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RESEARCH ARTICLE

BIOTECHNOLOGY AND BIODIVERSITY CONSERVATION: ARE THEY CONFLICTING?

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ABSTRACT

Biodiversity conservation is the protection, restoration and sustainable management of wildlife and natural resources such as forests, water and the biological diversity within it. Biotechnology is a set of techniques by which human beings modify living things or use them as tools. In its modern form, biotechnology uses molecular biology techniques to understand and manipulate the basic building blocks of living things. Biotechnology is the art of utilizing living organisms and their products for the production of food, drink, medicine or for other benefits to the human being, or other animal species. Biotechnology plays an immense role in biodiversity conservation such as vegetative multiplication of many species, allows the production of large numbers of plants from small pieces of the stock plant in relatively short period of time and in some cases for recovery of virus-free plants. Biotechnology also has potential application in production of somatic hybrids, organelle and cytoplasm transfer, genetic transformation and germplasm storage through freeze-preservation (Cryopreservation). Apart from its uses there are also some concerns or worries with modern biotechnologies such as the Terminator technology and Genetically Modified Organisms (GMO) which are developed through genetic engineering, which may cause "Genetic pollution" and "Genetic contamination" and they may have social consequences which needs economic, ethical and environmental considerations. Even though, biotechnology has so many advantages and different technologies which can complement conservation of biodiversity; as that of other new technologies the introduction and spread of new biotechnologies generally have social consequences with winners and losers. For biotechnology, this has led to intense public debate across many different aspects such as ethical, economic, legal and environmental issues. Modern biotechnologies such as terminator technology and GMO can have a negative effect on biodiversity. Genetic pollution" and "genetic contamination" are among the environmental concerns which need to be cleared or ascertained before releasing new technologies which can pollute the biodiversity and the natural/ wild genetic pool and may cause irreversible damage. Since many countries have banned the use of technologies such as GMO and terminator technology; for the country like Ethiopia, it is important to learn from others, rather than endangering or risking the genetic resources from genetic pollution and genetic contamination which may occur. On the other hand, the use of safe and known technologies should be encouraged and used to augment the biodiversity conservation efforts and other development efforts of the country.

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INTRODUCTION

Biodiversity conservation is the protection, restoration and sustainable management of wildlife and natural resources such as forests, water and the biological diversity within it. Through the conservation of biodiversity not only the survival of many threatened species and habitats can be ensured, but also these valuable resources will be secured for future generations and the well-being of eco-system functions protected. Unfortunately, there are several threats to these resources. According to the World Conservation Union (IUCN), Invasive Alien Species (IAS), next to habitat destruction has been a major cause of extinction of native species. This invasion by biological control agents and other natural and man-made threat has caused a significant loss of biodiversity. According to E. Wilson (1992), 20,000-30,000 species going extinct annually, we have up to 80 species going extinct each day. Biotechnology is a set of techniques by which human beings modify living things or use them as tools. In its modern form, biotechnology uses molecular biology techniques to understand and manipulate the basic building blocks of living things. The earliest biotechnology, however, was the selective breeding of plants and animals to improve their food value. This was followed in time by the use of yeast to make bread, wine, and beer. These early forms of biotechnology began

