

BIOTECHNOLOGICAL APPROACHES FOR BIODIVERSITY CONSERVATION**DUSHYANT KUMAR SHARMA^{a1} AND TRIPTI SHARMA^b**

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^aE-mail: dr_ds2004@rediffmail.com^bE-mail : s.varun97@yahoo.com**ABSTRACT**

Biodiversity is the degree of variation of life forms. It is the totality of genes, species and ecosystems of a region. In recent years ever increasing loss of biodiversity has posed a serious threat to the survival of mankind. Destruction of the habitat of plants and animals, introduction of exotic species, overexploitation of animals and plants, overpopulation of human and over consumption of natural resources are the root causes of all biodiversity loss. Climatic change, again a consequence of human activities, has very adverse effects on biological diversity. Global warming affects plants, animals and microorganisms, both by changing their habitats and by direct effects of temperature. In addition, inadequate knowledge, inefficient use of information and economic system and policies which fail to value the environment are also responsible for the loss of biological diversity. There is an urgent need for the conservation of biodiversity. Biotechnology offers new means of conserving biodiversity. Conservation may be in situ or ex situ, either in the natural or semi-natural habitat, or insome purpose-built environment. Biotechnology including tissue culture, micro-propagation, marker assisted breeding, conventional breeding, transgenic crops, and genomics, are all quite useful for conserving and propagating biodiversity in many unique ways.

KEYWORDS : Biodiversity, Biotechnology, Tissue Culture, Transgenic crops

Biological diversity or biodiversity is the degree of variations of life forms. It includes variation among animals, plants, microorganisms, the genetic variation among them and all their complex assemblages of communities and ecosystems. Biodiversity is the totality of genes, species and ecosystems of a region. The term 'biodiversity' was first used by Dasmann in 1968. There are three levels of biodiversity-genetic, species and ecosystem diversity. Genetic diversity refers to the variations of genes within the species. It includes all the different genes contained in all individual plants, animals, fungi and microorganisms. It occurs within a species as well as among species. Species diversity refers to the variety of species within a region. Ecosystem diversity refers to all the different habitats and biological communities within individual ecosystem.

According to Raven (1992) the number of species of plants, animals and eukaryotic micro-organisms is probably around 10 million, but only 1.4 million have been characterized and given a name by scientists. Distribution of biodiversity depends and varies according to the climate, altitude, soil structure and presence of other species in an area.

IMPORTANCE OF BIODIVERSITY

Biological diversity is the very basis of human survival and economic development as it provides food, housing, clothing, medicine and industrial raw material and

offers a potential for providing many more, yet unknown benefits to mankind. Production efficiency, exploitation and conservation of animal genetic resources are crucial not only for the global economy, but also for the environment. A wide range of industrial materials are directly obtained from biological resources. Rubber, oil, fiber, building material, timber and paper all are obtained from biological resources. Biodiversity supports a variety of natural ecosystem processes and services. Ecological services like photosynthesis, air and water purification, recycling of nutrients, pollination and prevention of soil erosion are provided by biodiversity. Biodiversity plays very important role in human health. About 80% of the world population depends on medicines obtained from nature (Behera et al., 2008). A large number of drugs are obtained directly or indirectly from biological sources. A wide range of industrial materials are directly obtained from biological resources. Biodiversity is also the source of non-material benefits like spiritual and aesthetic values, knowledge system, culture diversity and spiritual inspiration. It is a source of inspiration to musicians, painters, writers and other artists. Hobbies like gardening and animal keeping are possible because of biodiversity.

