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# Conservation of Forest Genetic Resources: Need and Challenges

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Threats to Forest Genetic Resources (FGRs) continue at an unprecedented rate and almost 20% of the FGRs are facing different categories of threats to their existence. There is an urgent need to address the issue to arrest degradation of natural populations of forestry species and improve status of regeneration from continuously increasing biotic pressure, assess conservation status of FGRs and develop a prioritized action plan as well as to prepare an elaborate inventory of the wild populations of FGR. Before embarking on a comprehensive programme for conservation of FGRs, there are many issues that need to be addressed, like inadequate knowledge about the genetic diversity of priority forest species; limited knowledge about conservation biology, population dynamics, reproductive biology and fruit/seed production; irregularity in flowering and fruiting; variability in seed production among species and regions- the causes of these variations are often uncertain; determining the seed storage behaviour of a species; devising appropriate methods of conservation for species producing intermediate and recalcitrant seeds. Under a programme for conservation of FGRs of Uttarakhand, *ex situ* conservation of valuable germplasm of economically important forestry species as well as the ones facing threats to their existence, is envisaged. The paper presents the entire programme and the approaches to successfully conserve the precious genetic resources through seeds.

**Key Words: Conservation, Challenges, Forest Genetic Resources, Seeds, Storage physiology**

## Introduction

Forest loss and degradation remain major global concerns despite the enormous efforts to achieve sustainable forest management. There is also increasing awareness of the critical values that forest genetic diversity provide per se and as means to confront global challenges, such as degradation of forests and climate change (www.fao.org/nr/cgrfa). Among the different components of biodiversity, genetic diversity is the building block of the evolutionary process. Conservation of Forest Genetic Resources, therefore, should accommodate evolutionary concepts to ensure continuous adaptation under changing environments (Eriksson *et al*., 1993). Several global and regional threats to forest ecosystems are contributing to profound changes in the pattern of distribution of tree genetic diversity (Koskela and Amaral, 2001 ).

Increased use of forest resources and a shrinking forest land base threaten the sustainability of forest genetic resources and highlight the importance of conservation and sustainable management of these resources. As forest trees are normally the keystone species of forest ecosystems, their continued existence is essential for many floral and faunal associations in these ecosystems. The major challenges include population decline and population structure changes due to forest removal and conversion of forest land to other uses, forest fragmentation, forestry practices, climate change, disease conditions, introduced pests, atmospheric pollution, and introgressive hybridization. Forest genetic resource conservation and resource use should be considered complementary rather than contradictory to each other (Rajora and Mosseler, 2001). Genetic diversity provides the fundamental basis for evolution of forest tree species. This diversity has enabled forests and trees to adapt to changing and adverse conditions for thousands of years, and has resulted in a unique and irreplaceable portfolio of forest tree genetic resources. Nevertheless, the vast majority of forest genetic diversity remains unknown (www.fao.org/nr/cgrfa).

## Threats to Forest Genetic Diversity

Conservation aims at maintaining as much as of genetic variation of the original sources as possible. Protection or conservation measures are essential for securing a sustained supply of genetic variation. Effective conservation of genetic variability is dependent on thorough knowledge of the species in respect of occurrence, mode of reproduction, breeding system, genetic structure and the number of other features related

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to them. Five major causes of biodiversity loss have been identified globally: (1) Habitat loss, fragmentation and degradation, (2) Unsustainable use of ecosystem and over-exploitation of resources, (3) Invasive alien species, (4) Pollution, and (5) Climate change (Sinha, 2011).

## Conservation and Management of Forest Genetic Resources in India

About 80 percent of forest genetic resources of India are found in ten bio-geographic zones in various forests in the country. Remaining 20 percent of plant genetic resources are found in sacred grooves, pasture lands, community lands, agricultural lands, urban areas, botanical gardens, etc. National Bureau of Plant Genetic Resources (NBPGR) in the country is mandated with planning, execution and coordination of all activities concerned with the germplasm collection, introduction, quarantine, evaluation, conservation and documentation of agriculture, horticultural crops, aromatic and medicinal plants and agroforestry species at national level. Despite vast FGRs, and its great importance, there is no separate Bureau of Forest Genetic Resources for exploration, collection, documentation, characterization, evaluation and conservation. As of now, there is no concerted and coordinated effort for the conservation and documentation of forest genetic resources in India (Kumar *et al*., 2016).

The National Forest Policy (1988) has conservation as its basic objective, that emphasizes conserving the natural habitat of the country by preserving natural forests and their vast variety of flora and fauna that represents the biological diversity and genetic resources of the country. The aim of genetic resources conservation is to secure the adaptability of population and species in changing environment by maintaining a sufficient level of genetic variability. This requires provenance trials and progeny tests to complement new research approaches.

**Provenance trials :** Provenance trials help in exploration of genetic resources called genecological exploration. Through genecological exploration, patterns of ecological and phenotypic variation within the natural range of species are studied, leading to provenance seed collection and provenance evaluation. Provenance trials have been established for species like teak, eucalyptus, casuarinas, acacias, neem, shisham, pines, melias, etc.

**Seed orchards:** Seedling seed orchards and clonal seed orchards are established for production of genetically improved seeds for operational planting programme and are a good form of *ex-situ* conservation.

***Ex-situ* conservation of FGRs in gene banks, *in vitro* banks and cryobanks:** Forest Genetic Resources of economically and ecologically important plant species have great importance in the genetic improvement programmes to inculcate desired traits like improved productivity, quality, drought/ cold/ salt tolerance, disease resistance, etc. before further genetic erosion, FGRs of priority species must be conserved in gene banks (at 0 to -20$^{o}$ C temperature) for medium/ long term conservation, *in vitro* culture and cryopreservation of forestry species is also lacking. Therefore, there is a need to carry out studies on the short, medium and long term storage of germplasm of the priority species using seed, tissues, organ, embryo and pollen.