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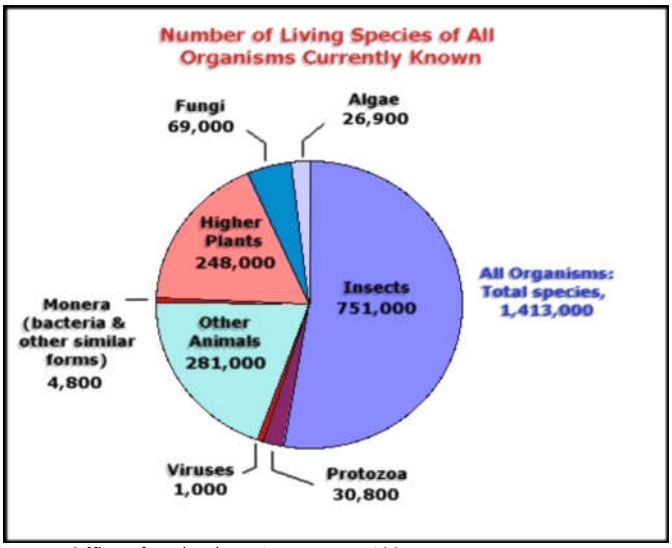
about ten thousand years ago and lie at the basis of human cultural evolution from small bands of hunter-gatherers to large, settled communities, cities, and nations, giving rise, in turn, to writing and other technologies. It is unclear that, at the outset, the first biotechnologists assumed the effects of their actions, and so the reason for their determination in pursuing, for example, selective breeding over the hundreds of generations essential to show much advantage in food value, remains something of a mystery (Rae, 2002). On the other hand, Biotechnology is the art of utilizing living organisms and their products for the production of food, drink, medicine or for other benefits to the human being, or other animal species. Biotechnology plays an immense role in biodiversity conservation such as vegetative multiplication of many species, allows the production of large numbers of plants from small pieces of the stock plant in relatively short period of time and in some cases for recovery of virus-free plants. It also has potential application in production of somatic hybrids, organelle and cytoplasm transfer, genetic transformation and germplasm storage through freeze-preservation (Cryopreservation). Apart from its uses there are also some concerns or worries which modern biotechnologies such as the Terminator technology and Genetically Modified Organisms (GMO) which are developed through genetic engineering, can cause "Genetic pollution" and "Genetic contamination" and they may have social consequences which needs economic, ethical and environmental considerations. “Genetic pollution” and collateral damage from GE field crops already have begun to wreak environmental havoc. Wind, rain, birds, bees, and insect pollinators have begun carrying genetically-altered pollen into adjoining fields, polluting the DNA of crops of organic and non-GE farmers (Cummins, 1999). EU regulators are considering setting an "allowable limit" for genetic contamination of non-GE foods, because they don't believe genetic pollution can be controlled. Because they are alive, gene-altered crops are inherently more unpredictable than chemical pollutants they can reproduce, migrate, and mutate. Once released, it is virtually impossible to recall GE organisms back to the laboratory or the field (Kolehmainen, 2001).This paper presents a review on the conservation of biodiversity, the important roles of biotechnology for the conservation of biodiversity and some potential ricks of modern biotechnology to biodiversity.

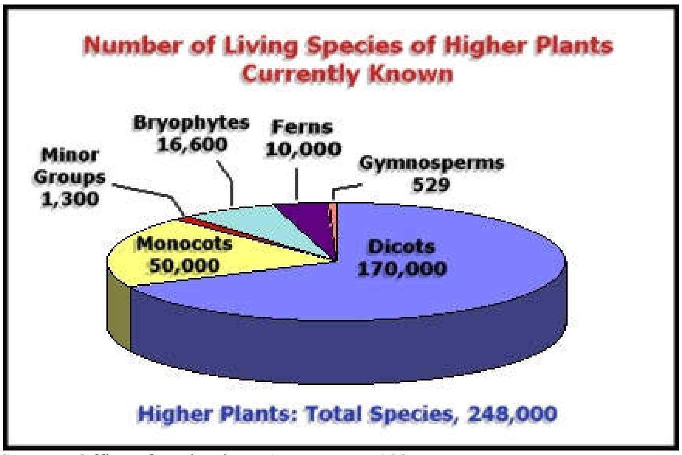
Biodiversity Conservation

Diversity can be defined as the number of different items and their relative frequency. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the chemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, genes, and their relative abundance (Office of Technology Assessment, 1987). (Gaston & Williams, 1996) also describes that, Biodiversity is a complex topic, covering many aspects of biological variation. They defined Biodiversity as, the variety of life forms on Earth, the different plants, animals and microorganisms, the genes they contain and the ecosystems of which they are a part, and the ecological and evolutionary processes that sustain it. Experts estimate the world's species diversity to be 10 to 30 million, but only 1.4 million species are "known to science" which means they have been classified by a specialist (Office of Technology Assessment, 1987). This can be presented diagrammatically by the following three pie charts (figure 1, number of species of all kinds), (figure 2, number of plant species)



Source: Office of Technology Assessment, 1987

Figure 1. Number of Living Species of All Organisms Currently Known



Source: Office of Technology Assessment, 1987

Figure 2. Number of Living Species of Higher Plants Currently Known

What is Biodiversity Conservation?