LOSS OF BIODIVERSITY

In recent years, ever-increasing loss of biodiversity has posed a serious threat to the survival of mankind. The main causes of biodiversity loss are: habitat

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destruction, invasive species, pollution, population, over-exploitation and climatic changes. Destruction of the habitat is the biggest threat to biodiversity. The ever-increasing spread of cities and the accompanying expansion of agriculture must be held largely responsible. Habitats can also be damaged by flooding, lack of water, climate changes, salination etc., all phenomena which may be both natural and man-made. Habitat extinction compels the species to move where they find it difficult to adapt and this may ultimately lead to their extinction. Invasion by exotic plant and animals is the second important factor responsible for biodiversity loss. Imported plant species that are eaten then attacked by being highly competitive and often by lacking local predators, such as insects or birds. Over-exploitation, in the form of hunting of animals and plants for their commercial value, is a major reason for reduction in biodiversity. Overpopulation of human and over consumption of natural resources are the root causes of all biodiversity loss. The world population now stands at 7 billion and is expected to reach 9 billion in 2045. A broad range of agricultural genetic diversity needs to be available and utilized in order to feed this growing population. (Lidderan and Sonnino, 2012). Genetic pollution i.e. uncontrolled hybridization, introgression and genetic swamping can lead to threatening and replacement of endemic species. As soon as a better variety is developed, the same is distributed far and wide and brought in use. As a result the local /endemic species are discarded and their specific genes are lost. Climatic change has very adverse effects on biological diversity. Since all organisms are adapted to a particular range of physical and chemical conditions, rapid climatic changes could lead to higher number of diseases, landslide and forest fire, which may result in destruction of animals and plants. Climate change is an added threat to biodiversity that significantly impact genetic resources for food and agriculture (GRFA) and food production. Global warming affects plants, animals and microorganisms, both by changing their habitats and by direct effects of temperature. Climatic changes also affect species at cellular level and can alter the genetic makeup of the cell.

CONSERVATION OF BIODIVERSITY

Biodiversity conservation is of global concern which requires a holistic approach. Recognizing the need of conservation of biodiversity, the United Nations prepared Convention on Biodiversity (CBD) and adopted it in 1992. This was the first time that a large majority of States agreed to a legally binding instrument for biodiversity conservation and the sustainable use of biological resources. The CBD is a comprehensive approach to biodiversity conservation of both wild and domesticated species. It aims at conservation at the genetic, species and ecosystem levels.

There are various methods to conserve biodiversity. Both in situ and ex situ methods of biodiversity conservation are equally important. It is now recognized that ex situ techniques can be efficiently used to complement in situ methods, and they may represent the only option for conserving certain highly endangered and rare species (Ramsay et al., 2000). The choice of one or the other technique, or a combination of both, depends on the particular case. The maintenance and protection of natural habitats are the in situ methods of conservation. Preserving the habitat is the most important issue in the conservation of biodiversity. Destruction of habitat should be immediately checked and steps should be taken to restore the habitat of animals and plant species. Since chemical pesticides are responsible for a large number of animal deaths occurring every year, minimizing the use of chemical pesticides is another technique for the survival of biodiversity. Conservation of biodiversity through establishment of protected areas like National Park, Wild life sanctuary, Biosphere Reserves, Marine Reserves etc. are very effective in controlling the loss of biodiversity. Special care should be taken for the species which are threatened and at the verge of extinction. Efforts should be made to protect the indigenous genetic diversity. There is an urgent need to check the unsustainable exploitation of the biological diversity. This should be improved through appropriate legal and institutional system. Preserving diversity through gene bank, seed bank and in vitro storage are effective methods for biodiversity conservation. In gene banks, the plant and animal materials are conserved and are available for breeding, reintroduction, research and other purposes. This method is useful for long living perennial trees and shrubs.

Seed banks are the most efficient and effective method for sexually reproducing seeds under long term storage. There are a number of seed banks in the world with specialization in the nature of the collection, geographical area, taxonomic groups, wild plants, forestry trees etc. There are a large number of species for which seed banking cannot be used as a method of conservation. Some plants such as banana do not produce seeds and are propagated vegetatively. Some species such as potato or sugarcane include both sterile genotypes and genotypes which produce orthodox seeds. However, these seeds are generally highly heterozygous and are thus of limited interest for the conservation of particular genotypes. Similarly, some fruit and forest tree species, produce recalcitrant seeds, i.e. seeds that cannot be dried to sufficiently low moisture level to allow their storage at low temperature (Roberts, 1973). For such plants other methods of conservation are used.

Restriction on the introduction of exotic species is another approach in biodiversity conservation. There should be restriction on introduction of exotic species without proper investigation.

