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National Program for
Conservation and Development of Forest Genetic Resources

Pilot Project Proposal

to be implemented at FRI, Dehradun
as Part of Phase-I (2016-2020)
of the Proposal to Establish FRI as

Centre of Excellence
on
Forest Genetic Resources (FGR) of India

Submitted to the

Ministry of Environment, Forest & Climate Change

for funding under
Adhoc CAMPA Fund

Forest Research Institute (FRI),
New Forest P.O., Dehradun 248 006.

Summary of Pilot Project Proposal

Title of the Program	**Centre of Excellence on Forest Genetic Resources (FGR) of India** *[A 20-year Program for Conservation & Development of FGR for implementation in four phases of 5 years each]*
Title of the Project	**Centre of Excellence on Forest Genetic Resources of India : Pilot Project to be implemented at FRI, Dehradun with special focus on North-West Himalayas**
Implementing Agency	Forest Research Institute, Dehradun
Project Tenure	**5 years** (01 January 2016 – 31 December 2020)
Program Highlights (of 20 year Program)	**(Given as Annexure-I)**
Highlights of the Pilot Project (2016-2020)	• Preparation of comprehensive inventory with population and threat status of 250 FGRs of Uttarakhand • Preparation of priority list of FGRs with road map for their conservation and development with eco-distribution maps of 50 priority FGRs. • Collection and depositing of seed of 100 FGR species in Seed Banks towards medium and long-term conservation. • Evaluation and molecular characterization of 5 important FGRs of commercial importance • Studying of genetic diversity and population structure of 5 important FGRs in for initiation of their *in situ* conservation measures • Establishment of Field Gene Banks of 10 FGR species of high conservation & commercial importance • Protection of Indian FGR diversity through registration/release of specific landraces, varieties, clones, etc. • Producing starting planting material of at least 10 important phenotypically superior tree species for providing to SFDs for further multiplication for plantation programs • Developing well studied, systematic and sustainable protocols for utilization of forest genetic resources for supporting livelihoods • Development of comprehensive computerized database on FGR of Uttarakhand.
Project Budget	**Rs. 861.20 lakh**
Project Director	Director, Forest Research Institute, Dehradun
Implementation Mechanism	<u>Research Work</u>: By FGR Cells to be set up at FRI in collaboration with other research organisations. FGR cells will be coordinated by a FGR –Nodal Officer.
Project Steering & Monitoring	At institute level: Project Implementation Committee with Director, FRI as Chairperson, invited experts from GBPIHED, NBPGR, WII, BSI, Dehradun and FSI.

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Centre of Excellence on Forest Genetic Resources of India: Pilot Project to be implemented at FRI, Dehradun with special focus on North-West Himalayas

1. Introduction

Biodiversity, encompassing the variety and variability of all life on earth, is the product of over 3.5 billion years of evolutionary history. An estimated 8 to 14 million different species are believed to inhabit the earth. To date, only about 1.7 million species of animals and plants have been described, while many more await discovery. It is likely that many of these species might disappear even before they are explored and described, or assessed for their potential value to the humanity. It would be a colossal loss as history shows that even species considered insignificant today may make vital contributions to human welfare in future.

Forests, with all their varied types, are the single most important repositories of terrestrial biological diversity and form source of a wide range of products and services to humanity across the world. Forest trees and other woody plants support many other organisms, and have developed complex mechanisms to maintain high levels of genetic diversity. This genetic diversity, both inter-specific and intra-specific, serves a number of fundamentally important functions. It allows trees and woody perennials to react to changes in the environment, including those brought about by pests, diseases and climatic change. It forms building blocks for evolution, selection and breeding for a wide range of uses to humanity. And, at different levels, it supports the aesthetic, ethical and spiritual values. It is, therefore, imperative that this biological diversity, along with the innate inter and intra-specific genetic variations, is conserved for posterity.

The Convention on Biological Diversity (CBD), adopted in 1992 and relating to ecological, social, economic and ethical values of diversity, affirms that States have sovereign rights over their biological resources and they are responsible for conserving their biological diversity and for using them in a sustainable manner. Since more than 80% of the biological diversity is believed to be held in the forest landscapes, its conservation can be achieved only if the forest management for goods and services is made compatible with conservation through sound planning and coordination of activities at national, local and eco-regional levels. Many countries have achieved this through enunciation and adoption of national policies or special programmes for the conservation of biological diversity, including forest biological diversity. The national policies and programs related to conservation of biodiversity cover a wide range of activities, spanning from conservation and protection of threatened species and their last remnant populations along with their habitats to comprehensive approaches to the management of landscapes, ecosystems and to adoption of appropriate regulatory and policy frameworks.

India has put in place fairly comprehensive policy and regulatory regime for conservation of biological diversity in the form of various statutes including the Biological Diversity Act, Wildlife Protection Act, Forest Conservation Act, and the Indian Forest Act and Rules and Guidelines made under these Acts. India has also set up National Bureaus on animal genetic resources (NBAGR), fish genetic resources (NBFGR) and plant genetic resources (NBPGR) for study on and conservation of biological resources in the country. The issue of serious concern, however, is that neither the forest biodiversity in its entirety has been documented nor threats to the forest biodiversity are fully appreciated. This situation has resulted in decline in the populations of many species from their natural habitats and many of the species have actually come to face the spectre of extinction. Many of these species are of high medicinal importance or form critical resource for meeting daily household needs of the local communities. With the pressures on the habitats increasing by the day, there is an urgent need to document the forest biodiversity in the country, assess the various threats being faced by the taxa and initiate immediate action for long-term conservation of the forest germplasm before it is permanently lost.

2. Importance and Status of Forest Genetic Resources (FGR) in India

Forest Genetic Resources (FGRs) constitute a very important sub-set of biodiversity. Defined as "the heritable materials maintained within and among tree and other woody plant species that are of actual or potential economic, environmental, scientific or societal value" (FAO, 2014[1]). FGRs are very essential for the adaptation and the evolutionary processes of forests and trees as well for improving their resilience and productivity. In addition, the FGRs at the levels of species, populations, and individuals form a very vital and irreplaceable resource for the benefit of mankind. In India alone, more than 340 million people are estimated to be dependent upon the FGRs for their livelihoods!

India is endowed with vast and diverse forests, which play a very crucial role in maintaining the country's biological diversity and ecological balance on one hand and in its social, cultural, historical, economic and industrial development on the other. Spread over nearly 7 lakh sq.km. and forming a little over 21% of the country's landmass (FSI, 2014[2]), forest in the country range in diversity from high alpine to temperate to dry tropical and tropical evergreen. As per present state of knowledge, India has 18,236 higher plant species (18,159 Angiosperms and 77 Gymnosperms) documented from the country (BSI, 2015[3]), of which more than 80% are contained in the forest habitats. More than half of this higher plant diversity is known to be used by the various ethnic communities in the country as non-timber forest produce to meet their day-to-day household needs, with nearly 6,000 of these plant species being used for health care purposes alone! In addition, other land use practices, especially the agriculture and the animal husbandry, also get immensely benefited by the forests and the forest produce. Whereas any depletion in the availability of forest usufructs to agriculture is likely to impair most of the farming activities, it will also adversely impact the animal husbandry as the forests form an important source of fodder in the pinch periods for more than half of the live stock in the country.

About half of the higher plant diversity comprises of trees and other woody species, the remaining half formed by herbaceous flora, including soft climbers, twiners, herbs and grasses. With about 80% of the higher plant diversity contained in forests, it is clear that we are talking of about 7,280 trees and other woody species (9,100 x 0.8) that constitute the known and documented Forest Genetic Resources (FGRs). The numbers may increase as the documentation of FGRs progresses. Whereas a large proportion of India's FGRs are known to be used by the local communities to meet their day-to-day needs of firewood, fodder, fibre, food, small timber, constructional material and household remedies, the FGRs also make

[1] FAO (2014). The State of the World's Forest Genetic Resources.
[2] FSI (2014). The India State of Forest Report 2013.
[3] BSI (2015). Plant Discoveries 2014.

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significant contribution in the GDP of the country in the form of timber and other forest produce. The important role of FGRs in carbon sequestration, mitigating impacts of climate change, soil and moisture conservation, and in maintaining almost all other life forms in forest ecosystems is also being increasingly appreciated. Evolved over millennia in their natural habitats, the forest genetic resources are the source material for the development of the improved varieties/ clones/ hybrids and their conservation is of critical importance for sustaining the tree improvement programme. It is imperative that this very important sub-set of the biodiversity is brought to focus, properly documented, and sustainably managed for its intrinsic value and for the benefit of the mankind.

2.1. *In situ* Management and Conservation of FGRs - Current Practices: In India, large proportion of the forests is owned by the government. The State Forest Departments manage the forests in respect of their states under the instrument of Working Plans that lay down specific management prescriptions for different forests and species. The major focus of the management has historically been centered around timber trees of commercial importance, usually with little concern for the FGRs in its entirety. The present practices of management of forests do not specifically attempt to document the diversity and range of FGRs, with different forest management systems favouring the target tree species. In fact many miscellaneous tree species and woody perennials with little known commercial timber value are actually removed under these prescriptions, causing hitherto un-assessed damage to the FGRs. Moreover, the silviculural systems employed to harvest the target timber species, under which usually the best trees are removed, are known to cause narrowing of intra-specific genetic diversity.

Management and conservation of FGRs *in situ* is also sought to be achieved by setting aside representative areas within each forest type as Protected Areas (PAs). The country has a total of 668 PAs with total area standing at 1.61 lakh sq kms. and forming about 20.6% of the country's forest area (ICFRE, 2010[4]). These PAs are managed under the provisions of Wildlife (Protection) Act, 1972. The prime focus of these PAs, however, has been on conserving flagship wild animal species, with no specific programs to conserve FGRs. In some cases, in fact, the populations of FGRs are manipulated to the advantage of flagship wild animal species purported to be conserved in the PAs. Conservation of FGRs in the PAs is, therefore, largely incidental.

Other *in situ* measures for *in situ* conservation of FGRs include establishment of preservation plots, seed stands, and seed production areas maintained by the respective state governments. The local people also protect and conserve FGRs in sacred groves established for local deities.

2.2. *Ex situ* Conservation and Development of FGRs - Initiatives: *Ex situ* conservation is considered to virtually safeguard the FGRs and provides a required supply of germplasm for research and breeding. The Botanical Garden Conservation International (BGCI) has a mission to 'ensure the world-wide conservation of threatened plants, the continued existence of which are intrinsically linked to global issues including poverty, human well-being and climate change' through this means. The usual approaches for *ex situ* conservation of FGRs include establishment of botanical gardens, arboreta, herbal gardens, clonal repositories, provenance trials, seed banks and cryopreservation banks. Our country has also, as *ex situ*

[4] ICFRE (2010). Forest Sector Report India, 2010.

conservation measures, developed germplasm banks of indigenous species viz. Shisham (*Dalbergia sisso*), Babul (*Acacia nilotica*), Neem (*Azadirachta indica*), Teak (*Tectona grandis*) and bamboos. Similarly a good germplasm collection of some exotic species viz. 3122 accessions in respect of *Acacia auriculiformis* and 4548 accessions in case of Rubber wood (*Hevea brasiliensis*) has also been made. Country also has a very large collection of seed (453 accessions) of Khejri (*Prosopis cineraria*) and a good *in vitro* collection (145 accessions) of *Jatropha curcas*.

ICFRE has, as part of its tree improvement program, also established germplasm banks in respect of many species viz. Teak (*Tectona grandis*), Neem (*Azadirachta indica*), Shisham (*Dalbergia sissoo*), Deodar (*Cedrus deodara*), *Gmelina arborea*, *Albizia* spp., Sandal (*Santalum album*), Pines, Bamboos, Acacias, Eucalypts, Poplars, *Casuarina* spp., and *Jatropha* spp. High yielding and disease resistant clones of Poplars, Eucalypts and *Casuarina* for different regions in the country have also been released and these clones have made a very significant contribution to the agro-forestry in the country.

However, as is apparent from the above, all the FGR related initiatives in the past have been centered around a few species of high economic value with little focus on the vast FGR diversity found in the forests.

3. Problem Statement [Why this Proposal]

India's forests are a very rich repository of forest genetic resources (FGRs), which are unique in that –

(a) these represents a very large subset of the documented higher plant diversity with most of these species being wild, and managed in natural habitats;
(b) these are typically long lived, highly heterozygous group with high levels of intra-specific variations;
(c) each of these species performs multiple functions in the form of products and services, making selection of management options rather complex;
(d) unlike agricultural and horticultural species, conservation and management of these species is impacted by and is dependent upon a diversity of externalities, mainly environmental and biotic; and
(e) the germplasm of FGR is either distributed in the form of scattered populations across various bio-geographic regions in the country or is restricted to very narrow localities making working on these a challenge.

3.1. Knowledge Gaps:

As compared to the genetic resources in agriculture and horticulture, our knowledge of FGRs is grossly inadequate for a well planned policy and management interventions. No comprehensive biodiversity inventory of forest habitats and quantitative information on its threat status is available. Whatever FGR measurements are available have been made in an ad hoc manner in studies disjointed in time and space[5]. There is very limited data on production and consumption of FGR based produce seriously affecting the planning for

[5]Singh J S & S P S Kushwaha (2008). Forest biodiversity and its conservation in India. International Forestry Review Vol. 10 (2). Pp 292-304.

NWFP and wood based industry. Further, 'there is no mechanism in the country to know the status of biodiversity of a given region at a given point of time to assess the change and take appropriate action accordingly'[6].

The first and the foremost requirement for management of a resource is comprehensive documentation of the resource. Even as the total number of FGRs in the country is pegged at ±7,280 out of a total of 18,236 higher plant species documented from the country till date, this documentation is believed to be far from complete. It could be appreciated from the fact that between the 2012 and 2014 Plant Discoveries published by the Botanical Survey of India (BSI), 236 more species have been documented from the country. Secondly, there are also no good records about the extent and regeneration status of most of the FGRs, with general inadequate data on their population biology, harvest pressures on these, etc. To compound the problem, the habitats of FGRs, especially the critical ecological niches, are experiencing an increasing pressure leading to further degradation and fragmentation, causing further depletion in the populations of many important FGRs making their conservation more difficult.

The very nature of FGRs makes appreciation of their deteriorating conservation status a challenge, as the existence of even a small population of a tree species gives an illusion of plenty and of no immediate concern. Due to such gaps in knowledge, any work on the FGRs would have to be taken up *ab initio*, as barring a few tree species of commercial importance, there is very little work on conservation initiatives and germplasm improvement on the large diversity of species of very high socio-economic concern.

3.2. Missing Institutional Mandate on FGRs:

This sorry state of affairs in respect of FGRs is mainly because of the absence of any national level designated agency and program to provide focus on the conservation and development of this very important and critically placed resource. As can be noted from the details given below, there are a number of national level organisations that have worked, at one point of time or the other, on different aspects of FGRs. However, such work by these organisations, with major mandate resting elsewhere, is only incidental -

- The Botanical Survey of India (BSI), with the major mandate to survey and document the plant resources of the country, does prepare inventories of the plant resources of the country and periodically sorts out the nomenclature issues. It also undertakes ex situ conservation of threatened plant species in the form of botanical gardens. Its mandate, however, does not include undertaking quantitative assessment, in situ conservation and management of FGRs and/ or improvement in the resource for higher productivity.

- The National Bureau of Plant Genetic Resources (NBPGR) is involved in conserving the plant germplasm for which it has established facilities for long-term storage of seeds. The mandate of the organisation is, however, mainly related to acquisition and management of indigenous and exotic plant genetic resources for food and agriculture including their introduction for cultivation and conservation of wild relatives in the country.

[6]Pandey D (2008). India's forest resource base. International Forestry Review Vol. 10 (2). Pp 116-124.

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- The National Facility for Plant Tissue Culture Repository (NFPTCR), created withing the NBPGR, undertakes cryopreservation of seeds, pollen, embryos, as well as in vitro culture of plants of economic and scientific value, especially the clonally propagated material and the species having recalcitrant seeds.

- The GB Pant Institute of Himalayan Ecology and Development (GBPIHED) does undertake assessment of biodiversity in niches areas, identify species of concern and carry out research on these. Major focus has, however, been on herbs with only a limited work on tree species viz. Rhododendron species in Sikkim. Moreover, the Institute works only in the Himalayan region.

- The National Bioresource Development Board (NBDB), set up by the GoI in 1999 under the aegis of DBT, is mandated to evolve effective strategies for *ex situ* conservation of bioresources of potential scientific and economic value. This Board has facilitated setting up of a few Centres to explore native bioresources in the country and undertake research on these. However, the program is too small to be of any significant impact.

- Wildlife Institute of India (WII) has been, as part of biodiversity studies in Protected Area Network, has been documenting FGRs. The information available with WII will be collated into the national FGR conservation and development program.

- The Indian Institute of Remote Sensing (IIRS) has prepared an inventory of country's biological resources. Similarly, the Forest Survey of India (FSI) is also engaged in preparing inventory of forest biodiversity. However, the mandate of these organisations in respect of FGRs is limited to drawing broad inferences in respect of major tree species.

In the absence of any designated national agency, ICFRE has been working on the FGRs within its limited resources for a long time and has made significant contribution on the subject. However, the work is far from complete and needs to be taken up in a program mode to fully accomplish the targets.

3.3. Status of FGR Management at State Level:

At the State level, the State Forest Departments (SFDs) act as the custodians and managers of the forest lands. However, the major focus of their management interventions continues to revolve around the timber species of commercial importance with management of the diversity of FGRs taking a back seat. In some States, the State Council's of Science and Technology have also prepared inventories of plant diversity of the state. Some other scientific organisations like TBGRI, KFRI, FRLHT, etc. have also made efforts at documenting plant resources in their area of work. However, most of this work has been carried out in isolation and has remained without consolidation at national level, making it difficult to know the extent of work that has been carried out on the subject till date.

With growing appreciation about the role of FGRs in addressing challenges of food security, poverty alleviation and environmental sustainability, the need to develop better understanding and conservation of FGRs has become more topical than ever. The lack of focus on the subject and absence of any designated agency in the country to address the conservation, management and development of FGRs is causing immense damage to this very important resource. The stage has come when we need to ask ourselves the following key questions to be able to work out strategic intervention for the conservation and development of FGRs in the country –

- How to consolidate the earlier works on the subject carried out by different organisations and build upon the same to find gaps in understanding and carry forward the task of conserving and developing FGRs?

- How to prepare a comprehensive inventory of the wild populations of FGRs to capture inter-specific variability in a time bound manner?

- How to work out intra-specific variations in important FGRs and characterize them?

- How to assess the conservation status of the FGRs and develop a prioritized action plan?

- How to conserve the genetic diversity of prioritized FGRs under *in situ* and *ex situ* conditions for developing improved varieties through research?

- How to arrest degradation of natural populations of the species and improve status of its regeneration in the face of continuing and increasing biotic pressure?

The piecemeal approach of the yesteryears has not helped in comprehensively addressing the above cited issues.

4. FGR Conservation & Development - a 20 Year Perspective Plan

From the foregoing it is clear that there is a definite need to address the FGR related issues through a comprehensive FGR conservation and development strategy and implementation plan. It is also become very clear that the piecemeal approach of addressing the issue through short-term, stand alone and scattered actions by different organisations will not help in addressing the conservation and development issues pertaining to FGRs holistically. We are already well behind the targets set for ourselves in the National Biodiversity Action Plan (NBAP), 2008 and the 20 Aichi Biodiversity Targets set in the Strategic Plan for Biodiversity by the Conference of Parties (CoP) to the CBD in 2010 at Nagoya, Japan. The vision of the Strategic Plan for Biodiversity (2011-2020) is that "by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people". This vision is envisaged to be achieved through 'effective and urgent action to halt the loss of biodiversity' with specific targets (target 5, 7, 9) towards reducing the loss of biodiversity in and sustainable management of landscapes[7].

The first and foremost action to achieve these targets is to have a reliable inventory and status of the FGRs, being the major subset of forest biodiversity. There is, therefore, an

[7] MoEF (2014). National Biodiversity Action Plan (NBAP) - Addendum 2014 to NBAP 2008.

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immediate need for initiating a country-wide dedicated, systematic and sustained long-term coordinated program for exploration, documentation, evaluation, characterization, conservation, development and augmentation of forest genetic resources. And implementation of a program of such magnitude is possible only through a national level dedicated nodal agency.

The Forest Genetic Resources (FGRs), unlike the agriculture or horticulture crops, are typically long-lived plant resources with scattered populations and most of the species coming to flowering at ages more than 10 years making collection of germplasm and its evaluation a long-drawn effort. With country's forest area spread over more than 21% of its landmass, it would take time to explore, document and assess conservation status of the multitude of FGRs. It is proposed to undertake this very important and critical task under a **20-year program (2015-2035)** with the Indian Council of Forestry Research & Education (ICFRE) as the lead agency for this work. The outputs envisaged at the end of the **'Forest Genetic Resources – Conservation and Development Program' (FGR-CDP)** after 20 years are -

i. Comprehensive inventory of the FGRs of the country with distribution maps of priority FGRs in place.
ii. Priority list of FGRs, based on the assessment of their conservation status on globally accepted IUCN guidelines, with road map and action plan for their conservation and development worked out.
iii. Seed of a minimum of 5,000 species constituting FGRs collected with passport data and deposited in Seed Banks towards medium and long-term conservation/ cryopreservation and use in FGR improvement programs.
iv. Evaluation and molecular characterization of 100 important FGRs of commercial importance for traits like morphology, growth, biochemical profile, resistance to disease and pests, etc. completed for its use in tree improvement programs.
v. Genetic diversity and population structure of important FGRs studied and their *in situ* conservation measures put in place.
vi. Germplasm of a minimum of 250 important FGRs conserved in the form of Field Gene Banks.
vii. Agro-techniques of Red-Listed FGRs standardized for multiplication of their germplasm and restoration, species recovery and conservation programs in respect of such species initiated.
viii. Protection of Indian forest genetic resource diversity through registration of specific landraces, varieties, clones and genetic stocks.
ix. Well studied, systematic and sustainable protocols for utilization of forest genetic resources in place for supporting livelihood and welfare of, especially the forest dwelling communities.
x. An ICFRE serviced dynamic FGR information and research network of organisations engaged in research on forest genetic resources established.
xi. A comprehensive computerized database on FGRs of India put in place.