The global geographical distribution of biodiversity by itself is interesting and relevant to conservation. Biological diversity is much rich near the equator, and declines towards higher latitudes. Tropical rain forests are especially known for their exceptional diversity. Some locations known as "hotspots" harbor an unusually rich local diversity, perhaps because conditions favor evolutionary diversification. Biodiversity conservation is the protection, restoration and sustainable management of wildlife and natural resources such as forests, water and the biological diversity within it. Through the conservation of biodiversity not only the survival of many threatened species and habitats can be ensured, but also these valuable resources will be secured for future generations and also the well being of eco-system functions protected.

Conservation strategies: The two broad classifications of biodiversity conservation strategies are *ex-situ* and *in-situ* conservations.

Ex-situ conservation

Ex-situ conservation refers to the conservation of elements of biodiversity out of the context of their natural habitats. This involves conservation of genetic resources, as well as wild and cultivated/ domesticated plant/animal species, and draws on a diverse body of techniques and facilities. Some of these include:

- Gene banks, e.g. seed banks, sperm and ova banks, field banks;
- In vitro plant tissue and microbial culture collections;
- Captive breeding of animals and artificial propagation of plants, with possible reintroduction into the wild; and
- Collecting living organisms for zoos, aquaria, and botanic gardens for research and public awareness.

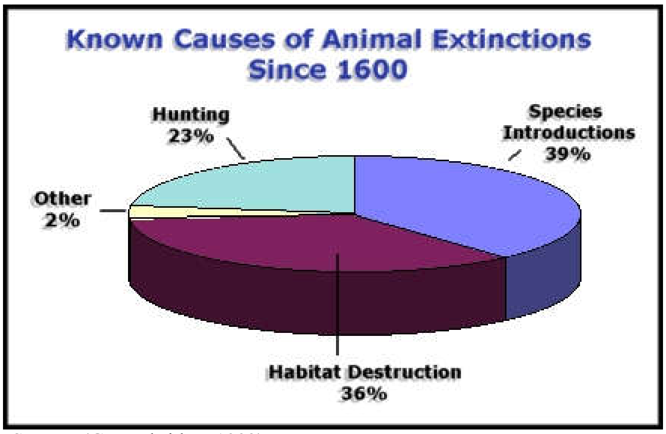
Ex-situ conservation measures can be complementary to in-situ methods as they provide an "insurance policy" against natural calamities and extinction. These measures also have a valuable role to play in recovery programmes for endangered species. Ex-situ conservation provides excellent research opportunities on the components of biological diversity. Some of these institutions also play a central role in public education and awareness raising by bringing members of the public into contact with plants and animals they may not normally come in contact with. It is estimated that worldwide, over 600 million people visit zoos every year (Glowka, Burhenne-Guilmin, & Synge, 1994).

In-situ conservation

In-situ refers to the conservation of habitats, species and ecosystems where they naturally occur, in which elements of biodiversity as well as the natural processes and interactions conserved. *In-situ* is considered the most appropriate way of conserving biodiversity. Conserving the areas where populations of species exist naturally is an underlying condition for the conservation of biodiversity. That is why protected areas form a central element of any national strategy to conserve biodiversity. Approximately 8,500 protected areas exist throughout the world in 169 countries. This covers about 750 million hectares of marine and terrestrial ecosystems, which amounts to 5.2 % of the Earth's land surface, (Grant *et al.*, 1998).

Major Threats to Biodiversity

*"The worst thing that can happen during the 1980s is not energy depletion, economic collapse, limited nuclear war, or conquest by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing in the 1980s that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly that our descendants are least likely to forgive us."*Even though, extinction is a natural event and, from a geological perspective, routine; in the modern era, we know that most species that have ever lived have gone extinct due to human actions. Species and ecosystems are threatened with destruction to an extent rarely seen in earth history. According to the World Conservation Union (IUCN), habitat destruction followed by Invasive Alien Species (IAS), has been a major cause of extinction of native species. This invasion by biological control agents has caused a significant loss of biodiversity. Globally the damage caused by invasive species has been estimated to be £1 trillion per year – close to 5% of global GDP (Lowe *et al.*, 2000). Some of the human actions which are threatening biodiversity specially being causes for animal extinction are shown in Figure 3 below.