APPLICATIONS OF BIOTECHNOLOGIES FOR CONSERVATION

Though it is generally believed that biotechnology has adverse effects on biodiversity, but in fact biotechnology offers new means of improving biodiversity. Seed banks are the most efficient and effective method of ex situ conservation for the majority of endangered species. In seed banks, genetic fingerprints are used to establish the origin of a seed or the relatedness of one plant variety to another.

Tissue culture techniques are of great interest for the collection, multiplication and storage of plant germplasm (Bunn et al., 2007). Such techniques allow propagating plant material with high multiplication rates in an aseptic environment.

Micropropagation refers to in vitro mass production of plant propagules from any plant part or cell. Such propagules are used to raise whole plants. Through micropropagation, elite clonal material can be very rapidly multiplied.

DNA barcoding is a technique in which species identification is performed by using DNA sequences from a small fragment of the genome, with the aim of contributing to a wide range of ecological and conservation studies in which traditional taxonomic identification is not practical. Some of the biotechnological methods used for production and conservation of animal genetic resources are:

Cryopreservation

Cryopreservation is the technique currently available to ensure the safe and cost-efficient long-term conservation of species. Materials such as cells, tissues, gametes, oocytes, DNA samples etc. are stored in a genetic databank for future use. There are two types of techniques: classical and new cryopreservation techniques. Classical techniques involve freeze-induced dehydration, where as new techniques are based on vitrification. Classical cryopreservation techniques involves low cooling down to a defined prefreezing temperature, followed by rapid immersion in liquid nitrogen. Vitrification based procedures offer practical advantages in compare is on to classical freezing techniques. Like ultra-rapid freezing, they are more appropriate for complex organs (shoot tips, embryos), which contain a variety of cell types, each with unique requirements under conditions of freeze-induced dehydration. A successful protocol for long-term conservation of two endangered plants viz. *Mantisia spathulata* and *M. wengeri* has been devised through cryopreservation of immature seeds (Das Bhowmik et al., 2011). In case of poultry, as many as 30% of poultry breeds are threatened with extinction and 9% have already gone extinct. A good technique of cell culture and freezing methods will give a broad perspective for unlimited storage of genetic resources, which in the future can be useful for the restoration of extinct species/breeds (Sawicka et al., 2011). Cryopreservation is an effective method used in the conservation of poultry breeds.

In Vitro Production of Embryos

In vitro embryo production is another way in biodiversity conservation. Methods used in the production of embryos in vitro include splitting and cloning of embryos, marker-assisted selection, sexing of embryos and transfer of new genes into an embryo. Embryo Culture and Transfer technique is used to introduce fertilized embryos

into surrogate mothers. Sometimes closely related species can be used to produce the offspring of an endangered species.

Transgenic farm animals

Production of transgenic crops and animals is another application of biotechnology in biodiversity conservation. Transgenic crops are more likely to increase agricultural biodiversity and help maintain native biodiversity rather than to endanger it. Such crops may prove to be very useful to the farmers and can be of commercial value. However, the practical benefits and risks of the crops need to be assayed in the field and their products scrutinized.

In case of animals, several lines of transgenic farm animals have been produced, but none have been commercialized. Some lines are made for the pharmaceutical industry to produce drugs in their milk. Others may show improved resistances towards certain infections. Biotechnological methods have many advantages to conventional captive breeding procedures. Since the animals need not to be moved around, less stress is experienced and the problem of space for keeping the animals is also solved since samples can be taken in the wild. Storage of genetic resources will help to preserve biodiversity and counter the effect of genetic drift on small populations. Even if an animal dies, its genes will still be available for future breeding work.

CONCLUSION

Though the biotechnological methods of biodiversity conservation offer many advantages to conventional procedures but these technologies have various social consequences. How will biotechnology benefit agricultural productivity, prevent the expansion of farm land and thereby help the preservation of biodiversity is a matter of debate. Biotechnology applications

must be integrated with ongoing conventional breeding and development programs in order to succeed. Additionally, the generation, adaptation, and adoption of biotechnologies require a consistent level of financial and human resources and appropriate policies need to be in place.

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