Plant Genetic Resources conservation: Integrated strategies

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Plant Genetic Resources (PGRs) comprise a heterogeneous group of plant species involving herbs, shrubs, lianas and trees. About 90% of the world's food comes from just 20 plant species. There is a need to increase the number of species to be brought under cultivation. Plant breeders find the need to use wild species and to introduce them into cultivated forms for the desired qualities of resistance to pests and diseases and the ability to withstand adverse soil and weather conditions. India's biological diversity is very rich but unfortunately its wealth is being eroded due to lack of integrated conservation approaches. This diversity needs to be conserved and the immediate task will be to devise and enforce time bound action plans for saving the plant species as well as their habitats. Action has to be directed towards all levels of conservation, *in situ* and *ex situ*. The conservation strategies need to be integrated and based on species specific decision support systems, which could be based on research and development outputs.

Appropriate links are desirable between *in situ* and *ex situ* conservation approaches keeping the *in situ* reservoirs as base biological capital, sourcing PGRs in a sustainable manner for creation of core *ex situ* reservoirs representing the entire genetic diversity of the desired species or a combination of them. Need based technological interventions for *ex situ* conservation such as creation of a back up *in vitro* active gene bank for an FGB, strengthened by cryobanking of species specific meristem, seed, pollen and DNA as complementary conservation approaches to capture the entire range of genetic diversity will have to be explored.

At this stage, it is essential to underline the complementarities of *ex situ* conservation techniques with other conservation strategies. While most *ex situ* conservation methods does not intend to replace conventional approaches for *in situ* and *ex situ* conservation, These techniques offer researchers, botanic gardens and curators a set of additional tools to allow them to improve conservation of collections placed under their responsibility and offer scope to conserve maximum genetic diversity. Conservation of PGRs needs to focus on integration and assessment of what is immediately achievable using all available techniques. It should be realized that there are greater benefits to be derived by the application of one or more basic proven techniques. For example, all PGRs will be relatively expensive to conserve in vitro and using cryogenic systems for conserving the desired levels of genetic diversity. A study of species biodiversity both within and between countries will help prevent needless duplication of efforts.

Genetic diversity of plant species is not evenly distributed throughout the world. It is more concentrated in tropical and sub-tropical areas, where the majority of developing countries are located. Plant genetic resources are of an inestimable value, and will continue to be so in the future, independently of whether used in conventional plant breeding or modern genetic engineering. The importance of plant genetic resources as the ultimate source of food and nutrition is enormous. Their loss constitutes a serious threat to world food security. Conservation goes far beyond just salvation of species, with objectives to conserve sufficient diversity within each species to ensure that its genetic potential will be fully available in future.

Biological resources are renewable, but they are being exploited at rates that exceed their sustainable yield. Human destruction of habitats, whether exploited for commercial or subsistence reasons, is the greatest threat. Genetic erosion is a term often used to describe the reduction of diversity within a species and as the main cause of species extinction. If the individuals we conserve from any one species contain only a small fraction of the total species gene pool, their ability to adapt to changing ecosystems in the future will be severely limited.

Genetic erosion is usually the loss of genetic diversity as a result of social, economic agricultural changes. UNCED's Agenda 21 states that *'the current decline in biodiversity is largely the result of human activity and represents a serious threat to human development'*.

The cost of conserving PGRs, though a fraction of the entire biodiversity, is high but it is certainly far less than the cost of allowing its degradation. While modern biological science and technology can do wonders, it has to be remembered that species extinction is forever. The world therefore needs a means of valuation which recognizes that the loss of this form of biological resource is irreversible. Our generation has a tremendous social responsibility to pass on this wealth of resource we have inherited. Only by doing this will we enable future generations to face unpredictable environmental changes.