Any initiative to conserve and develop FGRs would need to aim for all the above mentioned outputs to create impact of any significance on the ground. The implementation of the 'Forest Genetic Resources – Conservation and Development Program' (FGR-CDP) for the country would, therefore, need designation of a lead agency to steer, coordinate and

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monitor the program. The Indian Council of Forestry Research & Education (ICFRE), with its pan-India presence and technical strength in the field, is in an excellent position to undertake this challenging task. It is proposed to designate the ICFRE as a **'Centre of Excellence on Forest Genetic Resources' (CoE-FGR)** for the country and support this Centre of Excellence for undertaking this task as per agreed plan. The creation of a Centre of Excellence on Forest Genetic Resources will fill the long standing gap in effective FGR management and conservation in the country.

The scope and broad range of the initiatives and activities required to be undertaken over the 20 year period of the proposed perspective plan for conservation and development of the FGRs, in the light of discussion above, include implementation of this long-term Perspective Plan in **Four Phases**, each phase of 5-year duration, i.e. Phase-I (2016-2020); Phase-II (2020-2025); Phase-III (2025-2030); and Phase-IV (2025-2030). Phase-wise major activities and targets under this perspective plan are given in **Annexure-I**. Each of these four phases would have detailed 5-year plans, further split into Annual Action Plans. The broad plan of action and targets outlined above are based on the current knowledge on the subject, and shall be appropriately modified with more knowledge becoming available over the years. On the current prices, the total budgetary outlay on the proposed Perspective Plan is envisaged to be Rs. 62.21 crore. It is believed that the perspective plan as proposed above shall accord appropriate importance and focus to the subject and holistically address the issues towards conservation, development and sustainable use of the FGRs in the country.

It is proposed to implement a Pilot Phase of the project to orient the staff, standardize methodologies and protocols for implementation of the national program. It is also proposed to implement a five year Pilot phase of the program at Forest Research Institute (FRI) Dehradun.

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5. Forest Genetic Resources - Conservation and Development Program (FGR-CDP): Strategy and Action Plan for Pilot Project to be implemented at FRI, Dehradun as part of Phase-I (2016-2020)

The Forest Genetic Resources, as brought out above, are very important elements of Nature that play a critical role in keeping the ecological processes in balance, in carbon sequestration and in meeting multiple needs of the humanity on every day basis. In addition, the FGRs contain a huge potential in ensuring food and health security of the country's burgeoning human population and its livestock. It is an irony that a resource of such significance has thus far escaped the focus it deserves and is on a path of degradation with many species likely to become extinct even before these are properly documented. The efforts to deal with FGRs thus far have been too little and too spread out to be of any major significance. The entire world is now looking forward to find ways and means to conserve and develop this resource. There is an urgent need to initiate concerted efforts in our country also for conservation and development of the FGRs so that the potential benefits of these could be put to effective use. The ICFRE had during 2013 established a Chair of Excellence at IFGTB to formulate a 'National Forest Genetic Resources Conservation and Usage Plan. Dr. Nagarajan, the Chair of Excellence, after in-depth review of the status of FGRs, proposed an action plan to (a) establish a National Bureau of Forest Genetic Resource, (b) initiate a national coordinated tree improvement program, and (c) start a national forest seed project towards bringing in a timber revolution and to mitigate climate change[8]. Focused primarily on improvement of selected tree species of timber or pulp value, this ambitious plan is, however, pending approval from the Ministry.

The long-term proposed perspective plan on the subject, drawing some elements from the National Forest Genetic Resources Conservation and Usage Plan, is a comprehensive step towards conservation, development and sustainable utilization of FGRs for benefits to humanity. The major focus of Phase-I would be to document and bring out status of the FGRs in the country, put in place systems for networking and inter-institutional collaborative working, prioritizing FGRs for action on the basis of their conservation status and commercial value, and kick start research and conservation action on the prioritized FGRs. Major elements of this strategy and action plan are as under:

5.1. Establishing FRI as Centre of Excellence on Forest Genetic Resources (CoE-FGR):

The conservation and development of FGRs is a very broad issue with diverse, multidisciplinary and inter-sectoral activities that require steering, implementation and monitoring by a competent national level Nodal Agency. Forest Research Institute, Dehradun, has the necessary capacity, mandate and will to undertake this critically important task.

FRI's Credentials for this Task: Established as the Imperial Forest School in 1884 and upgraded as the Imperial Forest Research Institute in 1906, this forestry research institution has gone from strength to strength and has maintained its status as the premier forestry research institution in south Asia. The forestry research in the country was reorganized under the umbrella of ICFRE in 1986. This newly christened organization

[8]Nagarajan S. (2013). National Forest Genetic Resources Conservation and Usage Plan. IFGTB, ICFRE.

continues with added vigour to plan, promote, conduct and coordinate forestry research and extension programs on varied subjects viz. silviculture and forest productivity including improvement of genetic stock; biodiversity management including medicinal plants and other NTFPs; forest protection including from fire, insect-pests and pathogens; utilization of forest products including value addition; forest products including paper, pulp and composite wood; agroforestry: rural livelihood including promoting forest based craft; afforestation including rehabilitation of deserts and degraded lands; climate change; environment impact assessment; and policy research.

FRI is the prime forestry research and extension Institution in the country that has been serving the cause of forestry in the country for the past more than 100 years. The institution takes pride in developing adaptive forest management tools and practices including silvicultural systems, concepts of forest types, volume table and yield tables for different tree species and regions of the country. These tools and practices continue to be the basis on which forests in the country are being managed till this date. The institution also played a pioneering role in developing protocols and techniques for converting wood into pulp, paper and composite wood products in the country and its subsequent extension to the industry, a sector that has now grown to multi-billion dollar industry, making significant contribution to the country's GDP and livelihoods. The wood and bamboo preservation techniques developed and standardised by the organisation continue to be in use by industry and other users till today. Of the rather recent significant contributions of the institute is the spread of agro-forestry in the country. This work involved screening of the high yielding germplasm of various species, sustained extension efforts over the years and subsequent transfer of technology to stakeholders. This single initiative has resulted in shift of the major proportion of wood supplies from forestry to agro-forestry, helping in conservation of forests in the country. FRI has the second biggest herbarium in the country with more than 3.3. lakh accessions and maintains a good starting collection of FGRs in arboreta, botanical gardens and bambusetums at its various Institutes.

FRI Dehradun is performing as designated repositories of the National Biodiversity Authority (NBA) for flora since 2008. FRI Dehradun is also a designated Centre of Plant and Seed Quarantine against insects and diseases for export and import (for Phyto-sanitary Certification) of germplasm. FRI also providing expert inputs to the Protection of Plant Varieties and Farmers Rights' Authority (PPVFRA) New Delhi for developing descriptors for DUS testing of selected tree species. FRI has a well established National Forest library and Information Centre (NFLIC) housing more than 1.5 lakh books and subscribing 300 scientific journals.

FRI Dehradun has good building infrastructure, well equipped laboratories, and adequate scientific manpower to take up this task.

Major Functions of the Proposed Centre of Excellence: The proposed CoE-FGR will act as One Stop Centre for information and action on the FGRs and shall perform the following broad functions:

i. Coordinate, steer and monitor all activities related to FGR documentation, evaluation, exchange and conservation.
ii. Consolidate the earlier works on the subject as carried out by different organisations and build upon the same to enhance understanding on the subject and carry forward the task of conserving and developing FGRs.

iii. Serve as a national repository of all notified or released clones/ genotypes/ hybrids along with herbarium specimens and relevant information, besides being a national repository of original/ parental lines.
iv. Guide restoration of the landraces and varieties from areas that are frequently susceptible to natural disasters.
v. Coordinate, in collaboration with state forest departments, ICFRE institutes and other national organizations/ institutions, integrated conservation programs for threatened and economically important FGRs including generation of biological and genetic information about these species.
vi. Create and service forest genetic resource information and research network in the country. The MoEF&CC has already made a beginning to create a Forest Genetic Resource Management Network (FGRMN) with IFGTB as the node.
vii. Create and manage computerized national database on FGRs of the country.
viii. Bring out publications on the diversity, distribution, conservation and research status on FGRs.
ix. Provide guidance and assist policy development; and implement FGR related work plans based on national, bilateral and international agreements.

Proposed Structure of the Centre of Excellence: The Centre of Excellence (CoE) will be housed in Forest Research Institute, Dehradun with Director, FRI as **Project Director** who will be responsible for administering the project within the institute. He will also be responsible for establishing and maintaining liaison between (a) the ICFRE and the MoEF&CC, (b) the Council and its Institutes, (c) the Council and its Institutes and the State Forest Departments, and (d) the Council and other research organisations. He will also be responsible for securing necessary permissions from the National Biodiversity Authority for work on the FGRs.

A dedicated **CoE-FGR Cell**, duly supported with the FRI's subject matter experts and project staff, will be established in guiding, coordinating, steering and monitoring implementation of the project. The FGR-CoE Cell will be responsible for (a) networking of the various organisations engaged in research on FGRs, (b) for developing and servicing a national FGR database, (c) for bringing out publications on the diversity, distribution, conservation status and research actions on FGRs, and (d) acting as accredited national node on issues pertaining to global conventions/ initiatives on FGRs. The Cell would also be providing advisory services whenever called upon to do so.

5.2. Implementation Strategy:

The project will be implemented under the guidance of the project implementation committee under the chairmanship of Director, Forest Research Institute. Head Genetics and Tree Propagation Division and Head Botany division will be the members of the committee. Collaboration with other organisations working on the FGRs will also be entered into on case to case basis. Four dedicated cells to focus on different work arenas under the programs will be set up at FRI. Activities of the four dedicated cells at the Institute level will be coordinated by a designated **Nodal Officer** and overall monitoring will be done by the **Director, FRI**. The project implementation committee will review and monitor the program on quarterly basis.

Director FRI, Dehradun will be responsible for monitoring the progress in the Institute; keeping a check on the expenditure and accounts; collecting information/ progress reports from the cells, collating the same and submitting in time to the NCAC Secretariat. He will also ensure quarterly conduct of its review-cum-monitoring meetings. He will also be responsible for attending national level program meetings and make presentation on the project activities.

The four FGR cells would be required to implement the project as per the approved physical and financial targets maintaining the highest standards of scientific rigour and integrity, and timely submit progress reports to RPD. Specific responsibilities of the FGR cells would be as under:

(i) FGR Documentation Cell: It will be responsible for planning and undertaking field surveys to document the FGR diversity, record population size and assess regeneration status of different FGR species; screen FGR distribution information from records of accredited herbariums in the region and those available in the Forest Working Plans (such information will be sample verified to check the present status of presence of key species); prepare distribution maps of FGRs; collect seeds of various FGRs along with passport data; collect germplasm of priority species along with passport data; etc. The Cell will be headed by a leading plant taxonomist/ field botanist of the Institute who shall be supported with ecology expert and project staff.

(ii) FGR Seed Cell: It will be responsible for receipt, drying, cleaning, grading and care of FGR seeds brought to it by teams of documentation cell; carrying out viability studies; working out short, medium and long term storage protocols; keeping the seeds in short, medium and long term storage in collaboration with NBPGR; maintaining passport data of each consignment. The cell will also be responsible for developing protocols for long term storage of pollens and *in vitro* conservation of germplasm of priority FGR species in the form of tissue/ embryo cultures. The cell would also be responsible for standardising nursery techniques of priority FGR species for eventual maintenance in field gene banks. The Cell will be headed by a leading plant Seed Scientist of the Institute who shall be supported with tissue culture experts and project staff.

(iii) FGR Characterisation Cell: It will be responsible for studying genetic variability of the high priority FGR species; evaluation and molecular characterization of FGRs for marker assisted selection for traits like morphology, growth, biochemical profile, resistance to disease and pests, etc. towards enhancing productivity. The Cell will be headed by geneticist of the Institute who shall be supported with chemistry experts and project staff.

(iv) FGR Conservation Cell: This cell will be responsible for undertaking threat assessment of the FGRs; prioritise FGRs based on threat status and commercial value of species; plan for and establish field gene banks of priority species; maintain database of all FGR field gene banks, seed orchards, provenance trials, etc.; enhancing value and richness of arboreta and botanical gardens by introducing priority FGRs; developing and maintaining database of accessions in various arboreta, botanical gardens and bambusetums across the country; plan for *in situ* conservation of priority species; work out protocols for sustainable use of FGRs, including through value addition, etc. The Cell will be headed by geneticist/silviculture scientist of the Institute who shall be supported with a botanist and project staff.

In addition to the above mentioned in-house administrative strategy, the project would enter into collaboration with research institutes for activities including baseline studies, protocol development, etc. for effective and efficient implementation of the project. The project also would look at farming out some activities in the form of short-term consultancies. It is believed that the implementation strategy proposed above would be adequate to efficiently implement the FGR conservation and development project.

5.3. Action Plan (2016-2020):

All project activities have been clubbed as per the proposed scope of work of the four dedicated FGR cells at the institute level.

A. FGR Documentation: Detailed passport data will be prepared for all collections/ recordings made. Field explorations will be carried out forest type wise to maintain focus. Forest types for such exploration would be prioritized in consultation with the Institutes while preparing detailed project implementation plans. This cell would, along with its documentation process, make collections of seeds, pollens and germplasm for Seed Cell and Characterization Cell. Activities and targets of FGR documentation Cell are as under -

S. No.	Planned Activity	Yr1	Yr2	Yr3	Yr4	Yr5
A1	Field surveys to document FGR diversity & their population status with GPS referencing [*Target = 250 species*]	50	50	50	50	50
A2	Extraction of FGR distribution records from accredited national herbaria (including international herbaria viz. Kew) and from Forest Working Plans [*Target = 250 species*]	50	50	50	50	50
A3	Preparation of eco-distribution maps of priority FGR species, including orientation and training of project staff. [*Target = 50 species*]	0	10	10	15	15
A4	Modernization and upgradation of FRI Herbarium including digitization of herbarium sheets; and developing herbarium database, & incorporating new accessions to herbarium	20%	30%	30%	15%	5%
A5	Collection of seeds of FGRs from different accessions for long-term storage. Seed of each species to be collected from an average of five provenances/ seed zones. [*Target = 90 species*]	10	20	20	20	20
A6	Collection of germplasm for *in vitro* storage in the form of tissue/ embryo culture. [*Target = 10 species*]	0	2	2	3	3
A7	Collection of pollen for long term preservation [*Target = 10 species*]	0	2	2	3	3

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B. FGR Seed and Germplasm Storage: The seeds of FGR species brought from the field by the teams of FGR Documentation Cell will be extracted, cleaned, dried, graded and packed for medium term and long term storage. Minimum moisture content of the seeds to be stored will be worked out and storage protocols developed. The stored seeds would be subjected to periodic seed viability and vigour trials along with working out half-life of the seeds in storage. Biological models to predict risks associated with seed storage will be developed. The Cell would also be standardizing nursery techniques and raise nursery stock of priority species. Protocols for preservation of pollens and long term storage of *in vitro* cultures will also be standardized. Detail of activities under this Cell is as under –

S. No.	Planned Activity	Yr1	Yr2	Yr3	Yr4	Yr5
B1	Seed extraction, cleaning, grading, data recording, packing, labeling with passport data, etc. and putting the seeds under medium and long term storage, in collaboration with NBPGR. [*Target = 90 species*]	10	20	20	20	20
B2	Minimum moisture content and periodic seed viability and vigour trials on stored seed along with working out half-life of the seeds in storage, and developing biological models to predict risks associated with seed storage [*Target = 20 species*]	4	5	5	5	1
B3	Developing protocols for storage of FGR germplasm in the form of 'pollens' for red-listed species [*Target = 10 species*]	0	2	2	3	3
B4	Developing protocols for storage of germplasm of FGR species of very high conservation concern and those having recalcitrant seeds *in vitro*, minimal growth cultures and embryo culture [*Target = 10 species*]	0	2	2	3	3
B5	Development and standardization of nursery techniques of FGR species of very high conservation concern. [*Target = 5 species*]	0	0	2	2	1

C. FGR Characterization: The germplasm of priority FGRs will be evaluated and characterized for various traits like morphology, growth, biochemical traits, infestation of insect and diseases, etc. It will be a multidisciplinary program with physiologist, chemist, and pathologists collaborating with geneticists. Germplasm of high genetic diversity will be maintained in the form of repositories for eventual use in conservation programs. Data so generated will be catalogued and put on computer based management and retrieval system. Detail of activities under this Cell is as under –

S. No.	Planned Activity	Yr1	Yr2	Yr3	Yr4	Yr5
C1	Evaluation and molecular characterization of FGRs, specifically for biochemical traits, and screening for disease and pests towards enhancing productivity. [*Target = 5 species*]	0	1	1	1	2
C2	Genetic diversity studies of FGRs of conservation concern and high commercial value with germplasm collected from across the range of distribution of the species. [*Target = 5 species*]	0	1	1	1	2

D. FGR Conservation: The first and the foremost activity towards conservation of FGR would be to prepare list of red listed species based on their threat status in the wild. For this threat assessment workshops on the globally accepted IUCN guidelines will be organised at FRI Dehradun. A priority list of FGR species will thereafter be prepared based on threat status of the species and their environmental, socio-cultural and commercial value. *In situ* and *ex situ* conservation measures for priority species in the form of conservation reserves and field gene banks respectively would thereafter be put in place. Detail of activities under this Cell is as under –

S. No.	Planned Activity	Yr1	Yr2	Yr3	Yr4	Yr5
D1	Conservation assessment & management prioritization (CAMP) workshop for assessment of threat status of FGRs of Uttarakhand and preparation of Action Plans for conservation of species assessed as Red-listed under guidance of FGR-CoE [*Target = 1 Workshops*]		1			
D2	Establishment of Field Gene Banks of priority FGR species. Includes collection of germplasm of selected species from across the country, multiplying and maintaining it in the nursery, site preparation, planting, site protection, and maintenance [*Target = 5 species*]		1	2	1	1
D3	Conservation of FGR germplasm in FRI arboreta and botanical garden and preparing database of such accessions of all arboreta in Uttarakhand. [*Target = 100 species*]					
D4	Evaluation of selected PAs for their effectiveness in conserving priority FGRs. Floristic survey & transact studies in the selected PAs to cover different seasons.		1			

S. No.	Planned Activity	Yr1	Yr2	Yr3	Yr4	Yr5
	[*Target = 1 PA*]					
D5	Establishment of FGR Conservation Areas (FGR-CAs) in natural forests for species of high conservation concern. Population studies for selected species; and preparation and implementation of management plan. [*Target = CAs for 5 species*]		1	1	1	2
D6	*Circa situm* conservation of remnant individuals of important FGRs on lands outside forests. Survey for remnant populations of important FGRs on private lands.					

E. Establishment of Centre of Excellence (CoE-FGR): Establishment of Centre of Excellence (CoE) and supporting it to carry out the role of national accredited node on FGRs will be a very important activity under this program.

S. No.	Planned Activity	Yr1	Yr2	Yr3	Yr4	Yr5
E1	Setting up of CoE-FGR at FRI & maintenance including refurbishing of office infrastructure; routine office, travel and contingent expenses.					
E2	Creation of prototype computerized database on FGRs of India - Interactive database on inventory, and species-wise distribution maps, threat status and conservation initiatives, seed storage, FGBs, etc					
E3	Creation of national accredited hub on issues pertaining to global conventions/ initiatives on FGRs					

Notes:

a) No permanent posts are proposed to be created under this proposed long term program. Research Fellows and Project Assistants proposed to be engaged under the program to assist the program activities will be on contractual basis and their engagement will be co-terminus with the project currency.

b) All project activities will be carried out in accordance with a detailed Project Implementation Plan that will be prepared on receipt of getting in-principle approval of the project.

c) All the activities and the outputs from the project will be subsumed by the Council under its regular mandate after the program culminates.

d) Successful culmination of the project will be dependent upon timely release of funds by the Ministry and timely approvals by the National Biodiversity Authority.

e) All project outputs, including publications, reports, scientific papers, etc. will duly acknowledge the financial support provided by the Ministry.

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Forest Research Institute, Dehradun

Forest Genetic Resources - Conservation and Development Program (FGR-CDP): Phase-I Action Plan (2016-2020)

Recurring Costs

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
A. Documentation of FGRs									
A1	Field surveys to document FGR diversity & population status of 250 FGRs	Including GPS referencing of FGRs	5.00	6.00	6.00	6.00	2.00	25.00	2 RFs + 2 PAs + Travel, casual labour, consumables, etc.
A2	Collection of (a) seeds of 90 FGR species; (b) germplasm for *in vitro* storage of 10 species; and (c) pollens of 10 species for long term storage	Seed, germplasm and pollens to be collected from an average of 5 seed zones/ provenances	1.00	1.50	1.50	1.00	1.00	6.00	
A3	Extraction of FGR distribution records of 250 species from herbaria and from Forest Working Plans	Accredited national/ international herbaria	1.00	1.00	1.00	1.00	1.00	5.00	
A4	Preparation of eco-distribution maps of 50 FGRs	Including orientation & training of project staff	5.00	5.00	5.00	5.00	5.00	25.00	1 RA (GIS expert) at CoE-FGR hqrs.
A5	Modernization and upgradation of FRI Herbarium	Digitizing herbarium sheets; incorporating new accessions; developing herbarium database, etc.	25.00	25.00	25.00	25.00	25.00	125.00	1 RA + 2 RFs + 2 PA + consumables, etc.
		Sub-Total (A):	**37.00**	**38.50**	**38.50**	**38.00**	**34.00**	**186.00**	

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
B. FGR Seed and Germplasm Storage									
B1	Seed extraction, cleaning, grading, data recording, packing, labeling with passport data, etc. and putting seeds under medium and long term storage, in collaboration with NBPGR	Seed will be collected and provided by the documentation team. [Target = 90 species]	4.00	6.00	6.00	6.00	2.00	24.00	1 RF + 2 PA + Consumables, casual labour, etc. Seeds would be stored for medium term in walk-in storage chambers to be set up under this project.
B2	Minimum moisture content, periodic seed viability and vigour trials on stored seed along with working out half-life of the seeds in storage, & developing biological risk prediction models associated with seed storage	To establish the protocols for long-term storage. [Target = 20 species]	3.00	5.00	5.00	4.00	3.00	20.00	1 RF + consumables Long-term storage of FGR seeds would be in the seed storage facility of NBPGR.
B3	Developing protocols for storage of FGR germplasm in the form of 'pollens' for critical species	For species of very high conservation concern [Target = 10 species]	3.00	3.00	3.00	3.00	3.00	15.00	1 RF + consumable
B4	Developing protocols for storage of germplasm of priority FGR species *in vitro*, *minimal growth cultures* and *embryo culture*	For species of very high conservation concern and those having recalcitrant seeds [Target = 10 species]	3.00	3.00	3.00	3.00	3.00	15.00	One RF + consumables
B5	Development and	For species of very high	4.00	4.00	4.00	4.00	4.00	20.00	1 RF + 1 PA

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S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
	standardization of nursery techniques of priority FGRs	conservation concern [Target = 5 species]							+ consumables
		Sub-Total (B)	**17.00**	**21.00**	**21.00**	**20.00**	**15.00**	**94.00**	

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
C. FGR Characterisation									
C1	Evaluation and molecular characterization of FGRs. specifically for biochemical traits, and screening for diseases and pests.	Characterization for traits like morphology, growth, biochemical profile, screening for disease and pests, etc. towards enhancing productivity [Target = 5 species of high conservation concern/ high economic value]	9.00	10.00	10.00	10.00	6.00	45.00	1 RA + 2 PA + travel, consumables, etc.
C2	Genetic diversity studies of FGRs of conservation concern and high commercial value	Germplasm of the selected species to be collected from across different populations & genetic diversity and population structure estimated. Unique populations/ high diversity zones in the	8.00	15.00	15.00	15.00	7.00	60.00	1 RA + 2 RF + travel, consumables, etc.

