineered organism, but another firm may own the rights to the process used to produce it.

D. R. Gossett, updated by James S. Godde

Evidence #5
Many scientists support the development of genetically modified foods as a means to address biodiversity.

Excerpt from:
http://science.salempress.com/doi/abs/10.3331/glor_1503?prevSearch=genetically+modified+food&queryHash=3bf903f8b3eec316ac09407e65235097

Encyclopedia of Global Resources

United Nations Convention on Biological Diversity

Category: Laws and conventions

Date: Adopted June 5, 1992; entered into force December 29, 1993

During the 1992 United Nations Conference on Environment and Development (UNCED), world decision makers agreed on the concept of sustainable development as the main path for future development. The conservation of biodiversity is a key element of the sustainable development strategy because diverse ecological systems provide the basis for human life and sharing conservation benefits is a prerequisite for effective conservation management and poverty reduction.

Background

While nature conservation and environmental protection have long histories, one of the major events was the establishment of the Yellowstone National Park in 1872, which was followed by the global spread of the idea of national parks. However, establishing international frameworks for conserving biodiversity took more than one hundred years. Efforts for standardization were started by, among others, the International Union for Conservation of Nature (IUCN) with its system of categorization of protected areas, such as national parks, beginning in the 1970's. In 1987, the United Nations Environment Program (UNEP) began a process of expert talks for a joint framework (Ad Hoc Working Group of Experts on Biological Diversity) after having developed the idea of an international convention as early as 1982 at the World Congress on Protected Areas at Bali (Indonesia). In 1990, a UNEP-led group of legal and technical experts worked on legal instruments aimed at the conservation and sustainable use of biodiversity. A first formal draft of the Convention on Biological Diversity was presented in 1991, and, after several international working group meetings, the final text of the convention was adopted in 1992.

Provisions

The Convention on Biological Diversity is concerned with the conservation of biodiversity, the sustainable use of biodiversity components, and the fair and equitable use of genetic resources. The convention defines biological diversity (biodiversity) in terms of genetic, species, ecosystem, and landscape diversity. The conservation of biodiversity is founded on the fundamental value of biodiversity for human life on Earth and offers many benefits for humans, such as food, fuels, productive resources, stabilization of the climate, and recreation. The convention is designed to reduce the loss of biodiversity, especially of ecosystems and species. It provides policies and incentives for biodiversity conservation and sustainable use and regulates the access to genetic resources and the transfer of biotechnology. It also arranges scientific cooperation, education, and public awareness and considers financial support. Among the convention's numerous other provisions, it created the Cartagena Protocol on Biosafety (2003) as a subsidiary agreement covering genetically modified organisms.

Impact on Resource Use

The Convention on Biological Diversity offers a comprehensive and international framework for conserving and using biodiversity. An important precautionary principle prescribes political action even in the case of scientific uncertainty. In 2002, the convention members agreed on the 2010 Biodiversity Target to achieve a significant reduction in the rate of biodiversity loss. Critics argue that the path to comprehensively conserving biodiversity has only begun, and that there is still a long way to go to reduce the rates of biodiversity loss.

Michael Getzner