Plant genetic resources can be described as the part of biodiversity that nurtures people and is nurtured by people. They comprise a very wide range of species of vital importance to ensuring food, nutrition and health security. Governments have now recognized that the utilization of PGRs is the key to improving agri-horticultural productivity and sustainability which can contribute to socio-economic development, food security and alleviation of poverty. To achieve these desirable goals, the Global Plan of Action promotes an integrated strategy for the conservation and sustainable utilization of PGRs with the following features:

- ***Productivity*** – This calls for increasing species diversity under agriculture allowing greater use of plant genetic resources to contribute to the productivity increases needed to meet growing populations. This will require continued access to, and exchange of, the world's plant genetic resources;

- ***Sustainability*** **-** There is a need to ensure that such use of plant genetic resources in greater dimensions is coupled with the conservation of plant genetic resources, both *in-situ* and *ex-situ*. This will require, *inter alia*, approaches to genetic enhancement which allow maintenance of increased levels of genetic diversity and resources in production systems, thereby contributing to reduction of genetic vulnerability and genetic erosion. Additionally, conservation programs should be clearly linked with utilization efforts and the sharing of benefits, in order to reinforce the sustainability of such programs.

- ***Equity*** -Stakeholders responsible for conserving and developing plant genetic resources should be able to participate fully in the benefits derived from their use. There is thus a need to develop genetic enhancement approaches to enable farmers in marginal areas, as well as those in high-productivity areas to benefit fully from the utilization of plant genetic resources.

In meeting these challenges of harnessing plant genetic resources for sustainable use and future food, nutrition and health security, the role of botanic gardens will be crucial.

Conservation Strategies

Most plant species need conservation at three broad levels:

Ecosystem level (*in situ*)

Conserving biodiversity at large would accomplish the first level of conservation, by establishing biosphere reserves in identified hotspots with a known pattern of species distribution. Today, India has established several such reserves with the support of Ministry of Environment and Forests (MoEF). There is a growing national awareness regarding issues related to biodiversity conservation, with the establishment of NBA along with its act. This is expected to reduce the pressure on loss of biological resources in the Indian forest ecosystems. Several conservation friendly programs are supported through people's participation resulting in sustainable management of horticultural components/commodities in the entire biodiversity milieu. Botanic gardens like TBGRI in India focus on conserving species diversity *ex situ*, in near *in situ* ecosystems.

Genotype level (*ex situ*)

Conserving genetic diversity of plant species *ex situ* has been grossly accomplished for those which are in cultivation mode, as crops. Attempts have been made to conserve individual varieties or their wild relatives in one form of the other, containing a small fraction of the total gene pool, adapted to a given agro-ecosystem. The gene pool components include whole plants in tissue culture, meristem, somatic or zygotic embryos, seed, pollen etc., for which crop specific protocols have been optimized. Field gene banks & in vitro active gene banks are more specific which have been established for medicinal and tree species, particularly those that are not propagated through seed. In very few species core collections have been made which represent conservation of the entire gene pool. Seed conservation is accomplished globally for such species having orthodox seeds.

Gene level (molecular)

Biotechnological interventions at molecular level are currently somewhat neglected as far as collection & conservation are concerned. From a positive perspective, they represent a wealth of as yet untapped potential for valuable research effort and development. There is much that can be done using biotechnology techniques to conserve these species. There exists in the field of plant biotechnology the prospect of some spectacular breakthroughs, for example, being able to construct and store individual genes as genomic DNA or DNA sequence information. This possibility is currently a long way from reality and both new and traditional technologies have unique and complementary roles to play in the evaluation, conservation and use of plant genetic resources. It would be beneficial to extend research support to more basic techniques of collection, captive multiplication and slow growth techniques for species. Cryopreservation may be overtaken or supplemented by DNA storage systems for long term storage. However, it should be noted that mapping and sequencing of plant genomes has only gained momentum recently. Genomes of most species are virtually unexplored.

Integration of conservation approaches

At least in the context of the Indian biodiversity scenario, there is a great potential to integrate conservation strategies. The sub-continent is endowed not only with rich plant diversity, there is a rich faunal and cultural diversity associated with human populations. Conservation approaches *in situ* linked with livelihood support could play a major role in conservation of plant diversity. This has been achieved through a great extent through conservation of sacred grooves.