## Need for FGR Conservation

The forest genetic resources are facing several types of threats due to adverse abiotic and biotic stresses; habitat degradation, destruction, grazing, over-exploitation, forest fires, climate change and invasive alien species, etc., resulting in damage to forest ecosystem as well as loss of biodiversity. When genetic variation is lost through habitat destruction succeeding generation are more exposed to adverse conditions such as atmospheric pollution, climate change, pests and diseases, etc. in addition, illegal trade of forest germplasm poses problem of losing valuable resources permanently. A long-term, multi-faceted approach of conservation of forest genetic resources has to be evolved and followed in the country.

## Constraints in FGR Conservation

There are many constraints in the field of conservation of FGRs, which make priority-setting one of the most important tasks not only of conservation work but also of research. These are :

- State-wise inventories of FGRs, with quantitative assessment of population/threat status not available.
- Conservation of FGRs only incidental under 'tree-centric' forest management/PA management; or under Preservation Areas/Sacred Groves, etc.
- Inadequate knowledge about the population parameters and genetic diversity of priority forest species.

- Limited knowledge about conservation biology, population dynamics, habitat ecology, seed storage physiology of most of the important FGR species.
- *Ex situ* conservation efforts (Germplasm Banks/ Seed Banks) limited to only a few native species viz. teak, neem, shisham, babool, melia, and bamboos. Whereas major emphasis of such conservation being on exotic tree species like eucalypts, poplars, *casuarina, Jatropha*, rubber, and *Acacia auriculiformis*, etc.
- No designated national agency for undertaking programmes on conservation, management and development of FGRs. Agencies like Botanical Survey of India (BSI), ICAR-National Bureau of Plant genetic Resources (ICAR-NBPGR), National Biodiversity Authority (NBA), GB Pant Institute, National Bio-resource Development Board, IIRS and FSI working on FGRs within their limited mandate.

## Forest Genetic Resources Conservation and Development Program for North-Western Himalayas (Uttarakhand)

Uttarakhand being a part of Indian Himalayan region (IHR) with forest cover of 24,992 sq km (46.73 % of its total geographical area) (ISFR 2015) is home to vast variety and unique range of floral and faunal diversity of India as the state is uniquely endowed with a diverse assemblage of natural ecosystems. Its diversity under 1,503 genera and 213 families of flowering plants, including 93 endemic species is harboured in various vegetation types, ranging from sub-tropical forests in upper Gangetic Plain and Shiwaliks zone in the south to arctic-alpine vegetation of trans-Himalayan cold desert in the north in Uttarakhand. Major natural vegetation entails of pines, oaks (*Quercus* spp.), rhododendrons, walnut (*Juglans regia*) hill bamboos, etc. Below the snow line, the vegetation consists of forests of spruce (*Picea* spp.), fir (*Abies* spp.), cyprus, juniper (*Juniperus* spp.) and birch (*Betula* spp.)

A Research Programme on Creation of Centre of Excellence of FGRs is being implemented at Forest Research Institute, Dehradun. Its pilot phase (2016-2020) with special focus on the exploration and conservation of Forest Genetic Resources of North-West Himalayas, is being implemented. This programme will built the foundation for Creation of Centre of Excellence on Forest Genetic Resources of India in Indian Council of Forestry Research and Education.

The major activities of the programme include:

### *Documentation of FGRs*

Field surveys would be conducted to document the diversity and population of about 250 species of FGRs. Species distribution records of FGRs would be extracted from herbaria and Working Plans, based on these information eco-distribution maps of the species would be prepared upon completion of these.

### *FGR Seed and Germplasm Storage*

Collection of seed/ germplasm of prioritized FGR species and also pollens for *in vitro* storage, would be done. Seed extraction, cleaning, grading is being done and passport data will be maintained. Quality of the seed lot is evaluated. Sensitivity of the seed to desiccation is being studied using IPGRI-DFSC (2002) protocol, after which storage protocols for medium to long-term conservation will be developed (processed samples will be stored in the Genebank of NBPGR for long-term conservation). Protocols for storage of pollens of critically endangered species would also be attempted.

Protocols would be developed for *in vitro*, minimum growth, embryo culture storage for recalcitrant seeds of priority FGRs.

### *FGR Characterization*

Under this component evaluation and molecular characterization for biochemical traits and tolerance to disease and pests is being assessed. Genetic diversity studies of FGRs of conservation concern/high commercial value would be conducted through advanced molecular techniques.

### *FGR Conservation*

For this, Regional Conservation Assessment and Management Plan (CAMP) Workshops would be held to assess the threat status of FGRs based on the field surveys and population studies. Also Field Gene Banks of priority FGRs species would be established, preferably in their natural zone of occurrence.

## Conclusion

The pilot programme on Conservation of FGRs of the fragile ecosystems in North-Western Himalaya would enrich the team in such work, this would gradually be taken up for FGRs of other biogeographic regions of the country. Conservation of FGR aims to maintain the evolutionary processes of forests and the diverse

genepools they contain for present and future use. To make conservation or sustainable forest management successful a broad planning process involving different stakeholders within and outside the forest sector, needs to be evolved. The capacity of national institutions to carry out FGR conservation should be strengthened, and FGR conservation programmes should be included in national plans/policies for forestry and biodiversity conservation.

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