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
		species identified for conservation. [Target = 5 species of high conservation concern/ high economic value]							
		Sub-Total (C):	**17.00**	**25.00**	**25.00**	**25.00**	**13.00**	**105.00**	

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
D. FGR Conservation									
D1	Regional conservation assessment & management prioritization (CAMP) workshops for assessment of threat status of FGRs and preparation of Action Plans for conservation of species assessed as Red-listed.	1 workshop (3-day) for Uttarakhand including printing of reports. [@ Rs. 8 lakh/ workshop]	2.00	6.00	0	0	0	8.00	≈60 participants per workshop from amongst field botanists, ecologists, taxonomists, researchers, herb gatherers, traders, representatives of herbal industry, etc.)
D2	Establishment of Field Gene Banks of 5 priority FGR species	Includes collection of germplasm of selected species from across the country, multiplying and maintaining it in the nursery, site preparation, planting, site protection,	0	5.00	5.00	5.00	5.00	20.00	1 RF + casual labour.

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S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
		and maintenance [Target = 5 species]							+ fencing, transporting the planting material, consumables, etc.
D3	Conservation of FGR germplasm in arboreta and botanical gardens and preparing regional database of such accessions	Status of FGR accessions with different regional arboreta and botanical gardens; enrichment with new accessions.	2.00	2.50	2.50	2.50	2.50	12.00	
D4	Evaluation of selected PAs for their effectiveness in conserving priority FGRs	Floristic survey & transact studies in the selected PAs to cover different seasons. [Target = 1PA; @ Rs. 6.00 lakh/ PA]	1.00	3.00	2.00	0	0	6.00	RF, PA, local labour, travel, consumables, etc.
D5	Establishment of FGR Conservation Areas (FGR-CAs) in natural forests for 2 species of high conservation concern	Population studies for selected species; and preparation and implementation of management plan. [Target = CAs for 12 species; @Rs. 10 lakh/ CA]	0	8.00	8.00	2.00	2.00	20.00	RFs, PAs, local labour, travel, consumables, etc.
D6	*Circa situm* conservation of remnant individuals of important FGRs on lands outside forests	Survey for remnant populations of important FGRs on private lands.	0	1.50	1.50	1.00	1.00	5.00	
		Sub-Total (D):	**5.00**	**26.00**	**19.00**	**10.50**	**10.50**	**71.00**	

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
E. Establishment of Centre of Excellence (CoE-FGR)									
E1	Setting up of CoE-FGR	Refurbishing of office infrastructure; routine office, travel and contingent expenses.	2.00	2.00	2.00	2.00	2.00	10.00	1 RF + Office attendant + travel and office expenses
E2	Creation of a prototype of FGR information and research network (FGR-IRN) for the region.	Dynamic web-based network of Institutes/ organisations like BSI, NBPGR, TBGRI, KFRI, GBIHED, Research Wings of SFDs, ICFRE Institutes, NBRI, Agriculture Universities, FGR based Industries, Research NGOs, etc.	2.00	5.00	5.00	4.00	4.00	20.00	Network will be hosted by the Centre of Excellence. It will be strengthened with necessary server/ computer facilities. 1 RAs (Computer Engineers) special-izing in networking software.
		Sub-Total (E):	**4.00**	**7.00**	**7.00**	**6.00**	**6.00**	**30.00**	
		Grand Total (Recurrent):	**80.00**	**117.50**	**110.50**	**99.50**	**78.50**	**486.00**	

Note: RA (Research Associate); RF (Research Fellow); PA (Project Assistant)

Capital

FRI already has good building infrastructure including nurseries and laboratories. Thus, construction/ creation of no new building/ nursery infrastructure is proposed. Only minor modifications to the existing buildings will be made to make these suitable for this program. The only building that is proposed for major renovation is the building housing FRI Herbarium. The building requires urgent renovation and enhancement of its storage capacity for safe storage of stored FGR herbarium sheets and extending their storage life. This herbarium holds many priceless herbarium sheets, including many type specimens, collected by noted plant explorers of yore. The existing nurseries will be strengthened for multiplication of germplasm of FGR.

FRI has trained scientific manpower and well equipped laboratories for carrying out genetic diversity and characterization studies. Some the equipment has, however, become old and outdated and is proposed to be updated under this project.

Details of the expenses of the Capital nature are as under:

A. Building/ Nursery Infrastructure

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
A1	Strengthening of CoE building infrastructure	Minor refurbishing of buildings; fabrication of work stations; storage cabinets; furniture; fittings, etc.	3.00	2.00	0	0	0	5.00	At the CoE-FGR level
A2	Renovation and refurbishing of FRI Herbarium building	Major repair of roof, flooring & toilets; repair of processing rooms & stores; installation of dehumidifiers/ ACs; Fire alarm & extinguishing system, herbarium furniture, lighting, painting etc.	40.00	35.00	0	0	0	75.00	The building needs major repairs, including some modifications for installation of storage compacters for long-term preservation of herbarium specimens.

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
A3	Improving storage capacity of the FRI Herbarium	Installing compacter system for storage of 3.5 lakh herbarium sheets	50.00	25.00	0	0	0	75.00	The herbarium sheet storage space in the herbarium cabinets is full, with nearly 1 lakh sheets awaiting accession.
A4	Strengthening nurseries with green houses and shade houses	For maintenance of germplasm of FGRs [@ Rs. 10 lakh per nursery]	10.00	0	0	0	0	10.00	.
		Sub-Total (A):	**103.00**	**62.00**	**0**	**0**	**0**	**165.00**	

B. Scientific Equipment

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
B1	Refrigerated Micro centrifuge	For molecular characterization/ genetic diversity analysis work [*Rs. 5 lakh/ unit*]	5.00	0	0	0	0	5.00	
B2	PCR thermal cycler (96-well)	For molecular characterization/ genetic diversity analysis work [*Rs. 6 lakh/ unit*]	6.00	0	0	0	0	6.00	
B3	High throughput vertical gel electrophoresis unit with power pack	For molecular characterization/ genetic diversity analysis work [*Rs. 5 lakh/ unit*]	5.00	0	0	0	0	5.00	
B4	High throughput horizontal	For molecular	3.00	0	0	0	0	3.00	

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S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
	gel electrophoresis unit with power pack	characterization/ genetic diversity analysis work [*Rs. 3 lakh/ unit*]							
B5	Chip based electrophoresis system	[*Rs. 30 lakh/ unit*]	30.00	0	0	0	0	30.00	
B6	Deep freezer (-80^{0}C): 700 ltr.	For molecular characterization/genetic diversity analysis work [*Rs. 8 lakh/ unit*]	10.00	0	0	0	0	10.00	
B7	Pharmacia refrigerator	For molecular characterization/genetic diversity analysis work [*Rs. 6 lakh/ unit*]	6.00	0	0	0	0	6.00	
B8	Deep freezer (-20^{0}C) (1 unit)	Storage of samples and chemicals [*Rs. 3 lakh/ unit*]	3.00	0	0	0	0	3.00	
B9	Tissue culture equipments	For in-vitro storage [*Rs. 5 lakh/ sets*]	3.00	2.00	0	0	0	5.00	(Castor racks, laminar flow, distilled water unit etc.) one set for each institute
B10	Walk-in seed storage chamber (-20^{0}C)	For medium term seed storage. [*Rs. 30.00 lakh/ unit*]	0	28.00	0	0	0	28.00	
B11	Seed storage containers/ packaging	For storage of seeds	3.00	2.00	0	0	0	5.00	For medium term and short term storage of seeds.
B12	Seed testing equipments	Drying, grading, testing –viability, germination percent, etc.) [*Rs. 25 lakh/ Institute*]	8.00	12.00	5.00	0	0	25.00	Hot air oven, weighing scales, pH meters, conductivity meters, IR moisture meter, micropipettes, industrial

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
									refrigerator, seed germination chambers, etc.
B13	High resolution A3 scanner& binocular microscope	Scanning & microscopic study of herbarium sheets	3.00	0	0	0	0	3.00	For herbarium
B14	Bar coding system	Bar coding of herbarium specimens	1.00	0	0	0	0	1.00	For herbarium
		Sub-Total (B):	**86.00**	**44.00**	**5.00**	**0**	**0**	**135.00**	

C. Vehicles

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
C1	Pick up Van	For collection of seed and germplasm from various places to regional centre (FRI). [*Rs. 10.00 lakh/ unit*]	10.00	0	0	0	0	10.00	One pick up van for FRI
		Sub-Total (C):	**10.00**	**0**	**0**	**0**	**0**	**10.00**	

D. Office Equipment

S. No.	Activity	Details	Estimated Budget Requirement (Rs. in lakh)						Remarks
			Year-1	Year-2	Year-3	Year-4	Year-5	Total	
D1	Computers, printers, scanners, servers, etc.	[*Rs. 5 lakh for CoE office &* FGR cells	8.50	0	0	0	0	8.50	
D2	Basic furniture	[*Rs. 2.50 lakh each for FGR-CoE and FRI*]	5.00	0	0	0	0	5.00	

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Sub-Total (D):	13.50	0	0	0	0	13.50	
Grand Total (Capital):	212.50	106.00	5.00	0	0	323.50	

Total Project Cost

	Estimated Budget Requirement (Rs. in lakh)						Remarks
	Year-1	Year-2	Year-3	Year-4	Year-5	Total	
Grand Total (Recurrent):	80.00	117.50	110.50	99.50	78.50	486.00	
Grand Total (Capital):	212.50	106.00	5.00	0.00	0.00	323.00	
Grand Total (Recurring+ Capital)	292.50	223.50	115.50	99.50	78.50	809.00	
Grand Total (with 10% annual increment)	292.50	245.85	127.05	109.45	86.35	861.20	

(Rupees eight crore sixty one lakh and twenty thousand only)

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Annexure-I

The implementation of this long-term Perspective Plan is sought to be accomplished in **Four Phases**, each phase of 5-year duration, i.e. Phase-I (2015-2020); Phase-II (2020-2025); Phase-III (2025-2030); and Phase-IV (2025-2030). Phase-wise major activities and targets under this perspective plan are given below:

S. No.	Activity Targets	Phase-I (2015-20)	Phase-II (2020-25)	Phase-III (2025-30)	Phase-IV (2030-35)
1	Preparation of inventory and survey for populations status of the FGRs (as % of the total documented FGRs)	30%	25%	25%	20%
2	Prioritisation of FGRs based on their conservation status as assessed in accordance with globally accepted IUCN guidelines (based on current knowledge of FGRs in the country) and periodic re-assessment and updating of the priority list.	√	√	√	√
3	Preparation of eco-distribution maps of FGRs of conservation concern and of high commercial value (approx. 2000 species)	500	500	500	500
4	Collection of seeds of FGRs for long-term conservation (5,000 species including species of conservation concern & of high commercial value)	1500	1500	1000	1000
5	Evaluation and molecular characterization of FGRs for different traits viz. morphology, growth, biochemical profile, resistance to disease and pests, etc. (100 species of high commercial value)	20	30	25	25
6	Study of genetic diversity and population structure of important FGRs and working out their *in situ* conservation protocols (100	20	30	25	25

35б/

	species)				
7	Collection of germplasm of FGRs, standardising their agro-techniques for conserving in the form of Field Gene Banks established across the country (250 species); and for sustainable utilization	75	75	50	50
8	Creation of a forest genetic resource information and research network in the country.	√	√	√	√
9	Develop and keep updated comprehensive national database on FGRs	√	√	√	√

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दूरभाष/Phones :
कार्यालय/Offi. : 0135-2755277
0135-2224444
निवास/Resi. : 0135-2751679
0135-2224545
फैक्स/FAX : 91-0135-2756865
E-mail : dir_fri@icfre.org

डॉ० सविता, भा.व.से.
निदेशक व.अ.सं.
एवं
कुलपति व.अ.सं. सम विश्वविद्यालय
Dr. SAVITA, IFS
Director FRI
and
Vice-Chancellor FRI Deemed University

वन अनुसंधान संस्थान
(भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद्)
(पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार की एक स्वायत्त परिषद्)
डाकघर न्यू फॉरेस्ट, देहरादून—248006
FOREST RESEARCH INSTITUTE
(Indian Council of Forestry Research and Education)
(An autonomous body of Ministry of Environment, Forests & Climate Change Govt. of India)
P.O. New Forest, Dehra Dun—248006

अ०शा०सं० D.O.No. 9-108/DGTP-CoFGR/FRI 2016

दिनांक Dated. the Date 14-01-2016

To,

The Inspector General of Forests (FC) /CEO
Ministry of Environment, Forest and Climate Change
Indira Paryavaran Bhavan
Jorbagh Road
New Delhi - 110 003

Kind attention: Shri Rajagopal Prashant, AIG (FC)

Sub : CAMPA/NCAC- proposals for assistance-reg.

Sir,

Please refer to your letter no. 13-30/2015-CAMPA dated 07th December 2015 on the subject cited above. The project proposal entitled "**National Program for Conservation and Development of Forest Genetic Resources: Pilot Project Proposal to be implemented at FRI, Dehradun**" has been revised as per the directions of National CAMPA Advisory Council (NCAC) communicated through the above letter.

As desired, two copies of the revised project proposal have already been handed over personally to Shri Rajagopal Prashant AIG (FC) on 05-01-2016 with this office letter no. 9-96/DGTP/FGRMN/FRI 2016 dated 04-01-2016.

You are requested to kindly release the first instalment of funds so that the works could be started timely. The bank details for transfer of funds are given below :

Bank Account Number : 496902010088593
Branch : Union Bank of India, FRI Dehradun
IFSC Code : UBIN0549690
MICR Code : 248026003

Yours faithfully

14/01/2016

(Dr. Savita)
Director

Encl. As above

17/5 588

Put up in relevant file

AIG (RP) OSD CAMPA

OSD CAMPA

From: SINHA Priya
Sent: Friday, May 13, 2016 10:26 AM
To: 'igfc-mef@nic.in'
Subject: Best Practices Guidance for Restoration of Mining Sites

Dear Shri D.K. Sinha,
IUCN has been assigned a project under CAMPA to document best practices case studies on restoration of mining areas and prepare best practices guidelines on restoration. Copy of the proposal submitted by us and the sanction letter is attached for ready reference.

1323/CAMPA/16 20/05/2016

I am submitting herewith a midterm progress report on the project. As may be seen , work on documenting case studies is complete. Analysis of the case study is underway. Now we will undertake preparation of best practices guidelines. The draft guidelines would be presented in a workshop to be organized in consultation with your office before it is firmed up.
We had indicated in our proposal that the project would be completed within six months of the issuance of the sanction order. However it is taking time due to the complexities involved in the work which includes capturing recent initiatives like star rating of mines and the sustainable mining framework. Also in the budget line some revision between items are required within the overall budget.
Accordingly, a revised budget with revised time line is submitted herewith for your consideration and approval.
We will be submitting the draft final report by the end of October 2016 along with requisite utilization report.
Thanking you
Best Wishes
PRSinha

O/o IGF (FC)
Dy. No....6461....
Date....17.5.2016....

From: SINHA Priya
Sent: Friday, November 20, 2015 10:44 AM
To: S S GARBYAL; sharad.negi@nic.in
Cc: M. S. NEGI
Subject: Consultation on Best Practices Guidance for Restoration of Mining Sites

O/o AIGF (FC)
Dy. No....6461 AIG(RP)....
Date....19.5.16....

Dear Dr Negi,
As you are aware, IUCN has been assigned a project under CAMPA to prepare best practices guidance on restoration of mining sites. We already have collected case studies from across the globe on restoration practices as part of this exercise. Now we propose to hold a consultation with relevant stake holders to capture various dimensions of the issue at hand.
Kindly indicate your convenience sometime in early December and also accept our request to inaugurate it.
I am copying this mail to ADG(FC) and CEO CAMPA for their kind information and needful.
Thanks and Best Wishes,

Priya Ranjan Sinha (Mr)
Country Representative
India Country Office
IUCN (International Union for Conservation of Nature)
C- 4/ 25, Safdarjung Development Area, New Delhi 110016, India
Tel. +91 11 2652 5554, Extn.: 210, Fax +91 11 2652 7742,
www.iucn.org

589

Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority

Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in IA No.1337 with IA Nos.827, 1122, 1216, 1473 in WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGD Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 22nd September 2015.**

The Manager Incharge,
Corporation Bank, Lodhi Complex Branch,
Block No.11, CGO Complex, Lodi Road, **New Delhi 110003.**

Sub.: CAMPA/ NCAC – Assistance to IUCN – Developing a Tool kit for Restoration of Mining Sites.

Sir,

It is requested that an amount of Rs.28,75,000.00 (Rs Twenty eight lakhs and seventy five thousand) may kindly be transferred from SB Account No.24054 in the name of National CAMPA Advisory Council in your Bank, to Account No.522-0-571187-8 in the name of IUCN (International Union for Conservation of Nature & Natural Resources) in Standard Chartered Bank, Narain Manzil, 23 Barakhamba Road, New Delhi 110001 [IFSC Code SCBL0036020] under intimation to us.

Yours faithfully,

(M S Negi)
Inspector General of Forests and
Chief Executive Officer, Ad-hoc CAMPA

Copy to :

1. Mr Priya Ranjan Sinha, Country Representative, India Country Office, IUCN, C-4/25 Safdarjung Development Area, New Delhi 110016. It is requested that (1) Quarterly Progress Reports may kindly be furnished at the end of every Quarter (end of Sept., December, March and June); and (2) the final settlement account of the amount being released may kindly be sent immediately on completion of the Project ;
2. Director General, Indian Council of Forestry Research & Education, Dehradun ;
3. Deputy Inspector General of Forests (RT), Ministry of Environment Forests and Climate Change.

(M S Negi)
Inspector General of Forests and
Chief Executive Officer, Ad-hoc CAMPA

IUCN

Developing Toolkit for Management & Restoration of Mining Areas in India

Interim Progress Report

Photo credits @Vipul Sharma, II

60(1)

BACKGROUND

India is among the top ten mineral producing nations in the world and the country's mining and quarrying sector contributes around 2.5% percent to GDP. It is the largest producer of sheet mica, the third largest producer of iron ore and the fifth largest producer of bauxite in the world. The distribution of mineral reserve is mainly in eight states – Jharkhand, Orissa, West Bengal, Bihar, Chhattisgarh, Telangana, Madhya Pradesh and Goa. However, large parts of these deposits are located in dense forests –which have high biodiversity value. Since requirement of minerals is essential for economic development of our country, large forest areas in these states have been diverted for mining under the Forest Conservation Act, 1980. One of the major conditions stipulated while awarding approval for these mines is to restore the mined out area.

There are a few good examples of restoration of mining sites in India. However, these relate to restoration of Dumps. In some countries, there have been efforts to restore deep mined sites as well. These initiatives do not necessarily take into account ecological restoration. Moreover the biodiversity concerns are notmainstreamed across the life cycle of mining. It has therefore been a felt need for developing good practices guidelines for restoration of mined out areas.

IUCN has been working globally as well as in India on mining and biodiversity conservation issues. In 2002, IUCN and the International Council on Mining and Metals (ICMM) launched a joint dialogue on mining and biodiversity. This engagement has helped in mainstreaming Biodiversity concerns into Mining life cycle in leading global players in mining.

Drawing upon the examples and expertise available in the country and abroad, the current project will develop a Best Practices Guidance Book on Management and Restoration of Mining sites in India as a first step towards restoration of Mining sites.

PROJECT DESCRIPTION

Objectives and Scope of work

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- The overall purpose of the project is to strengthen the knowledge base with respect to the conceptualization, and management of restoration of mining sites in India.
- The specific objective is to document the best practices being used locally and globally and develop guidance book for mining industry on restoration.

The documentation and guidance book will endeavour to be as comprehensive as possible covering at least:

- The **origin of the concept of rehabilitation and restoration** (driving needs and motivations);
- **Specific areas where integration of rehabilitation plan into existing mines planning can be taken up for better management.**
- **Environmental requirements and protocols needs** to be in place for mine restorations.
- **National and International case studies** showcasing design and management of the process including studies prepared, actions undertaken and their results on ground.
- The **importance of different stakeholders and necessary interaction with them** for better management of restoration work.
- **Inputs from all the stakeholders** including government, mining companies and other through a consultative workshop.

Key activities

1. Establish a list of publications, files and documents (hard and electronic) that will need to be reviewed;
2. Establish a list of organizations and individuals that will need to be consulted and interviewed;
3. Develop and agree a methodology for the review and documentation;
4. Develop a clear understanding (and listing) of the key aspects of the rehabilitation process components and their parts that must be documented;
5. Develop and agree on a table of contents for the guidance book;
6. Travel to the mining locations to review the site, perform interviews take picture;
7. Produce a draft report on documentation of national and global best practices on rehabilitation for mining pits
8. Based on the above activities produce a draft guidance book.
9. Organise a consultative workshop involving all the stakeholders to provide inputs on

A13

the draft guidance book.