Sacred groves are islands of once existing natural ecosystems protected and preserved on religious grounds by the local traditional people. Assigning forest patches by traditional societies/communities as abode of Gods/Goddesses were prevalent in Greece, Rome, Asian and African countries. These protected forest patches are called sacred groves or sacred sites. At a global level, such type of protected areas have been reported from countries like Nigeria, Syria, Ghana, Afghanistan, Iran, Turkey, Pakistan, India, Bangladesh, Malaysia, Sri Lanka etc. and have survived in many regions despite tremendous economic pressure on forest resources.

In the Indian context and as elsewhere in many parts of the world, there are a number of communities practicing many forms of nature worship. It has been estimated that the total number of sacred groves in India is in the range of 100,000 and 150,000. In Kerala alone, an estimated 15,000 sacred groves existed in 1891, but now the sample survey report about 2000 with an area of 500 ha. Although limited in area, sacred groves of Kerala are distinct and unique in its biological diversity. A General survey on 173 sacred groves distributed in different districts of Kerala showed a floristic composition of 411 species of angiosperms belonging to 276 genera and 92 families, out of which 52 species are strictly endemic to Kerala /Western Ghats. Efforts are in progress to unravel the species diversity and estimate species loss which might have occurred over generations, along with species recovery and translocation attempts using modern conservation methods.

As a result of the high conservation and biodiversity values held in sacred groves, increasing attention is being focused upon their potential as a tool and model for biodiversity conservation. For example, in its report brought out in 1996 on Sacred Sites – Cultural Integrity, Biological Diversity (1996) UNESCO found that Sacred groves have served as important reservoirs of biodiversity, preserving unique species of plants, insects, and animals. Furthermore, in a number of instances sacred groves have also been instrumental in preserving the ecological integrity of entire landscapes. Sacred groves have survived in many regions despite tremendous economic pressure on forest resources.

At TBGRI, efforts to integrate conservation programs are in progress through participatory approach, for example, medicinal plants used by local communities face acute deficiency of planting material due to frequent extraction from the wild. These communities have been educated about conservation and sustainable use of these species through intervention of captive multiplication *ex situ*, using tissue culture techniques, in vitro conservation, production scheduling etc., for gainful economic returns.

Reintroduction and restoration of species hitherto existing in the wild is yet another program supported by TBGRI involving integrated conservation approaches. Estimates are obtained with regard to diminishing populations of specific endemic species from the Western Ghat biosphere reserve. These species are collected form known locations and brought to TBGRI where efforts are made to amplify them in captivity, through conventional and non-conventional approaches. Such species after establishment *in situ* are conserved and reintroduced to the locations where they naturally belong to, supporting *in situ* conservation programs in collaboration with the local forest department.

Thus, keeping *in situ* conservation as a base-line activity, other *ex situ* conservation approaches are integrated in a need based manner, as required by different species and ecosystems, ultimately supporting the overall conservation philosophy.

Recommendations

There is an immediate need for establishment of regional networks for conservation and use of PGRs and their wild relatives. The aims of such a network would be to encourage member countries and their representatives to document existing collections including accessions they contain. At the same time efforts are required to explore, identify, evaluate and conserve genetic diversity that exists in the wild.

Determine accessibility of PGRs to scientists in other countries taking into account sovereignty over resources, intellectual property rights and plant patents; provide for documentation and exchange of information and material via a database, newsletters etc;

Meet regularly to define regional goals and priorities to develop action plans. Encourage international collaboration and national research projects in need based technologies that are related to integrated conservation and use of PGRs. Priority should be given to research in basic techniques, particularly collectiion, culture, *in situ* conservation methodologies and *ex situ* technologies as they apply to conservation and use. Develop training programs for national personnel in relevant technologies in tropical countries where these skills are lacking.

Provide decision support systems to policy makers and encourage governments to fund for the establishment of networks, identification, evaluation and conservation of plant genetic resources of wild species, research and training programs relevant to their conservation and use.

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