Source: (Groombridge, 1992)

Figure 3. Known Causes of Animal Extinctions Since 1600

What is Biotechnology

Biotechnology is briefly defined as the art of utilizing living organisms and their products for the production of food, drink, medicine or for other benefits to the human being, or other animal species. Biotechnology existed long before there was a special word for it. Many of the principles and some of the techniques involved in biotechnology are ancient. Biotechnology in one form or another has flourished since prehistoric times. When the first human beings realized that they could plant their own crops and breed their own animals, they learned to use biotechnology. The discovery that fruit juices fermented into wine or that milk could be converted into cheese or yogurt, or that beer could be made by fermenting solutions of malt and hops began the study of biotechnology (Peters, 1993). More recently, cross-pollination of plants and cross-breeding of animals were macro-biological techniques in biotechnology, used to enhance product quality and/or meet specific requirements or standards. Even though, the discovery of microorganisms, antibiotics, causes of infectious diseases, and immunizations could probably be reckoned among significant discoveries; the most modern techniques in biotechnology get their existence to the discovery of DNA and several techniques necessary for gene cloning. What is special about biotechnology today is that, researchers can take a single gene from a plant or animal cell and insert it into another plant or animal cell of a different species (this is called transgenic technology).

The evolution of Biotechnology

Biotechnology focuses on applications made possible by biological research. Discoveries in the life sciences are driving a new revolution in biotechnology. Peters (1993),describes today known applications for biotechnology as a spectrum which are described as follows:

Green Biotechnology: refers to agricultural applications, such as production of disease-resistant or UV-resistant plants, or plants that have superior qualities, by means of genetic modification.

White (Grey) Biotechnology: is applied to industrial processes. An important example is bioremediation by microbes, where microbes are utilized to clean up toxic or hazardous industrial wastes in the environments.

Blue Biotechnology: applies to marine or aquatic applications, such as restoring or preserving various aquatic species.

Red Biotechnology: refers to medical applications of biotechnology, such as antibiotics and pharmaceuticals that are based on recombinant DNA technology.

Multicolored Biotechnology: is often interdisciplinary, and so many applications may be classified in more than one color category. For example, production of biodiesel fuel from agricultural or waste materials could be considered to be both white and green, or white and blue, biotechnology.

Importance of Modern Biotechnology to Biodiversity conservation

The Role of Plant Tissue Culture (Micro propagation) in Biodiversity Conservation

Plant tissue culture is a general term used for different techniques such as Cells-culture, Seeds-Tissue culture, Anther and Pollen culture, Plant Organ culture and Tissue culture, which have important role in Biodiversity conservation such as:

- For vegetative multiplication of many species,
- Allows the production of large numbers of plants from small pieces of the stock plant in relatively short periods of time,
- For recovery of virus-free plants,
- Production of somatic hybrids, organelle and cytoplasm transfer and
- Germplasm storage through freeze-preservation (cryopreservation).

Biotechnology in plant and animal breeding

According to (Ammann & Garden, 2004), there are two quite different applications of biotechnology or molecular biology that are relevant. The first is the use of biotechnology as a tool for acquiring knowledge, while the second is the use of biotechnology to directly intervene in plant and animal breeding, in particular to transfer genetic information from one sort of organism to a particular crop, or to a farm animal to make it transgenic (genetically modified). Today, biological research can hardly be conducted without using biotechnology in one way or another. Taxonomy uses molecular markers to identify individual strains of organisms or to identify species. This is useful for *ex situ* conservation of plants and micro-organisms. To study the relatedness of one plant variety to another, genetic fingerprints are used in seed banks and culture collections. Today most reliable classification of most micro-organisms has only become possible with these biotechnological methods. In plant and animal breeding, biotechnology has also proven useful to predict some of the expected properties of the progeny, by looking at the presence or absence of certain forms of genes and genetic markers. For instance by analyzing a few cells of the newly born calf or of the newly sprouted crop, one can predict a phenotypic property, which will only show up later in life, for instance certain characteristics of a cow's milk or the crop's expected resistance to an infectious plant disease (Ammann & Garden, 2004).