10. Produce a final guidance book based on the comments resulting from the consultation process, understanding that several iterations of the draft report may need to be provided;

Outputs

1. The first output of the project will be a final best practice guidance book for rehabilitation of deep pit mines.
2. The second output will be a consultative workshop involving all stakeholders.
3. The third output will be the documentation of national and global best practices on restoration in mined out areas.

PROJECT PROGRESS

1. Consultation Meeting

A consultation meeting with government officials, mining companies, representatives of mining companies and restoration experts from educational institutions was organized on 8th December 2015 under the chairmanship of DGF &SS, MOEF&CC. ADG(FC), IGF(FC) and other officials from Ministry also participated at the meeting. The outcome of the meeting was to provide guidance to IUCN on taking this work forward.he purpose of this meeting was to discuss perspective of various stakeholders the work done by them on restoration of mining sites and to give a snapshot of the work done under CAMPA.

2. Literature Collection and Review

Literature has been collected through in-depth search from various sources viz., official websites of Ministry of Mines, Indian Bureau of Mines, Ministry of coal, web search of legislations worldwide, published research work in journals on ecological mine restoration, guidelines and mine closure plans of international mining giants such as BHP Billiton, Anglo American etc.

In addition, Project staff visited the Wildlife Institute of India Library and Documentation Centre for collection of all available books/research articles on restoration of mined out areas. The information collected from various sources was either in the form of reprints, photocopies or as electronic copy of the publications.

A total of 150 publications were gathered following a thorough literature search from India and abroad. These documents includes various acts/rules/legislations related to mining, best practices/guidelines for mine site restoration/rehabilitation by mining companies, guidelines for preparing mine closure plans, national and international case studies on mine restoration, research articles/ thesis related to sustainable mine practices and ecological restoration/rehabilitation of mining sites. All the collected documents have been segregated into different sections as listed below:

- Government laws, policies and notifications
- Best Practices/guidelines used globally by companies
- Restoration/Rehabilitation Case Studies
- Scientific research related to ecological restoration

The activity wise update on the current progress and future planned work under the project is given in the table below:

	Key Tasks	Extent of work done
1.	Establish a list of publications, files and documents (hard and electronic) that will need to be reviewed	We have compiled approximately 150 documents including - • National and international Acts, Rules and Legislations, • Guidelines for mine closure planning, • Global publications related to ecological restoration of land degraded by mining activities, • National and International case studies including reclamation, restoration, rehabilitation and biodiversity offset, • Rehabilitation strategies and mine closure plans by national and international mining As a part of literature collection work our Intern also

		visited Wildlife Institute of India, Dehradun
2.	Establish a list of organizations and individuals that will need to be consulted and interviewed	Prepared a list of organisations/companies related to mining sector with which consultation needs to be done. Already in contact with Federation of Indian Mining Industries (FIMI) and Wildlife Institute of India (WII) who have the experience of mining and biodiversity related issues in the Indian context and can provide a good advisory support
3.	Develop and agree a methodology for the review and documentation	All the documents to be reviewed have been collected in hard and soft copies
4.	Develop a clear understanding (and listing) of the key aspects of the rehabilitation process components and their parts that must be documented	Key features of issues in national laws & policies, mining sector activities and approaches and restoration efforts to be addressed in the guidance book have been framed and understood clearly. An annotated bibliographical document based in the key findings from the collected literature is also being worked out.
5.	Develop and agree on a table of contents for the guidance book	Consulted Dr. Susie Brownlie, who is an international environmental / biodiversity practitioner from deVilliers Brownlie Associates, South Africa, regarding preparation of the draft guidance book
6.	Travel to the mining locations to review the site, perform interviews take picture	Planned to travel to different mining sites of SAIL, Coal India Ltd., TATA Steel Ltd., Sesa Goa Ltd. etc. to perform expert consultation, do a site review, take pictures and get an essence of the mining activities and the type of restoration work being performed
7.	Produce a draft report on documentation of national and global best practices on rehabilitation for mining pits	Consulted Dr. Susie Brownlie, who is an international environmental / biodiversity practitioner from deVilliers Brownlie Associates, South Africa, regarding preparation of the draft guidance book
8.	Based on the above activities produce a draft guidance book	Consulted Dr. Susie Brownlie, who is an international environmental / biodiversity practitioner from deVilliers Brownlie Associates, South Africa, regarding preparation of the draft guidance book
9.	Organise a consultative workshop involving all the stakeholders to provide inputs on the draft guidance book.	Will be organised upon development of first draft of guidance book.

Revised Budget for Developing Toolkit for Management & Restoration of Mining Areas in India (CAMPA):

DESCRIPTION	AMOUNT (INR)
Staff / Consultancy charges	13,00,000
Research and produce publication	300,000
Consultative workshop with stakeholders	600,000
Printing and dissemination	100,000
Travel	200,000
SUBTOTAL	25,00,000
Supervision and coordination (15%)	375,000
TOTAL	**28,75,000**

602

From SINHA Priya <Priya.SINHA@iucn.org>
Sent Friday, May 13, 2016 10:26 am
To "igfc-mef@nic.in" <igfc-mef@nic.in>
Subject Best Practices Guidance for Restoration of Mining Sites
Attachments

image001.gif	2K	image002.jpg	13K	GoI_Order_ CAMPA Mining Project.pdf	
Work Progress Report- Restoration of Mining areas.docx	1.3MB	Revised Budget for CAMPA Project.docx	15K		

Dear Shri D.K. Sinha,

IUCN has been assigned a project under CAMPA to document best practices case studies on restoration of mining areas and prepare best practices guidelines on restoration. Copy of the proposal submitted by us and the sanction letter is attached for ready reference.

I am submitting herewith a midterm progress report on the project. As may be seen , work on documenting case studies is complete. Analysis of the case study is underway. Now we will undertake preparation of best practices guidelines. The draft guidelines would be presented in a workshop to be organized in consultation with your office before it is firmed up.

We had indicated in our proposal that the project would be completed within six months of the issuance of the sanction order. However it is taking time due to the complexities involved in the work which includes capturing recent initiatives like star rating of mines and the sustainable mining framework. Also in the budget line some revision between items are required within the overall budget.

Accordingly, a revised budget with revised time line is submitted herewith for your consideration and approval. We will be submitting the draft final report by the end of October 2016 along with requisite utilization report.

Thanking you

Best Wishes

PRSinha

From: SINHA Priya
Sent: Friday, November 20, 2015 10:44 AM
To: S S GARBYAL; sharad.negi@nic.in
Cc: M. S. NEGI
Subject: Consultation on Best Practices Guidance for Restoration of Mining Sites

Dear Dr Negi,

As you are aware, IUCN has been assigned a project under CAMPA to prepare best practices guidance on restoration of mining sites. We already have collected case studies from across the globe on restoration practices as part of this exercise. Now we propose to hold a consultation with relevant stake holders to capture various dimensions of the issue at hand.

Kindly indicate your convenience sometime in early December and also accept our request to inaugurate it.

I am copying this mail to ADG(FC) and CEO CAMPA for their kind information and needful.

Thanks and Best Wishes,

Priya Ranjan Sinha (Mr)
Country Representative
India Country Office
IUCN (International Union for Conservation of Nature)
C- 4/ 25, Safdarjung Development Area, New Delhi 110016, India
Tel. +91 11 2652 5554, Extn.: 210, Fax +91 11 2652 7742.
www.iucn.org

IUCN

68

Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority

Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in IA No.1337 with IA Nos.827, 1122, 1216, 1473 in WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA Dated the 22nd September 2015.

The Manager Incharge,
Corporation Bank, Lodhi Complex Branch,
Block No.11, CGO Complex, Lodi Road, New Delhi 110003.

Sub.: CAMPA/ NCAC – Assistance to IUCN – Developing a Tool kit for Restoration of Mining Sites.

Sir,

It is requested that an amount of Rs.28,75,000.00 (Rs Twenty eight lakhs and seventy five thousand) may kindly be transferred from SB Account No.24054 in the name of National CAMPA Advisory Council in your Bank, to Account No.522-0-571187-8 in the name of IUCN (International Union for Conservation of Nature & Natural Resources) in Standard Chartered Bank, Narain Manzil, 23 Barakhamba Road, New Delhi 110001 [IFSC Code SCBL0036020] under intimation to us.

Yours faithfully,

(M S Negi)
Inspector General of Forests and
Chief Executive Officer, Ad-hoc CAMPA

Copy to :

1. Mr Priya Ranjan Sinha, Country Representative, India Country Office, IUCN, C-4/25 Safdarjung Development Area, New Delhi 110016. It is requested that (1) Quarterly Progress Reports may kindly be furnished at the end of every Quarter (end of Sept., December, March and June); and (2) the final settlement account of the amount being released may kindly be sent immediately on completion of the Project ;
2. Director General, Indian Council of Forestry Research & Education, Dehradun ;
3. Deputy Inspector General of Forests (RT), Ministry of Environment Forests and Climate Change.

(M S Negi)
Inspector General of Forests and
Chief Executive Officer, Ad-hoc CAMPA

Revised Budget for Developing Toolkit for Management & Restoration of Mining Areas in India (CAMPA):

DESCRIPTION	AMOUNT (INR)
Staff / Consultancy charges	13,00,000
Research and produce publication	300,000
Consultative workshop with stakeholders	600,000
Printing and dissemination	100,000
Travel	200,000
SUBTOTAL	25,00,000
Supervision and coordination (15%)	375,000
TOTAL	**28,75,000**

64

IUCN

Developing Toolkit for Management & Restoration of Mining Areas in India

Interim Progress Report

Photo credits @Vipul Sharma, IUCN

INTERNATIONAL UNION FOR CONSERVATION OF NATURE

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BACKGROUND

India is among the top ten mineral producing nations in the world and the country's mining and quarrying sector contributes around 2.5% percent to GDP. It is the largest producer of sheet mica, the third largest producer of iron ore and the fifth largest producer of bauxite in the world. The distribution of mineral reserve is mainly in eight states – Jharkhand, Orissa, West Bengal, Bihar, Chhattisgarh, Telangana, Madhya Pradesh and Goa. However, large parts of these deposits are located in dense forests –which have high biodiversity value. Since requirement of minerals is essential for economic development of our country, large forest areas in these states have been diverted for mining under the Forest Conservation Act, 1980. One of the major conditions stipulated while awarding approval for these mines is to restore the mined out area.

There are a few good examples of restoration of mining sites in India. However, these relate to restoration of Dumps. In some countries, there have been efforts to restore deep mined sites as well. These initiatives do not necessarily take into account ecological restoration. Moreover the biodiversity concerns are notmainstreamed across the life cycle of mining. It has therefore been a felt need for developing good practices guidelines for restoration of mined out areas.

IUCN has been working globally as well as in India on mining and biodiversity conservation issues. In 2002, IUCN and the International Council on Mining and Metals (ICMM) launched a joint dialogue on mining and biodiversity. This engagement has helped in mainstreaming Biodiversity concerns into Mining life cycle in leading global players in mining.

Drawing upon the examples and expertise available in the country and abroad, the current project will develop a Best Practices Guidance Book on Management and Restoration of Mining sites in India as a first step towards restoration of Mining sites.

PROJECT DESCRIPTION

Objectives and Scope of work

- The overall purpose of the project is to strengthen the knowledge base with respect to the conceptualization, and management of restoration of mining sites in India.
- The specific objective is to document the best practices being used locally and globally and develop guidance book for mining industry on restoration.

The documentation and guidance book will endeavour to be as comprehensive as possible covering at least:

- The **origin of the concept of rehabilitation and restoration** (driving needs and motivations);
- **Specific areas where integration of rehabilitation plan into existing mines planning can be taken up for better management.**
- **Environmental requirements and protocols needs** to be in place for mine restorations.
- **National and International case studies** showcasing design and management of the process including studies prepared, actions undertaken and their results on ground.
- The **importance of different stakeholders and necessary interaction with them** for better management of restoration work.
- **Inputs from all the stakeholders** including government, mining companies and other through a consultative workshop.

Key activities

1. Establish a list of publications, files and documents (hard and electronic) that will need to be reviewed;
2. Establish a list of organizations and individuals that will need to be consulted and interviewed;
3. Develop and agree a methodology for the review and documentation;
4. Develop a clear understanding (and listing) of the key aspects of the rehabilitation process components and their parts that must be documented;
5. Develop and agree on a table of contents for the guidance book;
6. Travel to the mining locations to review the site, perform interviews take picture;
7. Produce a draft report on documentation of national and global best practices on rehabilitation for mining pits
8. Based on the above activities produce a draft guidance book.
9. Organise a consultative workshop involving all the stakeholders to provide inputs on

𝑓4y

the draft guidance book.

10. Produce a final guidance book based on the comments resulting from the consultation process, understanding that several iterations of the draft report may need to be provided;

Outputs

1. The first output of the project will be a final best practice guidance book for rehabilitation of deep pit mines.
2. The second output will be a consultative workshop involving all stakeholders.
3. The third output will be the documentation of national and global best practices on restoration in mined out areas.

PROJECT PROGRESS

1. Consultation Meeting

A consultation meeting with government officials, mining companies, representatives of mining companies and restoration experts from educational institutions was organized on 8th December 2015 under the chairmanship of DGF &SS, MOEF&CC. ADG(FC), IGF(FC) and other officials from Ministry also participated at the meeting. The outcome of the meeting was to provide guidance to IUCN on taking this work forward.he purpose of this meeting was to discuss perspective of various stakeholders the work done by them on restoration of mining sites and to give a snapshot of the work done under CAMPA.

2. Literature Collection and Review

Literature has been collected through in-depth search from various sources viz., official websites of Ministry of Mines, Indian Bureau of Mines, Ministry of coal, web search of legislations worldwide, published research work in journals on ecological mine restoration, guidelines and mine closure plans of international mining giants such as BHP Billiton, Anglo American etc.

In addition, Project staff visited the Wildlife Institute of India Library and Documentation Centre for collection of all available books/research articles on restoration of mined out areas. The information collected from various sources was either in the form of reprints, photocopies or as electronic copy of the publications.

A total of 150 publications were gathered following a thorough literature search from India and abroad. These documents includes various acts/rules/legislations related to mining, best practices/guidelines for mine site restoration/rehabilitation by mining companies, guidelines for preparing mine closure plans, national and international case studies on mine restoration, research articles/ thesis related to sustainable mine practices and ecological restoration/rehabilitation of mining sites. All the collected documents have been segregated into different sections as listed below:

- Government laws, policies and notifications
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- Restoration/Rehabilitation Case Studies
- Scientific research related to ecological restoration

The activity wise update on the current progress and future planned work under the project is given in the table below:

	Key Tasks	**Extent of work done**
1.	Establish a list of publications, files and documents (hard and electronic) that will need to be reviewed	We have compiled approximately 150 documents including - • National and international Acts, Rules and Legislations, • Guidelines for mine closure planning, • Global publications related to ecological restoration of land degraded by mining activities, • National and International case studies including reclamation, restoration, rehabilitation and biodiversity offset, • Rehabilitation strategies and mine closure plans by national and international mining As a part of literature collection work our Intern also

6/6)

		visited Wildlife Institute of India, Dehradun
2.	Establish a list of organizations and individuals that will need to be consulted and interviewed	Prepared a list of organisations/companies related to mining sector with which consultation needs to be done. Already in contact with Federation of Indian Mining Industries (FIMI) and Wildlife Institute of India (WII) who have the experience of mining and biodiversity related issues in the Indian context and can provide a good advisory support
3.	Develop and agree a methodology for the review and documentation	All the documents to be reviewed have been collected in hard and soft copies
4.	Develop a clear understanding (and listing) of the key aspects of the rehabilitation process components and their parts that must be documented	Key features of issues in national laws & policies, mining sector activities and approaches and restoration efforts to be addressed in the guidance book have been framed and understood clearly. An annotated bibliographical document based in the key findings from the collected literature is also being worked out.
5.	Develop and agree on a table of contents for the guidance book	Consulted Dr. Susie Brownlie, who is an international environmental / biodiversity practitioner from deVilliers Brownlie Associates, South Africa, regarding preparation of the draft guidance book
6.	Travel to the mining locations to review the site, perform interviews take picture	Planned to travel to different mining sites of SAIL, Coal India Ltd., TATA Steel Ltd., Sesa Goa Ltd. etc. to perform expert consultation, do a site review, take pictures and get an essence of the mining activities and the type of restoration work being performed
7.	Produce a draft report on documentation of national and global best practices on rehabilitation for mining pits	Consulted Dr. Susie Brownlie, who is an international environmental / biodiversity practitioner from deVilliers Brownlie Associates, South Africa, regarding preparation of the draft guidance book
8.	Based on the above activities produce a draft guidance book	Consulted Dr. Susie Brownlie, who is an international environmental / biodiversity practitioner from deVilliers Brownlie Associates, South Africa, regarding preparation of the draft guidance book
9.	Organise a consultative workshop involving all the stakeholders to provide inputs on the draft guidance book.	Will be organised upon development of first draft of guidance book.

617

Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority

Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in IA No.1337 with IA Nos.827, 1122, 1216, 1473 in WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

NO.13-17/2012-CAMPA **Dated the 4th July 2016.**

The Country Representative,
India Country Office, I U C N,
C-4/25 Safdarjung Development Area,
New Delhi -110016.

Sub.: **CAMPA / NCAC : Best Practices Guidance for Restoration of Mining Sites.**

Sir,

Please refer to your letter dated 13th May 2016 on the subject mentioned above.

2. This is to convey that the Director General of Forests & Special Secretary/ Chairman, Ad-hoc CAMPA has desired to have a detailed Presentation in the matter, in his Conference Chamber 'Krishna', Level IV, Jal Wing, Indira Paryavaran Bhavan, New Delhi 110003, at 1600 hrs on Monday, the 11th July 2016. It is requested that your convenience for the presentation may kindly be conveyed by return e.mail; 10 copies of the hard copies of the presentation may kindly be made available to us in advance for distribution among the participants.

Yours faithfully,

(Nisheeth Saxena)
Asstt Inspector General of Forests
Tel No; 24695459

Copy to the following, with the request to please make it convenient to attend the presentation :

(1) Inspector General of Forests (EAP), MoEF&CC ;
(2) Deputy Inspector General of Forests (RT) ;
(3) Director (RO-Hq)/AIGF(RP)/ AIGF(NS)/ AIGF(SS).

(Nisheeth Saxena)
Asstt Inspector General of Forests
Tel No; 24695459

Copy to PPS to DGF&SS/ PPS to IGF.FC/ CEO Ad-hoc CAMPA

(Nisheeth Saxena)
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Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 12th July, 2016**

The Country Representative,
India Country Office, I.U.C.N.
C-4/25, Safdarjung Development Area,
New Delhi – 110 016.

Sub : CAMPA/NCAC : Best Practices Guidance for Restoration of Mining Sites.

Sir,

In continuation to this Office letter of even number dated the 4th July, 2016 on the subject mentioned above this is to convey that the detailed presentation on progress in respect of the subject Project which was earlier scheduled for 1600 hrs on Monday the 11th July 2016, will now be taken by Director General of Forests & Special Secretary/Chairman, Ad-hoc CAMPA on **Thursday, 14th July, 2016 at 1130 hrs** in his Conference Chamber 'Krishna', Level IV, Jal Wing, Indira Paryavaran Bhavan, New Delhi – 100 003. It is requested that your convenience for the presentation may kindly be conveyed by return e-mail; 10 hard copies of the presentation may kindly be made available to us in advance of distribution among the participants.

Yours faithfully,

(Rajagopal Prashant)
Assistant Inspector General of Forests
Tel. No.24695401

Copy to the following, with the request to please make it convenient to attend the presentation :

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2. Deputy Inspector General of Forests (RT), MoEF&CC ;
3. Director (RO-Hq)/ AIGF(R)/ AIGF(NS)/ AIGF(SS), MoEF&CC.

(Rajagopal Prashant)
Assistant Inspector General of Forests
Tel. No.24695401

Copy to PPS to DGF&SS/ PPS to IGF (FC) & CEO, Ad-hoc CAMPA, MoEF&CC.

(Rajagopal Prashant)
Assistant Inspector General of Forests
Tel. No.24695401

दूरभाष/Phones :
कार्यालय/Off. : 0135-2755277
0135-2224444
निवास/Resi. : 0135-2751679
0135-2224513
फैक्स/FAX : 91-0135-2756865
E-mail : dir_fri@icfre.org

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डॉ० सविता, भा.व.से.
निदेशक व.अ.सं.
एवं
कुलपति व.अ.सं. सम विश्वविद्यालय
Dr. SAVITA, IFS
Director FRI
and
Vice-Chancellor FRI Deemed University

वन अनुसंधान संस्थान
(भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद्)
(पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार की एक स्वायत्त परिषद्)
डाकघर न्यू फॉरेस्ट, देहरादून—248006
FOREST RESEARCH INSTITUTE
(Indian Council of Forestry Research and Education)
(An autonomous body of Ministry of Environment, Forests & Climate Change Govt. of India)
P.O. New Forest, Dehra Dun—248006

अ.शा.पत्र सं.
D.O.No 9-108/DGTP-CoFGR/FRI 2016

दिनांक
Dated, the Date 13-05-2016

CAMPA (C)
Dy. No. 684 (AIG FC)
Date 27/5/16

684/...
20.5.2016

To,

The Inspector General of Forests (FC) /CEO
Ministry of Environment, Forest and Climate Change
Indira Paryavaran Bhavan
Jorbagh Road
New Delhi - 110 003

Kind attention: Shri Rajagopal Prashant, AIG (FC)

Sub : **Adhoc CAMPA project - National Program for Conservation and Development of Forest Genetic Resources: Pilot Project Proposal to be implemented at FRI, Dehradun - Progress report reg.**

Sir,

Please find enclosed two copies of the progress report of the subject cited project, for the period of January - April 2016.

