



A Comparative Analysis of National and International Plant Conservation Techniques: A Review

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Abstract Rapid urbanization is leading cause of plant extinction throughout the world as increase in plant use is directly proportional to increase in urbanization. According to the world analysis estimates, the number of threatened plant species throughout the world has reached above 80,000 and is increasing day by day. This is quite an alarming situation thus there is a need to conserve the vulnerable plant species. Several plant conservation techniques have been developed worldwide with varied success rates, however, there is a huge gap between the conservation strategies and techniques used in developed and developing countries of the world and so is the success rate of these techniques in the respective regions. This paper presents a review of national and international plant conservation techniques and how their application can be made successful for the conservation of Pakistani flora.

Keywords Plants, endangered, conservation techniques, global strategies, national strategies.

Introduction

Since the beginning of the civilization to the present time people have used plants for various purposes. Plant species are becoming endangered and it is very important to spotlight them to conserve them. Plants form the basis of the food chain and they have their own economical and social value. According to an estimate of World Health Organization (WHO), 80% of the world's population depends on plant derived resources in their daily life. The larger part of traditional practice of plant involves plant extracts or their active compounds. Currently many plants are threatened due to various problems and comprehensive information about the species record is lacking. For most of the threatened plant species no particular conservation steps has been taken because there is no complete data about them in gene banks and much stress has been put on the discovery of new drugs. Many countries even do not have complete record of their plant species and much of the record on plant use is detained by traditional societies which are now under threat. Furthermore very less information has been stored in an organized manner.

The present world is becoming more modern and due to this various plant species are lost as the lands are cleared for construction purposes. Most of the plant species exist in the tropical areas of the world and enormous habitat destruction is occurring there that cause loss of plant varieties [1]. The conservation of plant diversity is essential to achieving sustainable development and it also gives flexibility for the present and future use of natural resources.

As plants not only have economical but social value as well it is necessary to prevent their extinction. Thus there is an increasing need to conserve the plant species as their extinction rate keeps rising. For this purpose various in-situ and ex-situ conservation techniques and methods have been developed and applied worldwide [2]. Some of these international plant conservation techniques are given in Table 1.



Objectives

The objectives of plant conservation techniques used worldwide are as follows:

- To stop the current and continuing loss of plant diversity worldwide.
- To provide a framework to facilitate harmony between existing strategies aimed at plant conservation and to identify gaps where new strategies are required to promote enlistment of the necessary resources.
- Provision of a tool to enhance the ecosystem approach to the conservation and sustainable use of biodiversity and focus on the important role of plants in the structure and functioning of ecological systems and guarantee provision of the goods and services such systems provide.

Table 1: Internationally used Plant Conservation Techniques and Methods

S. No.	Plant Conservation techniques	Advantages and Disadvantages
A.	Traditional	
	Botanical gardens Seed banks Field gene banks	<ul style="list-style-type: none"> • disadvantages regarding the necessary space • the work performed, costs, exposure to risk factors [3].
B.	Modern Methods	Procedures/steps
1.	<i>In vitro</i> conservation	<ul style="list-style-type: none"> • collection of the material • sterilization • initiation of <i>in vitro</i> culture • establishment of the • multiplication and <i>in vitro</i> • maintenance of the species [4].
2.	Cryoconservation	include basic steps; <ul style="list-style-type: none"> • cryoprotectant treatment • pre-culture • impregnation • freezing, rapid cooling, gradual and progressive thawing • resuming growth and multiplication [5].
3.	Reduction of growth	<ul style="list-style-type: none"> • reduction of proliferation and growth • increase of the period between subcultures <p>For the maintenance of viability and of the regeneration capacity of the cultures are applied;</p> <ul style="list-style-type: none"> • reduction of temperature and • intensity of the light • modification of the cultural environment by reducing the carbon or minerals sources • Reduction in the level of oxygen by using the oil stratum or liquid environment [6].
4.	<i>In vitro</i> gene banks	<ul style="list-style-type: none"> • active banks • basic collections [7].
C.	Modern Techniques	Description of Techniques
1.	Drill Seeding	Drill seeding mechanically presses the seed into the ground. As a seed drill moved across a field, seed from a hopper is metered out and falls through tubes into soil opening device (i.e. disc openers, chisels) that plants the seed at a set depth [8].