Direct Gene Transfer to Crops and Farm Animals

Since all genes consist of DNA, and the information in this DNA molecule is read in the same way in all organisms in order to make proteins, it is in principle possible to take any (single) gene from any organism and transfer it into any other organism so that the recipient produces a protein normally only made in the donor. The resulting organism is called transgenic or genetically-modified organism (GMO). According to Ammann and Garden (2004)from the time this simple strategy was devised, it took molecular biologists about twenty years until the first transgenic plants were made in 1985. Ten years later, the first transgenic crop appeared in supermarkets in the USA, the "FlavrSavr" tomato. In 2000 there were, worldwide, about 45 million hectares planted with commercial transgenic crops. All of these, and many more crops have been proven to work, in principle, in laboratory and glasshouse trials. The practical benefits and risks of the crops need to be assayed in the field and their products scrutinized, like any other novel food. As pointed out by (Ammann & Garden, 2004) many environmental issues still need to be clarified in this context.

The Concern of Genetically Modified Organisms(GMO) in Relation to Biodiversity Conservation

The methods of biotechnology can be applied to the study of virtually any biological phenomenon and will in some cases have practical applications for maintaining biodiversity. Conversely, threats to biodiversity by biotechnology also need to be considered. It is clear that, each application of Biotechnology needs to be studied carefully on a case-by-case basis, like any other new technology. A valid concern is the possible effect of Bt-crops and similar plants on non-target insects. The Bt-crops contain a gene coding for an insecticidal protein originally produced by the soil bacterium *Bacillus thuringensis*. They were developed to make the plants resistant to a particular, highly damaging pest and have been quite successful in reducing pesticide input when infestation rates are high. In laboratory studies, Losey showed that the pollen from Bt-corn could kill larvae of the Monarch butterfly when a large amount of pollen was sprayed on the larvae's favorite food plant, commonly called milkweed (Lowe *et al*., 2000). This shows that the impact of transgenic crops on non-target organisms or on native biodiversity should be given due emphasis.

As described by Ammann and Garden (2004) in addition to wild plants, old landraces might be threatened by transgenic crops. It should be remembered that vertical gene transfer by pollen has always occurred between different old landraces and between different new varieties of crops. Therefore, there is a great chance of transfer of pollen from a transgenic crop to its related non transgenic crops (landraces). In such cases it will never be possible to conserve the agricultural biodiversity in general and landraces in particular for their intrinsic value as well as for having starting material for future crop breeding. A good example is that of herbicide resistance transfer from a herbicide tolerant, transgenic crop canola to a close relative plant in Denmark (Mikkelsen *et al*., 1996). So, this would be of major significance if the recipient weed was controlled by this herbicide in this farm setting. In Africa in general and in

Ethiopia in particular, small- scale farmers used to produce several landraces (Farmers' varieties) in a small plot at the same season, as a risk minimization and as well as germplasm conservation. Therefore, the introduction of transgenic crops in such diverse farming system with diverse agricultural diversity; may cause higher unexpected and uncontrollable risk. This genetic contamination and pollution will be discussed in detail in the next sections.

Social Consequences of Genetically Modified Organisms

Generally, the introduction and spread of new technologies usually have social consequences with winners and losers. It may benefit some and may negatively affect others. For biotechnology, this has led to strong public debate across many different aspects; among them are ethical, economic, legal and environmental issues.

Economic Considerations

The green revolution, which improved wheat and rice production in Asia, was initiated in the public sector, in the Philippines at the International Rice Research Institute (IRRI) and in México at the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT), both institutions which belong to the Consultative Group of International Agricultural Research (CGIAR). On the contrary, today, most innovative research in agricultural biotechnology is largely done by a few large private companies, with very minimal contributions from the public sector. Those companies strive for intellectual property rights (IPR) through patenting or other protective mechanisms. One can imagine how the risk and the burden will be so huge for subsistent farmers in the developing countries such as Ethiopia; which have their own local seed production, exchange and conservation systems and which were the sole custodian of such precious genetic resources for generations. Particularly this issue should get maximum attention in developing countries such as Ethiopian which are biodiversity rich countries and the local seed system covers most of the seed supply system.

Environmental Considerations

The Cartagena Protocol on Biosafety: In view of the importance of biodiversity for the future of mankind, several international agreements have been reached. One of such agreement is the Cartagena Protocol on Biosafety. The Convention on Biological Diversity (CBD) provided a basis for developing an international agreement regulating the cross-boundary movement of living GMOs, called "living modified organisms" in the Protocol, which was agreed in 2000 in Montreal. The main aim of the Protocol is to ensure that GMOs would not endanger biodiversity in the recipient countries. Among the possible risks of GMO to biodiversity; "Genetic pollution" and "genetic contamination" Can be mentioned.