Yours faithfully
13/05
(Dr. Savita)
Director

Encl. As above

1346/CAMPA/16
24/05/16

AIGF(DD)
OSD/CAMPA

examine and put up
2015

OSD CAMPA

620

National Program for
Conservation and Development of Forest Genetic Resources

Pilot Project Proposal

to be implemented at FRI, Dehradun

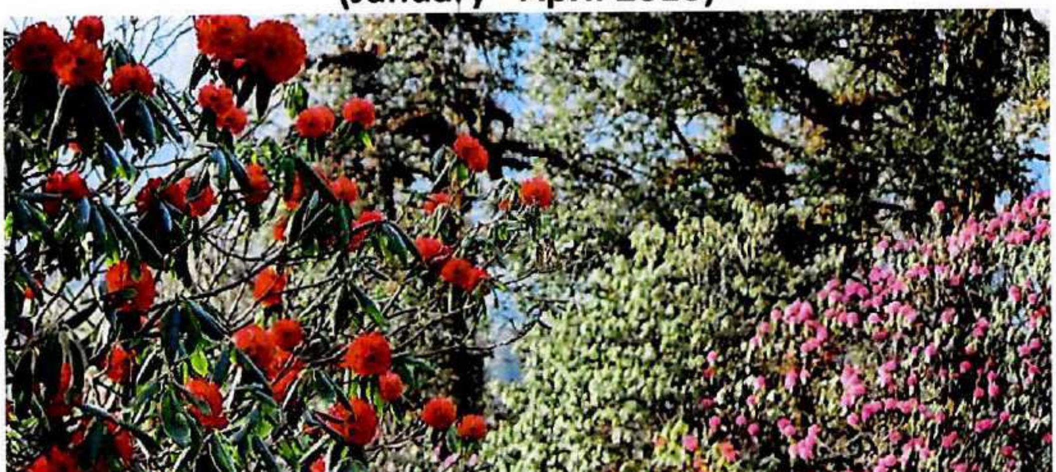
on

Creation of Centre of Excellence on Forest Genetic Resources (FGR) of India (CoFGR)

Funded under
Adhoc CAMPA Fund
Ministry of Environment, Forest & Climate Change
(2016-2020)

Progress Report

(January - April 2016)



Submitted by

Forest Research Institute (FRI),

New Forest P.O., Dehradun 248 006.

6

Project Summary

Title of the Project :	National Program for Conservation and Development of Forest Genetic Resources : Pilot Project Proposal to be implemented at FRI on Creation of Centre of Excellence on Forest Geetic Resources (CoFGR)
Funding Agency :	Adhoc CAMPA Fund Ministry of Environment, Forest & Climate Change, Govt. of India
Project Outlay:	Rs. 861.20 lakh (January 2016 – 31 December 2020)
Project Period :	5 years
Grants released :	1st installment - 146.25 lakh
Date of release :	1st installment on 21st January 2016
Project Executing Authority:	Director Forest Research Institute, Dehradun
Period of present progress report :	21st January 2016 to 30th April 2016

Background Information

Forest Genetic Resources (FGRs) constitute a very important sub-set of biodiversity Conserving FGR is vital, as they are unique and irreplaceable resources for the future. In India alone, more than 340 million people are estimated to be dependent upon the FGRs for their livelihoods! there is a definite need to address the FGR related issues through a comprehensive FGR conservation and development strategy and implementation plan.

As per present state of knowledge, 18,236 higher plant species (18,159 Angiosperms and 77 Gymnosperms) documented from India so far (*BSI, 2015: Plant Discoveries 2014*). More than 80% of this higher plant diversity is contained in the forest habitats (≈14,500 species). About half of this forest plant diversity constitutes FGRs (≈7,250 species), the remaining being herbaceous flora including soft climbers, twiners, herbs, and grasses. FGRs contain a huge potential in ensuring food and health security of the country's burgeoning human population and its livestock.

To generate understanding and knowledge on FGR, and to develop and strengthen in situ and ex situ FGR conservation programmes, the National CAMPA Advisory Council (NCAC) of Ministry of Environment and Forests & Climate Change, Govt. of India approved a project entitled "National Program for Conservation and Development of Forest Genetic Resources:

(6

Pilot Project Proposal to be implemented at FRI on Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)". The first instalment of the project 146.25 lakh has been received in third week of January 2016. A brief progress of activities for the period of January to April 2016 as per the action plan of the project has been summarized in the following points :

Progress of Works

As per the action plan of the project, activities were initiated and following four working groups have been created in FRI to achieve the targets of the project :

i. FGR Documentation
ii. FGR Seed and Germplasm Storage
iii. FGR Characterization Cell
iv. FGR Conservation Cell

The targets under the projects have been assigned to each of the working groups on individual scientist basis which is being closely monitored by the Coordinator of the project. The contractual staff required under the project has been appointed an now is in position. All the working groups have started their activities as per the assigned action plan. The brief description of the activities so far taken up has been detailed below:

A. FGR Documentation

Purchase of Mobile Herbarium Compactors

Detailed specification for purchase of herbarium compactors were made in consultation with Botanical Survey of India, Northern circle. E –tender for purchase of the compactor was floated in March 2016, unfortunately only one tender was received which was not considered by the purchase committee. The tender was floated again after making certain modifications in the specifications. The second tender is due to be opened on 13.05.2016.

Renovation of Herbarium Building

Detailed measurement and estimation of civil and electrical work with the help of Engineering Cell was prepared. Expert engineers were consulted for feasibility of herbarium building for installation of compactors. As per the expert opinion, certain modifications in the present internal structure are being considered by the engineering cell. These works are being taken up by Engineering Cell, FRI.

Digitization of DD Herbarium

The leftover works of digitalization of DD herbarium has been initiated. Till the initiation of the present project, out of the total **200** families existing in DD herbarium, digitalization of

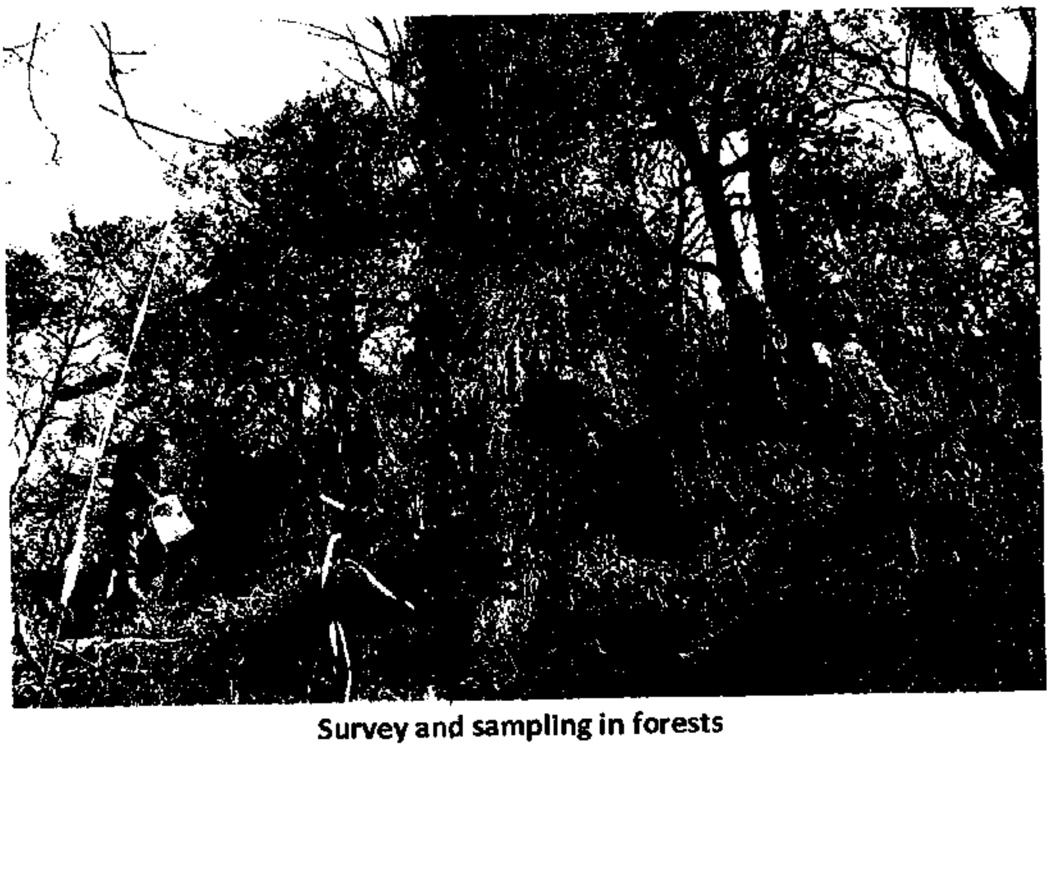
114 families were already completed in the previous projects. Since the inception of the CAMPA-CoFGR project, four more families (Columelliaceae) have been entered in to the database with complete details whereas; entry of 4 familiies viz. *Gesneriaceae, Bignoniaceae, Pedalineae* and *Acanthaceae* is under progress. Hence as on date a total of 118 families have been entered in to the database and work of 4 families is in progress.

Preparation list of selected Species

A total of 150 priority species list has been prepared. Out of which 50 species have been selected for the preparation of eco-distribution maps. Distribution of 50 species has been traced from the DD Herbarium. List of remaining 100 species is being prepared. Working plans of the respective division are being consulted.

Field Survey for distribution and regeneration

Uttarakhand has 13 districts. For smooth conduction of survey work, districts have been allotted to team members. For distribution of species, concerned division and working plan are being consulted. In addition to this, distribution of species is being worked out from the national herbaria of Uttarakhand. Field survey of Narendra Nagar, Haridwar , Chakrata and Champawat Forest Division has been made. Enumeration of species in strategic locations was recorded and regeneration of priority species was carried out.



Survey and sampling in forests

6

B. FGR Seed and Germplasm Storage

Visit to NBPGR New Delhi

A team of scientists from FRI visited National Bureau of Plant Genetic Resources, New Delhi to explore possibility of utilizing the long term storage facility of NBPGR for storage of forestry species and to obtain the information about drying process of seeds, various storage chambers, Cryo preservation cell etc. to establish comparable infrastructure at FRI. The team members had discussed the subject with Dr. R.K. Tyagi, Head, Division of Germplasm Conservation, Principal Scientists namely Dr. Kalyani Srinivasan, Plant Physiologist and Dr. Radhamani J. The objective was also to explore possibility of training of scientists of FRI on long term seed and germplasm storage. Based on the visit of scientists, process has been initiated for the training of scientists at NBPGR New Delhi and utilizing the National facility of NBPGR for long term storage of forestry species under this project.

Surveys of populations for seed collection

Under the project, it is intended to collect of seeds of 90 important FGR species of Uttrakhand in five year duration for their storage/conservation. To meet this target, surveys were conducted in different forest areas of Uttrakhand for demarcation of the populations of important FGR species and the availability of seeds. Surveys were conducted for following species in Dehradun Forest Division :

Forest Range	Species surveyed
Timli Forest Range	*Syzygium cumini* *Terminalia bellerica* *Holaptelia integrifolia* *Dalbergia sisoo* *ALbizzia procera (kalasirus)*
Ramgarh Park Range/Forest Range	*Terminalia chebula* *Ougenia oojensis* *Aegle marmelos* *Syzygium cumini* *Toona ciliata*
Lachhiwala Range	*Acacia catechu* *Dalbergia sisoo*
Rajaji Tiger Reserve, Motichur	*Ougenia oojensis* *Toona ciliata* *Bombex ceiba* *Terminallia chebula* *Terminallia bellerica*

Collection of seeds of FGRs

The team visited Radi Top area, Barkot, (Uttarkashi) for survey and seed collection of *Rhododendron arboreum* at an elevation of 2205 m. Pods were collected from this area which were in less quantity (400g with dry pods) as most of the *R. arboreum* trees were at flowering stage. Population density was measured from the collection area. Similarly seeds of *Hippophae salicifolia* (seabuck thorn) from Asnolgad, near Foolchatti at 2284 m elevation were collected.

Seeds of the following species have been collected for processing and testing at Forest Tree Seed Laboratory :

Ougenia oojensis-20 kg pods
Toona ciliate-15 Kg fruits
Aegle marmelos-13 kg fruits
Terminallia bellerica-4 kg fruits
Holoptelia integrifolia-5 kg seed (Quite light weight)

In-vitro storage of FGR species

For Developing protocols for *in-vitro* storage of germplasm of FGR species of very high conservation concern and ones having recalcitrant seeds, selected *Taxus contorta* as a target species. Explants of *Taxus contorta* collected from forest near Deovan (Chakrata) and Micropropagation trial initiated. Similarly explants of *Rhododendron arboreum* collected from forest area near Kaddukhal (Tehri/Musoori) and Micropropagation trial initiated.

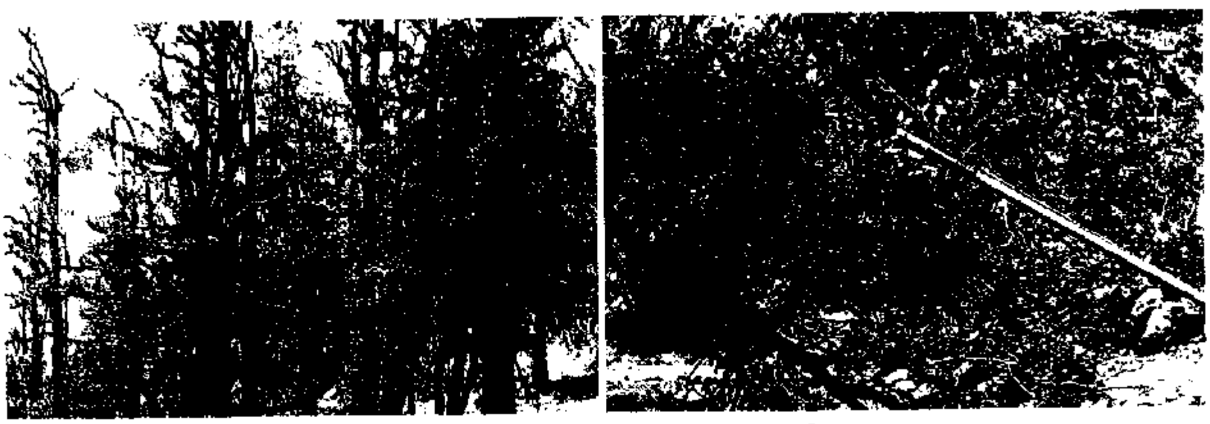
C. FGR Characterization Cell

Ten priority species have been identified for molecular characterization and genetic diversity estimation, out of which 6 species have been sort listed for immediate attention and initiation of work. The selected species are :

- *Rhododendron arboreum* (and other species also)
- *Texas wallichiana* (Thuner)
- *Quercus semicarpifolia (& Q. lanuginose)* (Kharsu oak and Rianj Oak)
- *Betula utilis* (Bhojpatra)
- *Myrica esculanta* (Kafal)
- *Diploknema butyreacea* (butter tree)

Collection of Samples: Extensive survey and sampling work has been initiated in Uttrakhand hills for the selected species. Samples of four species (*Rhododendron arboreum* var red, *Rhododendron arboreum* var pink, *Texas wallichiana* and *Quercus semicarpifolia*) have been collected from their natural zone of occurrence and stored at -80⁰ C. A total of 30 samples/trees were collected from each population in all the species. So far 16 populations have been sampled from Uttrakhand along with their geographical coordinates. The samples of these populations were segregated for chemical examination and DNA fingerprinting. The detail of the sampled populations is given in the following table :

Species	Population	Location
***Rhododendron arboreum* var red**	RA01	Kanchula Kharg, Chamoli
	RA02	Chopta, Chamoli
	RA03	Janglat Chowki, Chakrata, Dehradun
	RA04	Budher, Chakrata, Dehradun
	RA05	Near Nagthala, Churani, Chakrata, Dehradun
***Rhododendron arboreum* var pink**	RP01	Kanchula Kharg, Chamoli
	RP02	Chopta, Chamoli
Texas wallichiana	TB01	Kanchula Kharg, Chamoli
	TB02	Chopta, Chamoli
	TB03	Devban, Chakrata, Dehradun
	TB04	Bhujkoti, Chakrata, Dehradun
Quercus semicarpifolia	QS01	Kanchula Kharg, Chamoli
	QS02	Chopta, Chamoli
	QS03	Devban, Chakrata, Dehradun
	QS04	Bhujkoti, Chakrata, Dehradun
	QS05	Lokhandi, Chakrata, Dehradun



Sampling in *Quercus semicarpifolia* forest

Collection of samples for DNA fingerprinting

Genomic DNA extraction: Different protocols were tried for DNA extraction from *Rhododendron arboreum* and finally on the basis of concentration (ng/µl) and purity ($A_{260/280}$), the CTAB method given by Doyle and Doyle, 1990 was used for DNA extraction. The same protocol resulted in good yield of Genomic DNA in remaining three species. Genomic DNA has been extracted from the following 7 populations:

Species	DNA extraction done
Rhododendron arboreum var red	RA01, RA02
Rhododendron arboreum var pink	RP01, RP02
Texas wallichiana	TB01, TB02, TB03
Quercus semicarpifolia	QS01 is in progress

Quantitative and Qualitative analysis of Genomic DNA: The concentration and absorbance ratio (A_{260}/A_{280} nm) of the DNA samples were quantified using Biophotometer (Eppendorf-6131, Germany). The quality of extracted DNA was analyzed on 0.8% agarose gel.

Different variants of *Rhododendron* in Uttrakhand

Chemical Characterization : For chemical marker(s) assisted screening of *Rhododendron arboretum* and characterization of the elite accessions / genotypes desired numbers of flower samples of two population lines grown in Janglat Chowki, Kanasar Village, Charata and Budher, Kanasar Village, Charata were collected. The collected flowers were extracted with acidulated methanol. Some of the extracts were concentrated in vaccum and their yields were determined. Experiments for determining the total flavonoid contents in these extracts using spectrophotometric method were initiated and continued.

D. FGR Conservation

Five priority species have been sort listed for FGR Conservation as per the target of the project. The species are *Cinnamomum tamala, Diploknema butyracea, Rhododendron arboretum, Myrica esculanta* and *Taxus wallichiana*. Scientists have visited forest areas at Chakrata area for exploring the possibility of field gene banks.

National Program for
Conservation and Development of Forest Genetic Resources

Pilot Project Proposal

to be implemented at FRI, Dehradun

on

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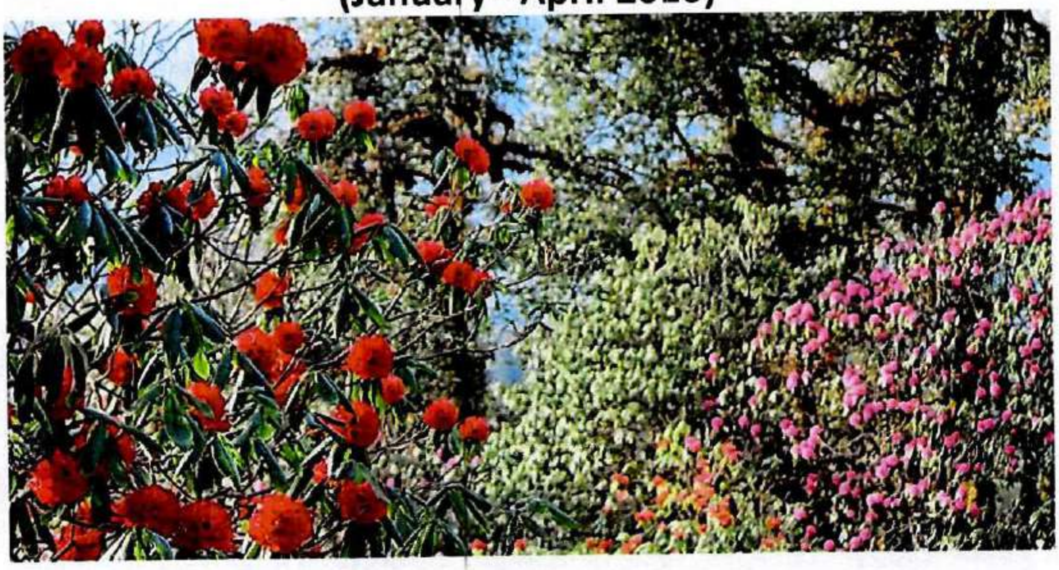

Submitted by

Forest Research Institute (FRI),
New Forest P.O., Dehradun 248 006.

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Collection of seeds of FGRs

The team visited Radi Top area, Barkot, (Uttarkashi) for survey and seed collection of *Rhododendron arboreum* at an elevation of 2205 m. Pods were collected from this area which were in less quantity (400g with dry pods) as most of the *R. arboreum* trees were at flowering stage. Population density was measured from the collection area. Similarly seeds of *Hippophae salicifolia* (seabuck thorn) from Asnolgad, near Foolchatti at 2284 m elevation were collected.

Seeds of the following species have been collected for processing and testing at Forest Tree Seed Laboratory :

Ougenia oojensis-20 kg pods
Toona ciliate-15 Kg fruits
Aegle marmelos-13 kg fruits
Terminallia bellerica-4 kg fruits
Holoptelia integrifolia-5 kg seed (Quite light weight)

***In-vitro* storage of FGR species**

For Developing protocols for *in-vitro* storage of germplasm of FGR species of very high conservation concern and ones having recalcitrant seeds, selected *Taxus contorta* as a target species. Explants of *Taxus contorta* collected from forest near Deovan (Chakrata) and Micropropagation trial initiated. Similarly explants of *Rhododendron arboreum* collected from forest area near Kaddukhal (Tehri/Musoori) and Micropropagation trial initiated.