2.	Broadcasting	Broadcasting is described as planting or sowing seeds across an area by scattering. It may be either by mechanical means or manually. Broadcasting is one of the most economical method of applying seed to large areas of land <ul style="list-style-type: none"> • Mechanical broadcast planters in general are cyclone spreaders driven by a tractor power take-off (PTO), an electric motor, or by hand operation. • Aerial broadcast (using an airplane or helicopter) seeding is used in certain areas and has proven successful when planting large inaccessible areas [9].
3.	Sprigging	Sprigging refers to a planting operation in which sprigs or rhizomes, stolons, or mature stems of vegetative propagated species are planted into a prepared seedbed. This is done by a machine commonly called as a sprigger which uses a disc or coulter to open the soil surface and into which vegetative parts are deposited 1-2 inch deep [6].
4.	Hydroseeder	Hydroseeders are intended to apply seed and some type of mulch in one operation through a Water based slurry system. These systems are used to plant steep slopes, areas where compaction is detrimental, and on sites not accessible by other means [7,10].

Global Strategy for plant conservation (GSPC)

The key objective of the development Global Strategy for Plant Conservation (GSPC) is to stop the progress of the existing and ongoing loss of plant diversity. It began as a grass-roots movement in 1999 at the 16th International Botanical Congress in St. Louis. This strategy is based on five objectives covering 16 main targets which are outcome-oriented and is developed under the Convention on Biological Diversity (CBD) set for 2010. Different botanical organizations, major being Kew, play a key role in the negotiation of the GSPC. The reviews on the implementation of the GSPC by these organizations noted that GSPC successfully allowed botanic gardens to engage in the work of the CBD. Additionally Kew botanical garden offers a wide-ranging specialist training programs and various courses for students, teachers, botanists, plant conservation specialists and horticulturists [11-12]. Kew works around the globe with partners to develop regional training courses outside of the United Kingdom covering numerous different aspects of plant conservation around the world [13].

Conservation status of Plants at National level

Pakistan has an area of 80,943 km². It has a variety of climatic zones and a distinctive biodiversity. It has about 6,000 species of higher plants. Due to increase in demand of plant derived resources, there is an immense pressure on the plant species that results in extinction of species. Various threats faced by the plant species of Pakistan include:

- Over population and urbanization
- Deforestation
- Soil degradation
- Habitat fragmentation
- Reduced genetic diversity due to genetic drift and limited gene flow
- Invasive plant species accumulation
- Illegal logging
- Over exploitation of threatened species

Thus, it is the need of time to conserve plant diversity before their extinction. Unfortunately no significant work has been done on endangered plants of Pakistan according to IUCN Red List categories and criteria. Little information is available on this issue. Recently the conservation status of the two species i.e. *Astragalus*



gilgitensis [14-16] and *Cadaba heterotricha* Stocks [17] was found for Pakistan that is based on field studies. On one hand, forest cover represents only 4.8% of the country's area, but on the other hand, country is highly dependent on trees as well as on non timber forest products that cause loss of plant species [18]. Different techniques can be used to save these threatened species from extinction. Out of these techniques, in-situ conservation and ex-situ conservation are in practice now days in Pakistan. The development of the protected areas and National Parks is also playing an important role in the in-situ conservation of plant species. In almost all provinces of Pakistan seed banks and botanical gardens are developed and are working for the ex-situ conservation of plants. Some of these organizations are listed in Table 2.

Table 2: Botanical Gardens and Seed Banks of Pakistan

No.	Organization	Vision	Ongoing and completed projects	City
1	Faisalabad Botanical Garden (part of Gatwala Wildlife Park)	Initiated a pioneer research on genetic resources of plant species from different parts of KPK and is responsible for collection, preservation and evaluation of primitive crop cultivars from the area as well	National Research Program on Weeds of Cereals. Improving salt tolerance in wheat through pre-sowing seed treatment with plant growth regulators or inorganic salts. Exploitation of forage legume diversity endemic to Soon Valley in the Salt Range of the Punjab. Development of techniques for the commercial scale propagation of medicinal plants indigenous to salt range in Pakistan etc.	Faisalabad
2	Government College University Botanic Garden of GCU	Contains 700 different plant species and conserves exotic and rare flora of Pakistan	Pakistan Botanic Gardens Network Secretariat (PBGN) has published a report covering Jan 2007-Dec 2008. GCU Botanic Garden organized a 2nd Pakistan Botanic Gardens Conference on "Botanic Garden: A Vehicle to Strengthen the Public/private/NGO partnership for plant conservation" from February 02 to 04, 2009.	Lahore
3	Karachi University Botanic Garden (KUBG) of Karachi University (KU)	Serves both as botanic garden and herbarium and conserves threatened plant species and cultivates new ones	The KUBG has recently become a member of the Botanical Gardens Conservation International (BGCI), the world's largest botanical gardens and plant conservation network. Seed bank and plant conservation laboratory had been established and a plant nursery would open soon. Besides, projects such as an educational/visitors centre, souvenir shop and launching of a website are also in the pipeline. An in vitro conservation project of 'Cadaba heterotricha' at Dr. A. Q. Khan institute of biotechnology and genetic engineering at KU.	Karachi
4	National Herbarium	Has a collection of	-	Islamabad