"Genetic pollution" and "genetic contamination": Hybridization between cultivated crops and their wild relatives is likely to have existed since the origins of agriculture, about 10,000 years ago (Gepts & Papa, 2003). Hybrids between wheat and *Aegilops* were identified in French agriculture in the mid-19th century (Lane, 2005). Ellstrand, Prentice, and Hancock (1999), reported that hybridization occurs between crops and their wild relatives in 12 of the 13 crops most cultivated worldwide, including barley, cotton, maize, rice, sugar cane, potato and wheat. (Raybould & Gray, 1993) reviewed 31 domesticated plant species in the UK and found that about one third spontaneously hybridize with one or more elements of the local flora. As descried above, naturally or in breeding programs hybridizations is normally takes place between sexually compatible individuals. Thus, gene transfer is limited by reproductive isolation boundaries. On the contrary, Genetic Engineering (GE) is a technology that removes these sexual compatibility barriers and genes can be introduced into recipient genomes from donor organisms that would not otherwise cross with the recipient organisms. For example, genes from viruses, bacteria, animals and plants have been introduced by GE into plant genomes. Thus, the main potential contribution of GE to plant breeding is to broaden the genepool available as a source of genes for crop improvement (Gepts, 2002). On the other hand, a potential disadvantage of GE is that it introduces genes from very different genetic backgrounds that may lead to unexpected metabolic and ecological effects (Snow *et al*., 2005). On September 2002, the Mexican environment ministry (INE) announced that cornfields in the states of Puebla and Oaxaca turned up GM-positive. In November, Nature magazine published an article that confirmed INE's findings. According to Antonio Serratos, of the Mexico-based International Center for the Improvement of Maize and Wheat (CIMMYT), if a farmer with a one-hectare plot plants a single row with GM seed, 65% of the plot will be GM within only seven years (Silvia, 2001). In an article published in the Mexican daily, La Jornada, Silvia Ribeiro wrote, "*This is pollution in the very center of origin of a crop of major importance for world nutrition. This pollution can spread not only to native and traditional maize, but also to wild relatives; this gene flow is polluting and degrades one of Mexico's major treasures.*"

The other good example is cross-pollination of GM and local canola seed (rape seed) has commonly occurred in Japan, as rape seed is imported from Canada. Around ports and the roads to major food oil companies, GM canola has now been found growing wild. A report from the Japanese National Institute for Environmental Studies (NIES) confirms that herbicide-resistant genetically engineered canola plants were identified in five of the six Japanese ports where samples were collected (http://en.wikipedia.org). In general, the cases showed that, there is a great risk of genetic contamination to local landraces by GM crops without the intention of farmers they are growing them, which can be said as pollution or contamination. Therefore, care should be taken before the introduction of GM crops especially in countries such as Ethiopia which is center of origin and diversification of many crops and wild relatives.

The Terminator technology

As described by the American cotton seed company Delta and Pine Land and the United States Department of Agriculture (USDA) announced they had received a patent on a technique that genetically disables a plant to set seeds that germinate when planted again. This technology can potentially be used in all cultivated crops. Varieties of crops like rice, wheat, sorghum and soybean, which could not effectively be marketed using hybrids, may now be commercially protected by using this new technology. This would open some of the world's largest food crops to profitable breeding and further increase the risk of genetic erosion, which has already progressed extensively in these crops. The net effect of this technology is likely to be negative (Visser, 1998). Though, biotechnology has so many advantages and different technologies which can complement conservation of biodiversity; technologies such as terminator technology and GMO can have a negative effect on biodiversity.

Governmental support and opposition on GMO

As sited by Wikipedia the free on-line encyclopedia (http://en.wikipedia.org) different governments support and oppose the use of GMO. Some of them are mentioned as follows:

Australia

Several states of Australia had placed bans on planting GM food crops, beginning in 2003. However, in late 2007 the states of New South Wales and Victoria lifted their bans. Western Australia lifted their state's ban in December 2008, while South Australia continues its ban. Tasmania has extended its moratorium until November 2014. The state of Queensland has allowed the growing of GM crops since 1995 and has never had a GM ban.