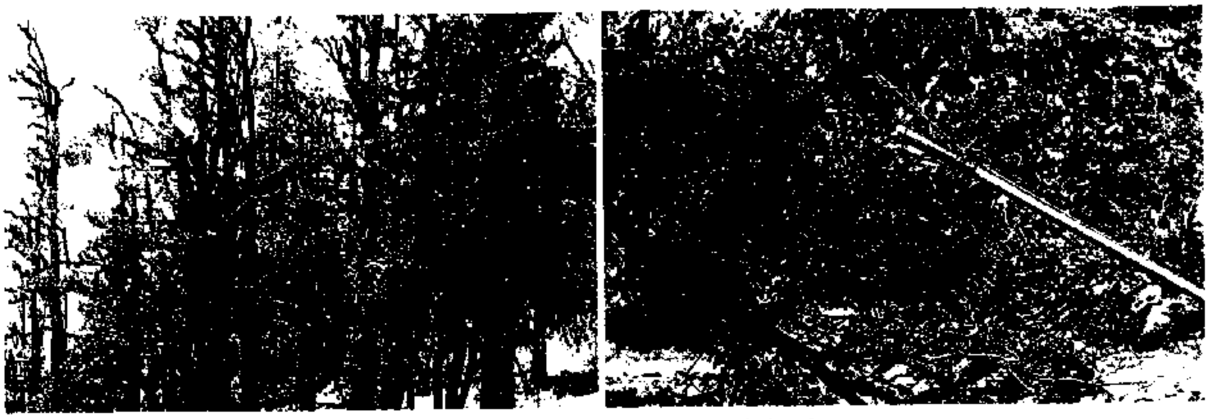
C. FGR Characterization Cell

Ten priority species have been identified for molecular characterization and genetic diversity estimation, out of which 6 species have been sort listed for immediate attention and initiation of work. The selected species are :

- *Rhododendron arboreum* (and other species also)
- *Texas wallichiana* (Thuner)
- *Quercus semicarpifolia (& Q. lanuginose)* (Kharsu oak and Rianj Oak)
- *Betula utilis* (Bhojpatra)
- *Myrica esculanta* (Kafal)
- *Diploknema butyreacea* (butter tree)

Collection of Samples: Extensive survey and sampling work has been initiated in Uttrakhand hills for the selected species. Samples of four species (*Rhododendron arboreum* var red, *Rhododendron arbareum* var pink, *Texas wallichiana* and *Quercus semicarpifolia*) have been collected from their natural zone of occurrence and stored at -80⁰ C. A total of 30 samples/trees were collected from each population in all the species. So far 16 populations have been sampled from Uttrakhand along with their geographical coordinates. The samples of these populations were segregated for chemical examination and DNA fingerprinting. The detail of the sampled populations is given in the following table :

Species	Population	Location
***Rhododendron arboreum* var red**	RA01	Kanchula Kharg, Chamoli
	RA02	Chopta, Chamoli
	RA03	Janglat Chowki, Chakrata, Dehradun
	RA04	Budher, Chakrata, Dehradun
	RA05	Near Nagthala, Churani, Chakrata, Dehradun
***Rhododendron arboreum* var pink**	RP01	Kanchula Kharg, Chamoli
	RP02	Chopta, Chamoli
Texas wallichiana	TB01	Kanchula Kharg, Chamoli
	TB02	Chopta, Chamoli
	TB03	Devban, Chakrata, Dehradun
	TB04	Bhujkoti, Chakrata, Dehradun
Quercus semicarpifolia	QS01	Kanchula Kharg, Chamoli
	QS02	Chopta, Chamoli
	QS03	Devban, Chakrata, Dehradun
	QS04	Bhujkoti, Chakrata, Dehradun
	QS05	Lokhandi, Chakrata, Dehradun



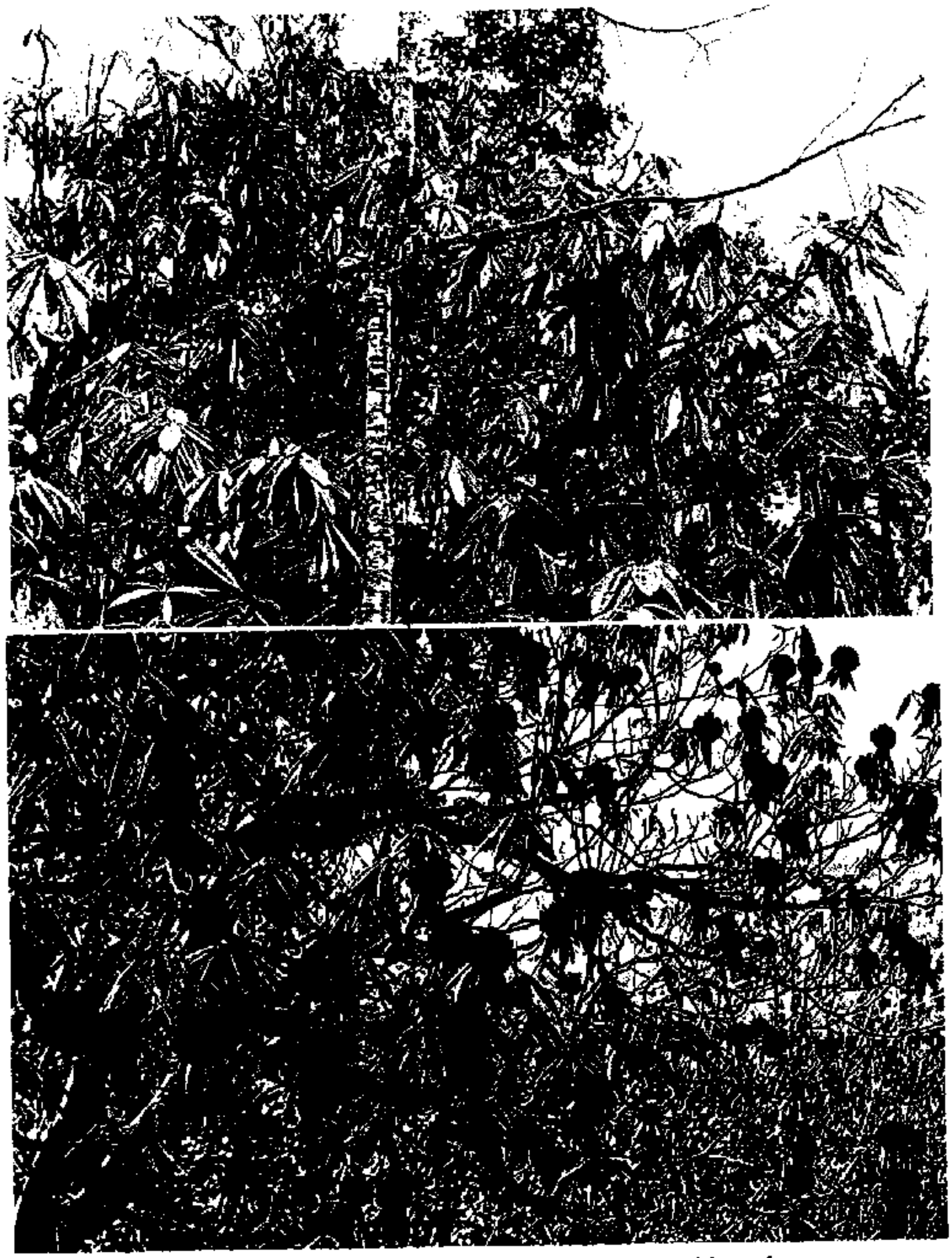
Sampling in *Quercus semicarpifolia* forest

Collection of samples for DNA fingerprinting

Genomic DNA extraction: Different protocols were tried for DNA extraction from *Rhododendron arboreum* and finally on the basis of concentration (ng/µl) and purity ($A_{260/280}$), the CTAB method given by Doyle and Doyle, 1990 was used for DNA extraction. The same protocol resulted in good yield of Genomic DNA in remaining three species. Genomic DNA has been extracted from the following 7 populations:

Species	DNA extraction done
Rhododendron arboreum var red	RA01, RA02
Rhododendron arboreum var pink	RP01, RP02
Texas wallichiana	TB01, TB02, TB03
Quercus semicarpifolia	QS01 is in progress

Quantitative and Qualitative analysis of Genomic DNA: The concentration and absorbance ratio (A_{260}/A_{280} nm) of the DNA samples were quantified using Biophotometer (Eppendorf-6131, Germany). The quality of extracted DNA was analyzed on 0.8% agarose gel.



Different variants of *Rhododendron* in Uttrakhand

Chemical Characterization : For chemical marker(s) assisted screening of *Rhodadendron arboretum* and characterization of the elite accessions / genotypes desired numbers of flower samples of two population lines grown in Janglat Chowki, Kanasar Village, Charata and Budher, Kanasar Village, Charata were collected. The collected flowers were extracted with acidulated methanol. Some of the extracts were concentrated in vaccum and their yields were determined. Experiments for determining the total flavonoid contents in these extracts using spectrophotometric method were initiated and continued.

D. FGR Conservation

Five priority species have been sort listed for FGR Conservation as per the target of the project. The species are *Cinnamamum tamala, Diploknema butyracea, Rhadadendron arboretum, Myrica esculanta* and *Taxus wallichiana.* Scientists have visited forest areas at Chakrata area for exploring the possibility of field gene banks.

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डॉ० सविता, भा.व.से.
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एवं
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(पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार की एक स्वायत्त परिषद्)
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FOREST RESEARCH INSTITUTE
(Indian Council of Forestry Research and Education)
(An autonomous body of Ministry of Environment, Forests & Climate Change Govt. of India)
P.O. New Forest, Dehra Dun—248006

अ०शा०सं० D.O.No 9-108/DGTP-CoFGR/FRI 2016

दिनांक Dated, the Date 5-08-2016

To,

The Inspector General of Forests /
Chief Executive Officer (CEO), Ad-hoc CAMPA
Ministry of Environment, Forest and Climate Change
Indira Paryavaran Bhavan
Jorbagh Road
New Delhi - 110 003

O/o AIGF (FC)
Dy. No. 1234/AIGF(FC)
Date 19.9.16

Kind attention: Shri Rajagopal Prashant, AIG (FC)

Sub : **Adhoc CAMPA project - National Program for Conservation and Development of Forest Genetic Resources: Pilot Project Proposal to be implemented at FRI, Dehradun – Quarterly Progress Report reg.**

O/o IGF
Dy. No. 1234/IGF
Date 19.9.2016

Sir,

Please find enclosed two copies of the progress report of the subject cited project, for the period of January – June 2016. The report of the first quarter has already been submitted to your office.

You are requested to kindly release the balance 50 % amount of the first year project outlay at the earliest as many of the activities and procurement processes of the current year are under mid way.

examine and put up
19/9

AIGF(BA)
OSD/CAMPA 19/9

Encl. As above

Yours faithfully

5/08
(Dr. Savita)
Director

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National Program for
Conservation and Development of Forest Genetic Resources

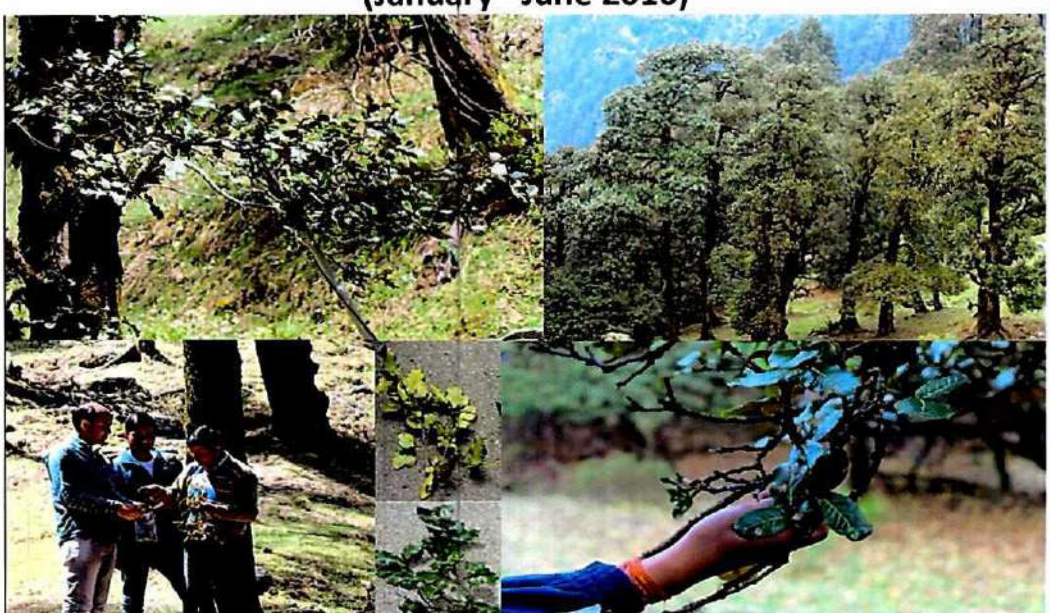
Pilot Project
(Implemented at FRI, Dehradun)

on

Creation of Centre of Excellence on Forest Genetic Resources (FGR) of India (CoFGR)

Funded under
Adhoc CAMPA Fund
Ministry of Environment, Forest & Climate Change
(2016-2020)

Progress Report
(January - June 2016)



Submitted by

Forest Research Institute (FRI),
New Forest P.O., Dehradun 248 006.

Project Summary

Title of the Project :	National Program for Conservation and Development of Forest Genetic Resources : Pilot Project Proposal to be implemented at FRI on Creation of Centre of Excellence on Forest Geetic Resources (CoFGR)
Funding Agency :	Adhoc CAMPA Fund Ministry of Environment, Forest & Climate Change, Govt. of India
Project Outlay:	Rs. 861.20 lakh (January 2016 – 31 December 2020)
Project Period :	5 years
Grants released :	1st installment - 146.25 lakh
Date of release :	1st installment on 21st January 2016
Project Executing Authority:	Director Forest Research Institute, Dehradun
Period of present progress report :	Cumulative progress upto 30th June 2016

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Background Information

Forest Genetic Resources (FGRs) constitute a very important sub-set of biodiversity Conserving FGR is vital, as they are unique and irreplaceable resources for the future. In India alone, more than 340 million people are estimated to be dependent upon the FGRs for their livelihoods. There is a definite need to address the FGR related issues through a comprehensive FGR conservation and development strategy and implementation plan.
As per present state of knowledge, 18,236 higher plant species (18,159 Angiosperms and 77 Gymnosperms) documented from India so far (*BSI, 2015: Plant Discoveries 2014*). More than 80% of this higher plant diversity is contained in the forest habitats (≈14,500 species). About half of this forest plant diversity constitutes FGRs (≈7,250 species), the remaining being herbaceous flora including soft climbers, twiners, herbs, and grasses. FGRs contain a huge potential in ensuring food and health security of the country's burgeoning human population and its livestock.

To generate understanding and knowledge on FGR, and to develop and strengthen in situ and ex situ FGR conservation programmes, the National CAMPA Advisory Council (NCAC) of Ministry of Environment and Forests & Climate Change, Govt. of India has sanctioned a project entitled "National Program for Conservation and Development of Forest Genetic Resources: Pilot Project Proposal to be implemented at FRI on Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)". The first instalment of the project 146.25 lakh was received in third week of January 2016. A brief progress of activities for the period of **January to June 2016** as per the action plan of the project has been summarized in the following points :

Progress of Works

As per the action plan of the project, activities were initiated and following four working groups have been created in FRI to achieve the targets of the project :

i. FGR Documentation
ii. FGR Seed and Germplasm Storage
iii. FGR Characterization Cell
iv. FGR Conservation Cell

The targets under the projects have been assigned to each of the working groups on individual scientist basis which is being closely monitored by the Coordinator of the project. The contractual staff required under the project has been appointed an now is in position. All the working groups have started their activities as per the assigned action plan. The brief description of the activities so far taken up has been detailed below:

A. FGR Documentation

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1. Upgradation of DD Herbarium:

Purchase of Mobile Herbarium Compactors

Detailed specification for purchase of herbarium compactors were made in consultation with Botanical Survey of India, Northern circle. E –tender for purchase of the compactor was floated in March 2016, unfortunately only one tender was received which was not considered by the purchase committee. The tender was floated again after making certain modifications in the specifications. The whole process of tendering was repeated three times and now finally the supply order has been placed for purchase and installation of compactors in the herbarium of FRI. The installation of the compactors will facelift the existing old herbarium and will help to safeguard the documentation/preserved samples of the valuable genetic resource of the country.

Renovation of Herbarium Building

Detailed measurement and estimation of civil and electrical work with the help of Engineering Cell was prepared. Expert engineers were consulted for feasibility of herbarium building for installation of compactors. As per the expert opinion, keeping in view the load of compactors per square meter, these compactors could be installed in the herbarium section at the ground floor only with certain modifications in the present internal structure which are being considered by the engineering cell. These works are being taken up by Engineering Cell, FRI.

Listing and Prioritization of the FGR Species

A list of total 150 priority species out of 250 has been prepared. Out of which 50 species have been selected for the preparation of eco-distribution maps. The criteria used for the selection of the species were i) indigenous occurrence ii) woody perennial iii) species that are of economic, environmental, scientific or social value iv) threat perception on the species. Distribution of 100 species has been traced form the DD Herbarium. List of remaining 100 species is under progress with the consultation from expert members/ working plans of the respective divisions/ literary work from respective areas etc.

Field Survey for distribution and regeneration

Species wise geographical location for field survey is being collected from the literature survey/ forest working plans and herbaria based information. For smooth conduction of survey work, districts have been allotted to team members. For distribution of species, concerned division and working plan are being consulted. In addition to this, distribution of species is being worked out from the national herbaria of Uttarakhand. Field survey of five districts (6 Forest Divisions) viz. Dehradun (Narendra Nagar, Chakrata) Haridwar, Champawat, Almora and Pithoragarh Forest Division were carried out. Enumeration of species in strategic locations was carried out and regeneration of priority species was recorded.

Collection of field data from (a) pure chir pine forest and (b) mixed forest from Ranikhet Range of Almora Forest Division

Collection of field data from Pithoragarh Forest Division

Collection of field data from Champawat Forest Division

Development of Eco distribution maps of important FGRs

Development of mapping methodology

For development of mapping methodology and sampling technique, the project team discussed and had a series of meetings and brain storming sessions with the experts of this field from Indian Institute of Remote Sensing, Forest Survey of India, Wild Life Institute of

India, Uttrakhand Space Application Centre, Director Rajaji National Park, ICFRE etc. Based on the discussions with the experts and review of literature, following plan of action was prepared for the development of eco-distribution maps of the FGR species.

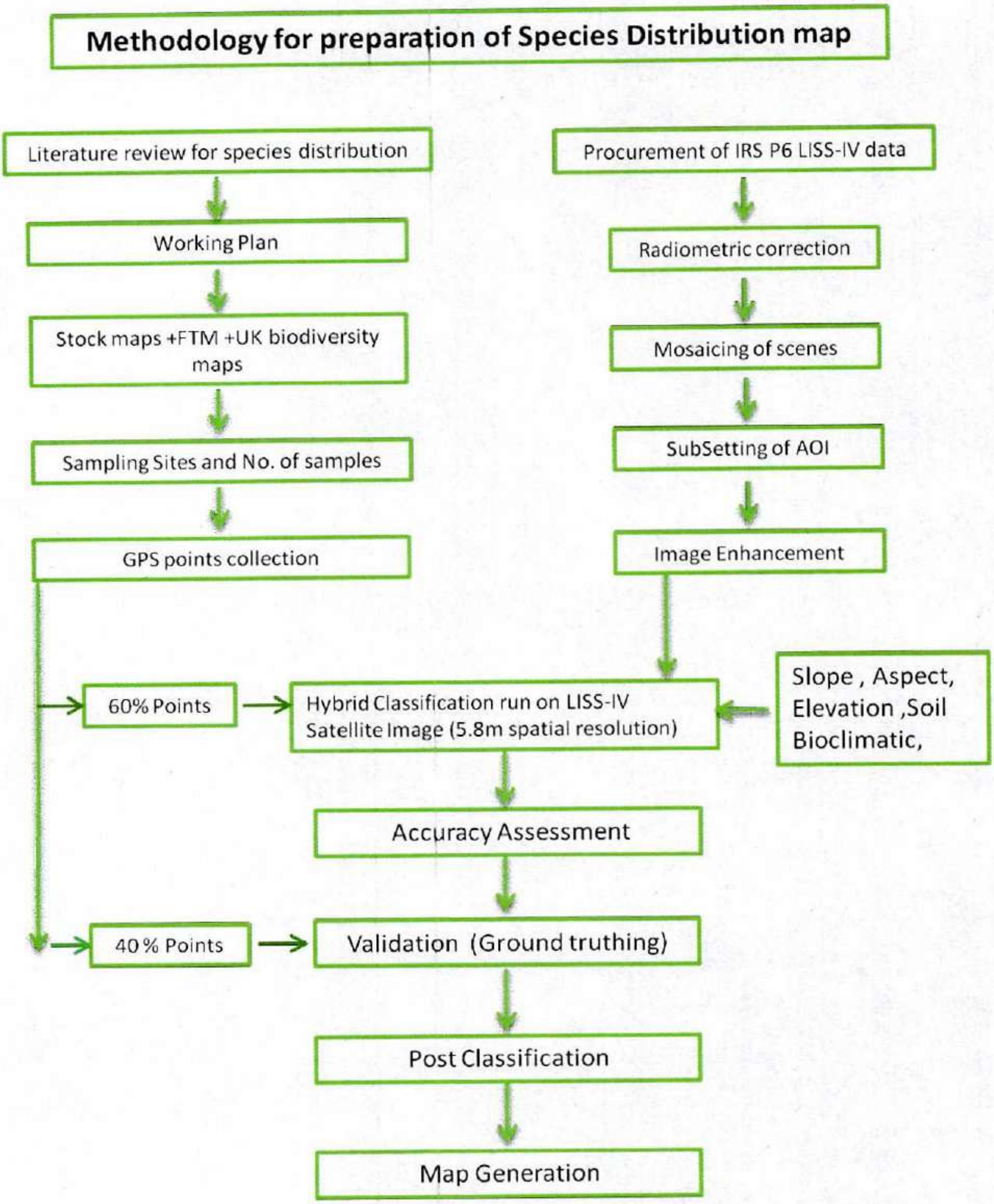

Fig . Flow chart showing the methodology for preparation of species distribution map

Sampling Methodology

To collect GPS points of species, sampling methodology was developed. For image classification, LISS-IV image will be used. LISS-IV has spatial resolution of 5.8m x5.8m, means one pixel of image cover $33.64m^2$ on the ground. Therefore, sampling plot size was set as 6m x 6m = $36m^2$. Data on plant height, DBH, latitude, longitufe and altitude will be recorded on the number of species covered under plot size $36m^2$.

Testing of Methodology

Field visits were carried out in the Mohand and Sukhblock of Chilllawalii Range, Rajaji National Park, Dehradun (Uttrakhand). This area is 80 % (approx.) hilly and cover mostly with mix deciduous forest. A total of 80 sample points/GPS locations each of 6 m x 6 m were laid down in a track of 40 kms and various parameters recorded.