		over 100,000 of plants placed according to families		
5	Botanical Garden of Pakistan Forest Institute	Provision of research and education in field of Forest botany and related fields	<p>Selection and propagation of important indigenous and exotic forest tree species to increase wood production.</p> <p>Development of dry zone afforestation techniques for arid and semi arid areas.</p> <p>Control of forest tree pests and diseases for healthy forest production and minimize wood losses.</p> <p>Production and distribution of quality seeds of forest tree and grass species for afforestation/ reforestation purposes.</p> <p>Biological rehabilitation of waterlogged and saline areas.</p> <p>Production of disease free silk seed through selection and breeding.</p> <p>Develop integrated silkworm disease management modules.</p> <p>Selection and propagation of mulberry varieties for silkworm rearing etc.</p>	Peshawar
6	Pakistan Botanic Gardens Network Secretariat	Provision of a forum for mutual linkage development amongst the already existing botanical gardens and encourage establishment of new ones	<p>Flood plains thorn forests with <i>Salvadora oleoides</i>, and <i>Prosopis cineraria</i>, <i>Tamarix aphylla</i> and <i>Capparis decidua</i> at Harappa.</p> <p>Tropical dry deciduous forest (remnant) with <i>Butea monosperma</i> at Shakargarh.</p> <p>Scrub forests with <i>Olea ferruginea</i> and <i>Acacia modesta</i> and a threatened palm species <i>Nannorops ritchianna</i> in the Soan Valley.</p>	Lahore
7	Botanical Garden, University of Baluchistan	Conservation of rapidly depleting vegetation of Baluchistan due to water loss and urban stress	The garden includes a park, herbs, medicinal plants, cacti, succulents, shrubs, climbers and creepers, perennials, trees, conifers, rare, extra ordinary plants, plants of Baluchistan, Sindh and from other countries. This will also be open for public and will provide opportunity for visitors to see, learn and develop basic understanding of biodiversity.	Quetta

(Source: [2]; <http://www.bgci.org>; <http://pfi.gov.pk>; <http://www.uob.edu.pk>; <http://www.pbgn.com>; <http://www.gcu.edu.pk>)



Conservation techniques applied in different parts of Pakistan for various species of medicinally important plants as well as other potentially important or seriously threatened plant species is given in Table 3.

Table 3: Currently applied plant conservation techniques in Pakistan

S. No.	Plant Conservation Technique	Plant category
1	Integrated Participatory Approach	Endangered Medicinal Shrub (<i>Commiphorawightii</i>) [19]
2	<i>In-situ</i> and <i>Ex-situ</i> Conservation	Threatened plan species (<i>Taxus fauna</i>) [20-21]
3	Captive breeding practices*	Endangered and threatened plant and animal species [14]
4	In-vitro Conservation Protocol	<i>Cadaba heterotricha</i> [17]

(*Among the above mentioned conservation techniques, captive breeding technique which is one of the best ways to ensure future existence of these species is currently applied for animal conservation in various parts of Pakistan but it has potential for successful plant conservation as well.)

Many of the plant species threatened to become endangered or extinct in Pakistan mostly are those having medicinal importance and therefore the scientists have focused their research in this domain [1, 18, 22]. Researchers have also been conducted on forest resources that continue to deplete despite the efforts of international donors and national organizations. Conservation of natural resources of countries like Pakistan is essential not only for socio-economic development but also for the rural development and thus is a pre-requisite for sustainable development [23]. Thus is a need to develop and maintain a substantial and diverse ex-situ collection of rare and threatened plant species. Additionally there is a need to ensure that the plants conservation centers and organizations are established with specialization in the conservation and floristic studies with special reference to flora of Pakistan. Furthermore steps should be taken for the development of a Germ plasm/seeds bank of not just the indigenous species but the cultivars as well.

Conclusion and Recommendations

Conservation of plant resources is a key to sustainable development of any country as the survival of human beings depends on these plants derived resources and they are vital part of the food chain, so we cannot take the risk of putting them to extermination. Thus steps should be taken by the government as well as local people to conserve these resources at grass root level. Attempts should be made to apply internationally successful strategies and techniques in Pakistan where they will provide us with the best outcomes. However, to start the plant conservation based programs, strengths and weaknesses should be recognized. Few of the problems that arise during various conservation activities include; poverty, lack of education and awareness, lack of marketing opportunity, heavy human and animal pressure on plant resources. Communities should be given exposure and awareness that they start working for the environment and all the plant biodiversity that needs to be protected. They can join institutions to support this purpose and play their role in conserving these massive endangered plant species. Furthermore government should ensure provision and promotion of advanced facilities for research and study in different aspects of plant conservation and should also promote and arrange courses, conferences, lectures and training courses at different levels for those already engaged in this field as well as general public.

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