Canada

Genetically modified crops have been widely adopted in Canada and have been grown since 1995. Nearly all of the canola grown in Canada is GM, as are significant proportions of corn and soybean. In general, biotechnology is well-accepted by Canadian consumers and farmers, with some exceptions.

Japan

As of 2009, Japan has no commercial farming of any kinds of genetically modified food. Consumers have strongly resisted both imports and attempts to grow GMO in the country. Campaigns by consumer groups and environmental groups, such as Consumers Union of Japan and Greenpeace Japan, as well as local campaigns, have been very successful. In Hokkaido, a special bylaw has made it virtually impossible to grow GMOs, as the No! GMO Campaign collected over 200,000 signatures to oppose GMO farming.

New Zealand

In New Zealand, no genetically modified food is grown and no medicines containing live genetically-modified organisms have been approved for use.

United States of America

In 2004, Mendocino province, California became the first county in the United States to ban the production of GMOs. The measure passed with a 57% majority. In California, Trinity and Marin provinces have also imposed bans on GM crops.

Eastern and Southern Africa countries

In 2010, after nine years of talks, the Common Market for Eastern and Southern Africa (COMESA) produced a draft policy on GM technology. This proposed policy was sent to all 19 national governments for consultation in September 2010. Under the policy, a member country which wants to grow a new GM crop would inform COMESA who would have sufficient scientific expertise to make the decision as to whether the crop was safe for the environment and for humans. At the moment, few countries have the resources to make their own decisions. Once COMESA had made their decision, permission would be granted for the crop to be grown in all 19 member countries. Member countries would retain the power not to grow the crop in their own country if they wanted.

France

The cultivation of Monsanto's MON 810 corn was forbidden in France on February 9, of 2008.It was the only GMO authorized in France. The safeguard measure is taken as far as side effects on human health will be known. In 2010 Marion Guillou, president of the National Institute for Agronomical Research and one of France's top farm researcher, said she can no longer work on developing new GMOs due to widespread distrust and even hostility by European consumers.

Germany and other European Countries

Germany placed a ban on the cultivation and sale of GMO maize in April 2009. MON 810 (maize) was the first GMO crop to be cultivated in Europe. The initial lines of maize were approved in 1997 and, by 2009; 76,000 hectares of GM maize were grown in Spain (20% of Spain's maize production). Smaller amounts were produced in the Czech Republic, Slovakia, Portugal, Romania and Poland. However, in addition to France and Germany, other European countries that have placed bans on the cultivation and sale of GMOs include Austria, Hungary, Greece, and Luxembourg. Ireland has also banned GMO cultivation. Poland has also tried to institutionalize a ban, with backlash from the European Commission. Bulgaria effectively banned cultivation of genetically modified organisms on March 18, 2010.On 2nd of March 2010 a second species of GM potato named Amflora, was approved for cultivation for industrial applications in the EU by the European Commission and was grown in Germany, Sweden and the Czech Republic that year. On the 13th of July 2010, the European Commission issued a recommendation that in future individual states in the EU should be able to ban the growing of specific GM crops that had been scientifically approved at the EU level. A ban could be justified on cultural, economic or ethical grounds.

Conclusion and recommendations

Biotechnology has a lot of contribution for the conservation of biodiversity; it complements the conventional conservation techniques. Biotechnology can be used for the production of fine chemicals, production of pathogen -free plants, germplasm conservation through in-vitro and cryopreservation, large scale plant propagation which saves time, get uniform quality and disease free plants. Even though, biotechnology has so many advantages and different technologies which can complement conservation of biodiversity; as that of other new technologies the introduction and spread of new biotechnologies generally have social consequences with winners and losers. For biotechnology, this has led to intense public debate across many different aspects such as ethical, economic, legal and environmental issues. Modern biotechnologies such as terminator technology and GMO can have a negative effect on biodiversity. Genetic pollution" and "genetic contamination" are among the environmental concerns which need to be cleared or ascertained before releasing new technologies which can pollute the biodiversity and the natural/ wild genetic pool and may cause irreversible damage. Since many countries have banned the use of technologies such as GMO and terminator technology; for the country like Ethiopia, it is important to learn from the others, rather than endangering or risking the genetic resources from genetic pollution and genetic contamination which may occur. But, the use of safe and known technologies should be encouraged and used to augment the biodiversity conservation efforts and other development efforts of the country.

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