Mohand and Sukh Block, Rajaji National Park, Date of data taken 11-12 June, 2016

Fig . Collections of GPS points and other information during field survey

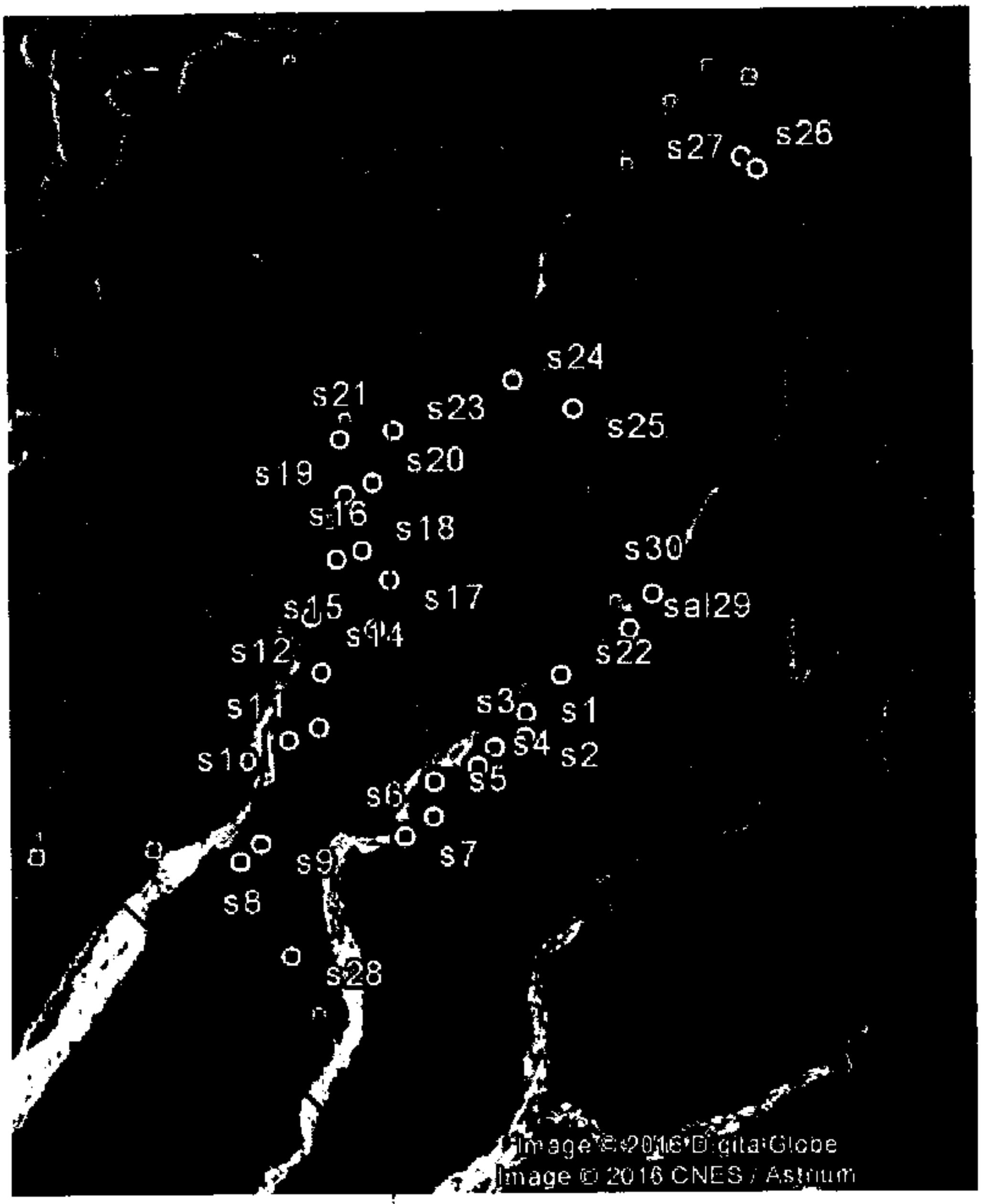

Fig . GPS points of Sal species in Mohand and Sukhblock area

Mapping

After the collection of the GPS points, supervised image classification algorithm run on LANDSAT-8 (freely available satellite data). Only 60% points were used to trained satellite data for showing Sal forest and rest of 30 % points used for accuracy assessment.

Conclusion

The forest area in Mohand and Sukh block of Chillawalli Range, Rajaji National Park works out to be 8.86 square km area under the Sal cover. This estimation is quite similar to the FSI Forest Type Report (Satellite Image LISS III used) and working plan (methodology not known to us) for Rajaji National Park. This indicates the reliability and accurateness of the adopted methodology.

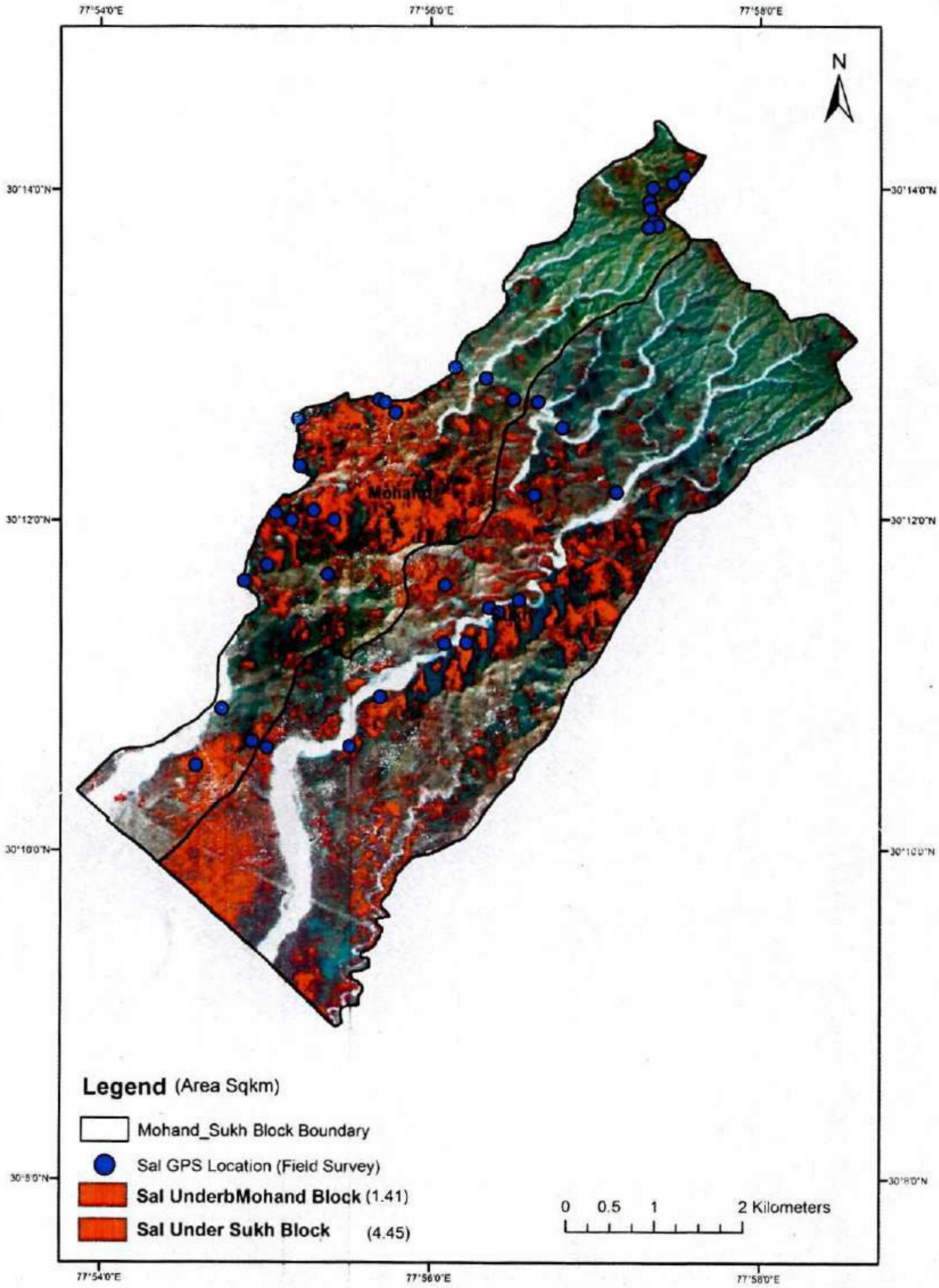

Fig. Distribution of Sal forest in Mohand and Sukh block, Chillawalli Range (Map) using the developed methodology bwo

B. FGR Seed and Germplasm Storage

Visit to NBPGR New Delhi

A team of scientists from FRI visited National Bureau of Plant Genetic Resources, New Delhi to explore possibility of utilizing the long term storage facility of NBPGR for storage of forestry species and to obtain the information about drying process of seeds, various storage chambers, Cryo preservation cell etc. to establish comparable infrastructure at FRI. The objective was also to explore possibility of training of scientists of FRI on long term seed and germplasm storage. Based on the visit of scientists, process initiated for the training of scientists at NBPGR New Delhi and utilizing the National facility of NBPGR for long term storage of forestry species under this project.

Training at NBPGR New Delhi

As per the request of FRI, National Bureau of Plant Genetic Resources (NBPGR) New Delhi organised a training course on "Techniques for of Conservation of Plant Genetic Resources" from 27th June to 2nd July, 2016. Ten Scientists and research personnel working in various components of CoFGR-CAMPA project, participated in the training. The training covered following topics with hands-on practical experience and was very much helpful for the skill upgradation of the scientists on the aspect of FGR conservation, exploration and characterization under the project:

Activity
Lecture 1 - Conservation of plant genetic resources: Principles and practices
Lecture 2 – Plant exploration and collection of genetic resources
Practical 1 -Handling of Germplasm for Pest-Free Conservation
Practical 2- Germination testing in different media
Practical 3- Germination and moisture testing
Lecture 3 – Information Management in conservation of PGR
Practical 4- Database handling
Practical 5 - Germination and moisture testing (continued from previous day)
Practical 6 - Dormancy breaking treatments
Lecture 4 – Categorization of seeds and identifying appropriate conservation methods and seed drying
Practical 7 - Seed drying (including ultra-drying) and packaging
Practical 8 - Molecular techniques used in conservation of plant genetic resources
Practical 9 - Tetrazolium test for quick estimation of viability

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Lecture 5 - Seed health testing for conservation of PGR
Practical 10 - Seed health testing using conventional and modern methods
Practical 11 - Seed health testing using conventional and modern methods (continued)
Lecture 6 - Plant tissue culture: Principles and practices
Practical 12- Preparation of stock solutions and media, sterilization techniques
Practical 13- Culture establishment (aseptic techniques and explant preparation), shoot induction and multiplication
Lecture 7 - In vitro conservation: Principles and practices
Lecture 8 - Tree tissue culture: Bottlenecks and opportunities
Practical 14 - Methods for cost effective conservation of germplasm
Lecture 9 – Disease indexing of plant tissue cultures
Lecture 10 - Somaclonal variation in PTC: Impediment or Opportunity?

The training was very useful for all the participants and techniques learnt regarding processing and desiccating seeds for medium to long-term conservation will be used under the component.

Some glimpses of the training

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Survey of populations for seed collection

In order to capture sufficiently large genetic diversity in a species, seeds from at least five populations of each species have been planned for their medium term/long term storage. Hence, population survey was conducted in various ranges of some Forest Divisions of Uttarakhand and identified the population of following species for seed collection:

Locations	Species identified
Kansro Forest Range, Dehradun Forest Division	*Adina cordifolia* (haldu) *Aegle marmelos* (bel) *Albizia procera* (siris) *Holoptelia integrifolia* (kanju papri) *Lannea grandis* (jhingan) *Schleichera oleosa (kusum)* *Terminalia bellirica* (bahera)
Rishikesh Forest Range, Dehradun Forest Division	*Aegle marmelos* (bel) *Albizia procera* (siris) *Bombax ceiba* (semal) *Holoptelia integrifolia* (kanju papri)
Gaula Range Forest, Haldwani Forest Division	*Albizia odoratissima* (kali Siris) *Acacia catechu* (khair)
Kishanpur Forest Range, Haldwani Forest Division	*Bombax ceiba* (semal) *Lagerstroemia parviflora* (Dhauri)
Haldwani Forest Range, Central Tarai Forest Division, Haldwani	*Adina cordifolia* (haldu) *Albizia procera* (safed siris)
Chhakata Range, East Tarai Forest Division, Haldwani	*Acacia catechu* (khair) *Adina cordifolia* (haldu) *Holoptelia integrifolia* (kanju papri)
Tanda Range Central Tarai Forest Division, Haldwani	*Acacia catechu* (khair) *Garuga pinnata* (kharpat) *Mallotus philippensis* (rohini) *Toona ciliata* (tun)
Pipalpadav Forest Range Central Tarai Forest Division, Haldwani	*Acacia catechu* (khair) *Bombax ceiba* (semal)
Fatehpur Forest Range, Ramnagar Forest Division	*Adina cordifolia (haldu)* *Aegle marmelos* (bel) *Anogeissus latifolia* (bankuli) *Bombax ceiba* (semal) *Dalbergia sissoo* (shisham) *Holoptelia integrifolia* (kanju papri) *Desmodium oojeinensis* (sandhan) *Schelichera oleosa* (kusum) *Terminalia bellirica* (bahera) *Toona ciliata* (tun)
Bhakhra Forest Range Central Tarai Forest Division, Haldwani	*Aegle marmelos* (bel) *Emblica officinalis (aonla)*

Barhani Forest Range Central Tarai Forest Division, Haldwani	*Acacia catechu* *Aegle marmelos* (bel) *Bombax ceiba* (semal) *Holoptelia integrifolia* (kanju papri) *Mallotus philippensis* (rohini)
Nandhaur Forest Range Tarai East Forest Division, Haldwani	*Acacia catechu* *Adina cordifolia (haldu)* *Dalbergia sissoo* (shisham) *Dioscorea bulbifera* (genthi) *Desmodium oojeinensis* (sandhan) *Schleichera oleosa (kusum)*
Barakoli Forest Range, Sitarganj Tarai East Forest Division, Haldwani	*Acacia catechu* (khair) *Dalbergia sissao* (shisham) *Dalbergia sissoo* (shisham) *Holoptelia integrifolia* (kanju papri) *Schleichera oleosa (kusum)*
Kaladhoongi Forest Range, Ramnagar Forest Division	*Adina cordifalia (haldu)* *Anageissus latifolia* (bankuli) *Lannea grandis* (jhingan) *Schleichera oleosa (kusum)*
Almora Forest Range, Almora Forest Division	*Myrica esculenta* (kaphal) *Quercus leucotrichophora* (banj oak) *Toona ciliata* (tun)
Someswar Forest Range, Almora Forest Division	*Quercus glauca* (phaliyant) *Quercus leucotrichophora* (banj oak) *Rhododendron arboreum* (burans)
Ranikhet Forest Range, Almora Forest Division	*Myrica esculenta* (kaphal) *Quercus leucotrichophora* (banj oak)

Collection of seed

Seeds of following species were collected:

Species	**Fruit/pod Qty.**	**Site of Seed Collection**
Aegle marmelos *Terminalia bellirica* *Holoptelea integrifolia*	13 kg fruits 5 kg fruits 500 g	Kansro Forest Range, Dehradun Forest Division
Holoptelea integrifolia	0.500 kg	Timli Forest Range Dehradun Forest Division
Desmodium oojeinensis *Toona ciliata*	20 kg Pods 15 kg fruits	Rajaji Tiger Reserve, Dehradun Forest Division
Aegle marmelos	81 kg fruits	Fatehpur Forest Range, Haldwani
Toona ciliata	60 Kg fruits	Almora Forest Range, Almora Forest Division

Seed collection of *Desmodium oojeinensis* and *Rhododendron arboreum*

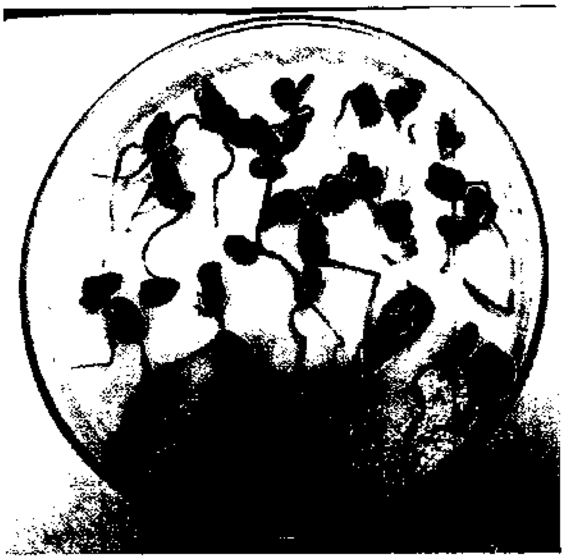
Seed extraction and processing

Seeds was extracted from the fruits, cleaned and processed for further tests. Initial parameters on seed weight, seed moisture content, seed germination, etc. were recorded

Seed extraction

Seed germination in *Hippophae salicifolio* and *Holoptelio intergrifolio*

Seed germination in *Desmodium oojeinensis* and *Toono cilioto*

Procurement and repair of lab equipments

E tender floated for procurement of seed drier and incubator. Procurement of few office items such as printer has been completed. Repairing of few laboratory equipments is under progress.

***In-vitro* storage of FGR species**

For Developing protocols for *in-vitro* storage of germplasm of FGR species, following activities have been planned:

- Developing protocols for *in-vitro* storage of germplasm of FGR species of very high conservation concern and ones having recalcitrant seeds
- Developing protocols for storage of germplasm of red-listed species of FGR in the form of 'pollens'
- Maintaining minimal growth cultures and embryo cultures

As the prerequisite for the development of any *in vitro* conservation methods for storage of FGR (in this case either FGR of very high conservation concern or those having recalcitrant seeds or both) is the availability of a standardized *in vitro* regeneration protocol. Thus experiments have been initiated to devise *in vitro* regeneration or micropropagation protocols for selected species as given below:

a) *Rhododendron arboreum*
b) *Taxus contorta*
c) *Desmodium oojeinensis*
d) *Quercus floribunda*
e) *Q. semecarpifolia*

a) *Rhododendron arboreum*

Plant sample collection: Mussourie and Chakrata area of Dehradun and Mazgaon (Tehri Garhwal), Uttarakhand.

i) Culture Initiation from nodal explants:

Culture Initiation: nodal explants were cultured in Murashige & Skoog's medium (MS), Driver-Kuniyuki Walnut medium (DKW) and Anderson's Medium (AM) supplemented with different concentrations of plant growth regulators viz. 6-Benzylaminopurine (BAP) and 2, 4 dichlorophenoxyacetic acid (2,4 D)

S.No.	Culture Initiation Medium
1.	1/10 strength MS (pH 5.8) + 1(mg/l) BAP
2.	1/10 MS(pH 5.8) + 2 mg/l BAP
3.	1/10 MS(pH 5.8) + 3 mg/l BAP
4.	1/10 MS(pH 5.8) + 4 mg/l BAP
5.	1/10 MS(pH 5.8) + 1 mg/l BAP+ 1 mg/l 2,4-D
6.	MS (pH 4.8)+ 1mg/l BAP+ 1 mg/l 2,4-D
7.	DKW (pH 4.8)+1.5 mg/l BAP
8.	DKW (pH 4.8)+ 2 mg/l BAP
9.	DKW (pH 5.8)+1.5 mg/l BAP
10.	DKW (pH 5.8)+ 2 mg/l BAP
11.	AM (pH 4.8)+1.5 mg/l BAP
12.	AM (pH 4.8)+2 mg/l BAP

13.	AM (pH 5.8)+1.5 mg/l BAP
14.	AM (pH 5.8)+2 mg/l BAP
15.	1/10 MS (pH 4.5) + 5 mg/l BAP+ 100 mg/l casein hydrolysate
16.	1/10 MS (pH 4.5) + 5 mg/l Kinetin+ 100 mg/l casein hydrolysate
17.	1/10 MS (pH 4.5) + 5mg/l BAP+ 25 mg/l Adenine sulfate
18.	1/10 MS (pH 4.5) + 5mg/l Kinetin+ 25 mg/l Adenine sulfate

***In vitro* response:** Nodal segments cultured on different growth medium combinations did not show any axillary or adventitious bud break or callus formation in cultures. Bacterial and fungal contamination in cultures was also a challenge in the establishment of *in vitro* cultures. Standardization of effective concentration of sterilants, duration of treatments and concentrations of plant growth regulator etc. is further ongoing in order to overcome the problem of microbial contaminations and achieve successful culture establishment

Fig.: Culture initiation of nodal segments of *R. arboreum*

ii) **Culture Initiation from leaf explants**

Culture Initiation: Small sections of leaves were cultured on MS medium supplemented with different concentrations of BAP and 2, 4-D to initiate callus cultures.

S.No	MS Medium Combinations at pH 5.8	Response	Textures of callus	Intensities of callus
1	0.5 mg/l BAP+0.5 mg/l 2,4-D	Callus induction started	yellowish	+++
2	0.5 mg/l BAP+1 mg/l 2,4-D	Leaf curling with little callus induction	Greenish yellow	++
3	2 mg/l BAP+1 mg/l 2,4-D	Primarily only leaf curling	No callus	0
4	4 mg/l BAP+2 mg/l 2,4-D	leaf curling and leaf browning	Negligible amount of yellowish callus	+
5	MS (pH 4.5) + 1 mg/l kinetin+2 mg/l IAA	Under observation	-	-
6	MS (pH 4.5) + 1 mg/l kinetin+2 mg/l 2,4D	Under observation	-	-
7	MS (pH 4.5) + 0.5 mg/l BAP+1 mg/l IBA	Under observation	-	-
8	MS (pH 4.5) + 0.5 mg/l BAP+ 0.5 mg/l 2,4-D	Under observation	-	-

***In vitro* response:** callus formation was initiated in some of the cultures and these are now under multiplication and will be used to induce somatic embryogenesis or organogenesis.

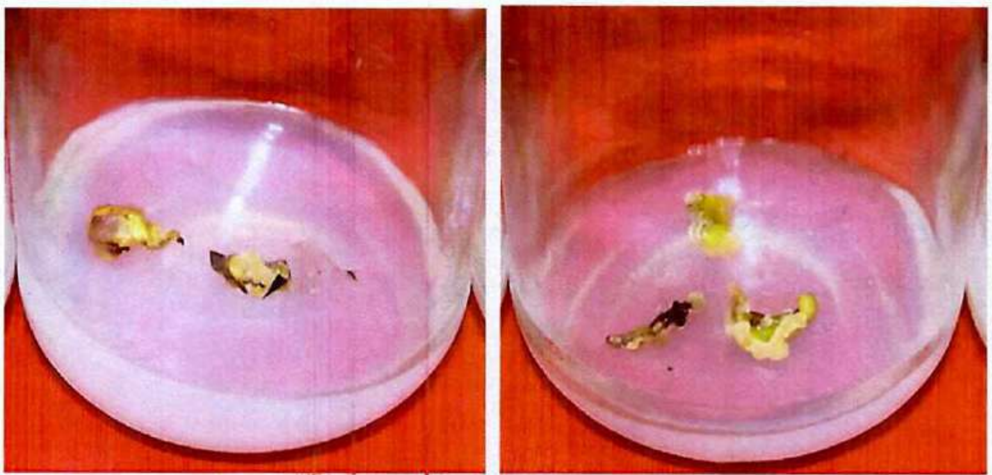


Fig.: Callus formation from leaf explants of *R. arboreum*

b) Taxus contorta

Plant Sample Collection: Deoban, Chakrata area of Dehradun, Uttarakhand.

Culture initiation from nodal explants: current year growth i.e. green and soft tissue of stem was taken for culture initiation. Nodal explants were cultured in Murashige & Skoog's medium (MS) supplemented with different concentrations of plant growth regulators viz. 6-Benzylaminopurine (BAP) and 2, 4 dichlorophenoxyacetic acid (2,4 D)

S.No.	Culture Initiation Medium
1	MS+ 2 mg/L 2,4-D
2	MS+ 2 mg/L 2,4-D + 5 mg/L Activated Charcoal (Hussain et al., 2013)
3	MS+ 2 mg/L BAP (Hussain et al., 2013)

***In vitro* response:** Callus formation initiated in some of the cultures. New shoot bud initiation unsuccessful due to contamination and necrosis of cultures.

Fig.: culture initiation of shoot segments of *T. contorta*

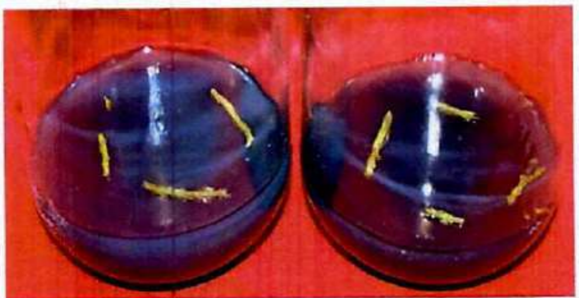


Fig.: culture initiation of shoot segments of *T. contorta* on activated charcoal containing medium

Fig.: Callus formation from shoot explants of *T. contorta*

c) *Myrica esculenta*

Plant Sample Collection: VMG in Botany Division of FRI

Culture Initiation from nodal explants: Young current season shoot and leaves were taken as explants. Nodal segments and leaf explants were cultured in Murashige & Skoog's medium (MS) and Woody Plant Medium (WPM) supplemented with different concentrations of plant growth regulators viz. Kinetin, 6-Benzylaminopurine (BAP) and Napthalene acetic acid (NAA).

S.No.	Culture Initiation Medium	Explant type
	WPM + 10 µM Kinetin + 0.1 µM NAA + 0.5% PVP (Bhatt and Dhar, 2004)	Nodal segments
	WPM + 10 µM Kinetin + 0.1 µM NAA (Bhatt and Dhar, 2004)	Nodal segments
	MS + 5 mg/L Kinetin + 0.05 mg/L NAA (Nandwani, 1994)	Nodal segments
	MS basal	Leaf sections
	MS + 0.5 mg/l BAP	Leaf sections
	MS + 1 mg/l BAP	Leaf sections
	MS + 1.5 mg/l BAP	Leaf sections

***In vitro* response:** Excessive release of phenolics was observed in cultures within 24 hours of culture initiation. To overcome this, treatment of explants in 0.5% PVP solution was done prior to culture and in other case 0.5% PVP was added into the culture medium. Incorporation of PVP into the medium however controlled the release of phenolics to some extent. However no *in vitro* axillary bud induction or callus initiation was observed in any of the treatments.

Fig.: culture initiation from nodal segments of *M. esculenta*

Fig.: culture initiation from leaf explants of *M. Esculenta*

d) Quercus semecarpifolia

Plant Sample Collection: Sample collected from Kanatal (Tehri Garhwal).

Culture Initiation: nodal segments were cultured in Murashige & Skoog's medium (MS) and Woody Plant Medium (WPM) supplemented with different concentrations of plant growth regulators viz. 6-Benzylaminopurine (BAP) and Indole acetic acid (IAA)

S.No.	Culture Initiation Medium
	WPM + 1 mg/l BAP
	WPM + 2 mg/l BAP+ 0.25 mg/l IAA

	WPM + 3 mg/l BAP
	WPM + 5 mg/l BAP
	MS + 1 mg/l BAP

***In vitro* response:** The cultures are being observed for any *in vitro* bud induction.

Fig.: culture initiation from nodal segments of *Q. semecarpifolia*

e) Quercus floribunda

Plant Sample Collection: Sample collected from Kanatal (Tehri Garhwal).

Culture Initiation: similar as in *Q. semecarpifolia*

***In vitro* response:** The cultures are being observed for any *in vitro* bud induction.

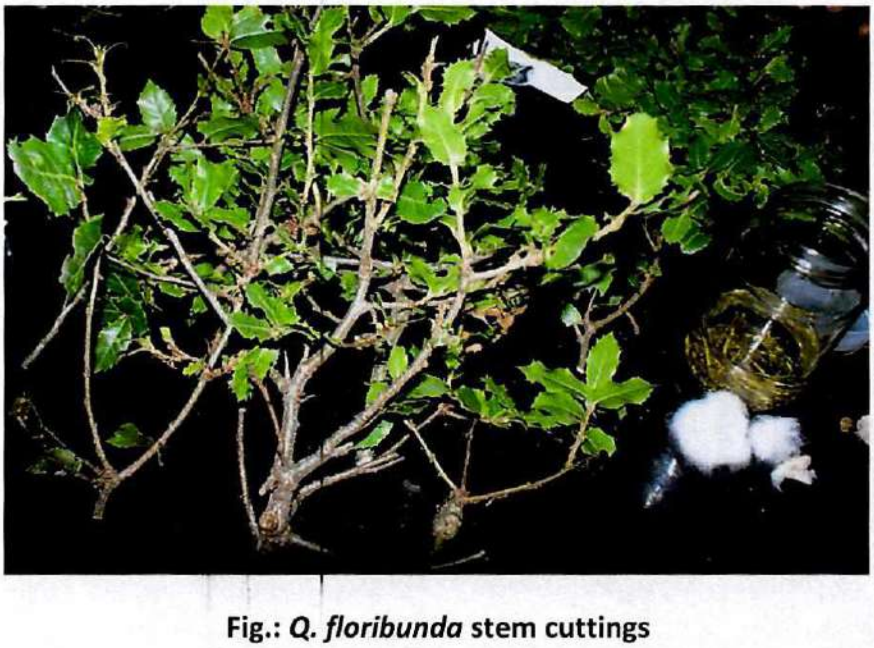


Fig.: *Q. floribunda* stem cuttings

Fig.: culture initiation from nodal segments of *Q. floribunda*

f) *Desmodium oojeinensis*

Plant Sample Collection: Seeds were procured from Forest tree seed laboratory, Silviculture Division, FRI.

***In vitro* seed germination**

Culture Initiation: surface sterilized seeds were put for germination in petriplates under four different conditions as given in the table:

S.No.	Seed germination Medium
1	Autoclaved distilled water
2	Solidified Agar
3	½ strength MS
4	Full strength MS

***In vitro* response:** In all the cases predominant seed browning was observed along with slight emergence of radical which ultimately died after few days.

Fig.: *In vitro* seed germination in *D. oojeinensis*

Hence in the next set of experiments time duration of $HgCl_2$ treatment was reduced to 5 & 7 minutes and seeds were aseptically placed on filter paper bridges in culture tubes containing liquid MS basal medium.

Duration of $HgCl_2$ treatment	**Culture medium**	**Total seeds cultured**	**Percent germination after 6 days**
5 minutes	MS Basal	21	71.4%
7 minutes	MS Basal	21	66.6%

The seeds germinated well in both the conditions and cotyledons emerged after 5 days. Different explants such as hypocotyls, cotyledonary nodes, and epicotyls would be taken from these *in vitro* seedlings and regeneration protocols would be worked upon. Another experiment with time duration of $HgCl_2$ treatment less than 5 minutes is also being carried out.

Fig.: ***D. oojeinensis* - *in vitro*** **seed germination in liquid MS cultures**

Fig.: ***D. oojeinensis* - *in vitro*** **emergence of cotyledons from seeds surface sterilised with $HgCl_2$ for 5 minutes**

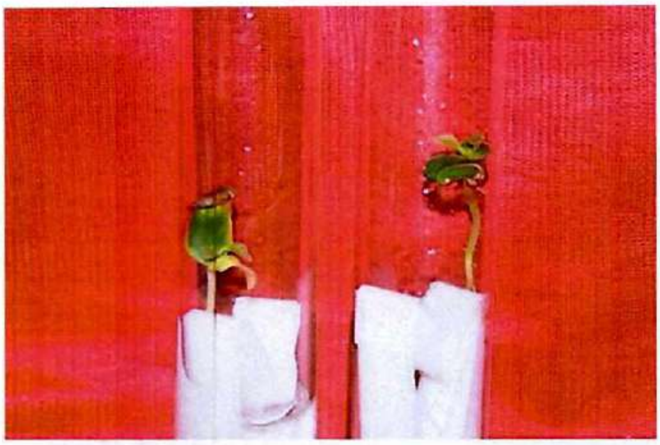


Fig.: *D. oojeinensis - in vitro* emergence of true leaves from the seedling

C. FGR Characterization

Ten priority species have been identified for molecular characterization and genetic diversity estimation, out of which 6 species have been sort listed for immediate attention and initiation of work. The selected species are :

- *Rhododendron arboreum* (Burans)
- *Texas wallichiana* (Thuner)
- *Quercus semicarpifolia (& Q. lanuginose)* (Kharsu oak and Rianj Oak)
- *Betula utilis* (Bhojpatra)
- *Myrica esculanta* (Kafal)
- *Diploknema butyreacea* (butter tree)

Collection of Samples: Extensive survey and sampling work has been initiated in Uttrakhand hills for the selected species. Samples of four species (*Rhododendron arboreum* var red, *Rhododendron arboreum* var pink, *Texas wallichiana, Quercus semicarpifolia, Myrica esculenta and Betula utilis*) have been collected from their natural zone of occurrence and stored at -80^0 C. A total of 30 samples/trees were collected from each population in all the species. So far 21 populations have been sampled from Uttarakhand along with their geographical coordinates. The samples of these populations were segregated for chemical examination and DNA fingerprinting. The detail of the sampled populations is given in the following table:

Species	Population	Location
***Rhododendron arboreum* var red**	RA01	Kanchula Kharg, Chamoli
	RA02	Chopta, Chamoli
	RA03	Janglat Chowki, Chakrata, Dehradun

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	RA04	Budher, Chakrata, Dehradun
	RA05	Near Nagthala, Churani, Chakrata, Dehradun
***Rhododendron arboreum* var pink**	RP01	Kanchula Kharg, Chamoli
	RP02	Chopta, Chamoli
	RP03	Anusuya devi temple, Hans bugyal, Chamoli
Texas wallichiana	TB01	Kanchula Kharg, Chamoli
	TB02	Chopta, Chamoli
	TB03	Devban, Chakrata, Dehradun
	TB04	Bhujkoti, Chakrata, Dehradun
	TB05	Anusuya devi temple, Hans bugyal, Chamoli
Quercus semicarpifolia	QS01	Kanchula Kharg, Chamoli
	QS02	Chopta, Chamoli
	QS03	Devban, Chakrata, Dehradun
	QS04	Bhujkoti, Chakrata, Dehradun
	QS05	Lokhandi, Chakrata, Dehradun
	QS06	Anusuya devi temple, Hans bugyal, Chamoli
Betula utilis	BU01	Anusuya devi temple, Hans bugyal, Chamoli
Myrica esculenta	ME01	Anusuya devi temple, Hans bugyal, Chamoli

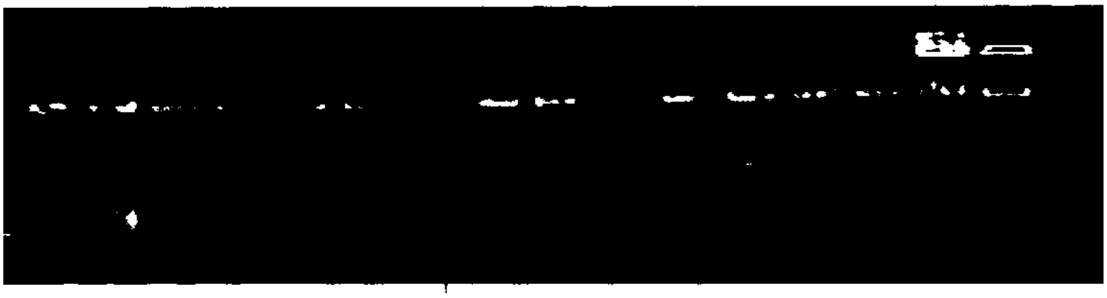
Genomic DNA extraction: Different protocols were tried for DNA extraction from *Rhododendron arbareum* and finally on the basis of concentration (ng/μl) and purity ($A_{260/280}$), the CTAB method given by Doyle and Doyle, 1990 was used for DNA extraction. The same protocol resulted in good yield of genomic DNA from *R. arboreum* var pink, *Texas wallichiana* and *Quercus semicarpifolia*. Genomic DNA has been extracted from the following 19 populations.

Species	DNA extraction done
Rhododendron arbareum var red	RA01, RA02, RA03, RA04, RA05
Rhododendron arboreum var pink	RP01, RP02, RP03
Texas wallichiana	TB01, TB02, TB03, TB04, TB05
Quercus semicarpifolia	QS01, QS02, QS03, QS04, QS05, QS06
Myrica esculenta	ME01 under progress

Protocol has been standardized for DNA extraction from *Myrica esculenta*. CTAB method given by Doyle and Doyle, 1990 with some modifications resulted in good quality DNA. Standardization of protocol for DNA extraction from *Betula utilis* is under progress.

Quantitative and Qualitative analysis of Genomic DNA: The concentration and absorbance ratio (A_{260}/A_{280} nm) of the DNA samples were quantified using Biophotometer (Eppendorf-6131, Germany). The quality of extracted DNA was analyzed on 0.8% agarose gel.

Genomic DNA extracted from *Rhododendron arboreum* var. red



Genomic DNA extracted from *Rhododendron arboreum* var. pink

Genomic DNA extracted from *Quercus semicarpifolia*

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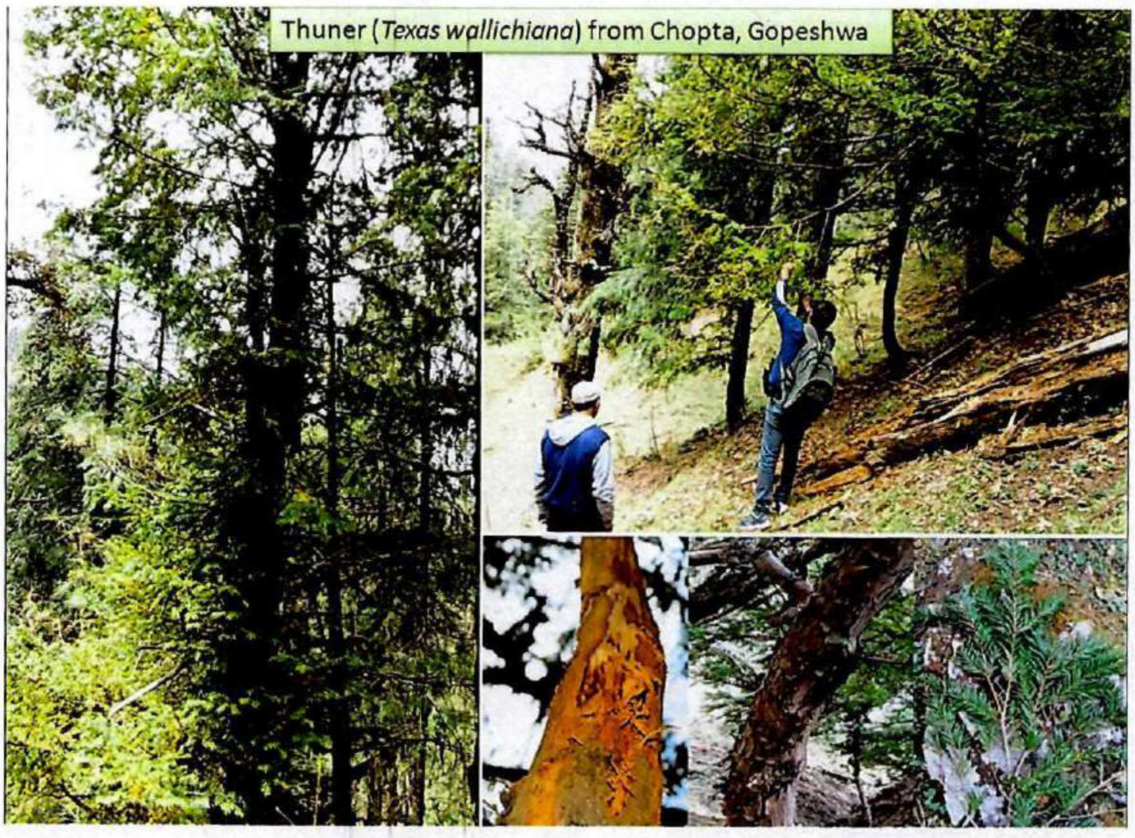
Bhojpatra (*Betula utilis*) from Rudranath trekking route, Gopeshwar



Thuner (*Texas wallichiana*) from Chopta, Gopeshwa

Kafal (*Myrica esculenta*) from trekking route of Ansuya Devi temple, Gopeshwar

Chemical Characterization : For chemical marker(s) assisted screening of *Rhododendron arboreum* and characterization of the elite accessions / genotypes desired numbers of flower samples of two population lines grown in Janglat Chowki, Kanasar Village, Charata and Budher, Kanasar Village, Charata were collected in the first quarter. The collected flowers were extracted with acidulated methanol. Some of the extracts were concentrated in vaccum and their yields were determined. Experiments for determining the total flavonoid contents in these extracts using spectrophotometric method were continued in this quarter also.

Further stem bark samples collected from one population line (ME 01) of *Myrica esculenta*, and leaves samples collected from one population line (QS 06) of *Quercus semicarpifolia* were freeze dried and milled for their chemical analyses. Extraction of the stem bark samples of ME 01 using 25% aqueous methanol for estimation of total tannin content was initiated and continued.

D. FGR Conservation

Five priority species have been sort listed for FGR Conservation as per the target of the project. The species are *Cinnamomum tamala, Diploknema butyracea, Rhododendron arboretum, Myrica esculanta* and *Taxus wallichiana*. The survey and review and literature through records was conducted to know distribution and status of prioritized species. Scientists have visited forest areas at Chakrata area for exploring the possibility of field gene banks. Preliminary survey of all the species selected for conservation of their genetic resources was completed in both lower and middle Himalaya. However, a detailed survey of *Taxas wallichiana* and *Rhododendron arboretum* was made in different forest ranges by exploring the areas at Devban, Kanasar range; Bhujkoti, Riknar range; Lokhandi village, Kanasar range of Chakrata Forest Division and some locations of Kedarnath Wildlife Sanctuary. The GPS locations of the intact promising populationswas recorded. Six populations of *Diploknema butyracea* have been located in Distt Pithoragarh at altitudinal range of 780 to 1290 m. Germplasm will be collected at time of seed maturation. Two nursery sites have been tentatively identified in District Pauri Garhwal and Chakrata for multiplication of germplasm. Scientists have also visited Dev Van Forest Nursery to explore the possibility to establish field gene bank and propagation of *Texas wallichiana*.

Species Name	Population	Location	Geo-coordinates
Texas wallichiana	**TWCH1**	Devban, Kanasar range, Chakrata	Lat: N 30^{0}44’52.4” Long: E 77^{0}51’58.3” Alt: 2818 m
	TWCH2	Bhujkoti, Riknar range, Chakrata	Lat: N 30^{0}47’14.2” Long: E 77^{0}55’24.2” Alt: 2693 m
	TWCH3	Near Hans bugyal on rudranath trekking route, Gopeshwar	Lat: N 30^{0}29’34” Long: E 79^{0}18’40.1 Alt: 3135 m
	TWKN1	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30^{0}27’11.5” Long: E 79^{0}14’29.9” Alt: 2577 m
	TWKN2	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30^{0}28’51.9” Long: E 79^{0}11’52.3” Alt: 2937 m

Species Name	Population	Location detail	Geo-coordinates
Rhododendron arboreum var Red	**CHRA-01**	Janglat Chowki, Kanasar range, Chakrata	Lat: N 30^{0}43’43.7” Long: E 77051’52.5” Alt: 2363 m

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	CHRA-02	Budher, Kanasar range, Chakrata	Lat: N $30^{0}45'43.5''$ Long: E $77^{0}47'08.8''$ Alt: 2442 m
	CHRA-03	Near Nagthala, River range, Chakrata,	Lat: N $30^{0}35'25.1''$ Long: E $77^{0}56'16.3''$ Alt: 2161 m
	KNRA-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N $30^{0}27'11.5''$ Long: E $79^{0}14'29.9''$ Alt: 2577 m
	KNRA-02	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N $30^{0}28'51.9''$ Long: E $79^{0}11'52.3''$ Alt: 2937 m
Rhododendron arboreum var Pink	**KNRA(P)-01**	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N $30^{0}27'11.5''$ Long: E $79^{0}14'29.9''$ Alt: 2577 m
	KNRA(P)-02	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N $30^{0}28'51.9''$ Long: E $79^{0}11'52.3''$ Alt: 2937 m
	GRA(P)-03	Near Hans bugyal on rudranath trekking route, Gopeshwar	Lat: N $30^{0}29'34''$ Long: E $79^{0}18'40.1''$ Alt: 3135 m

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Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority
Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in IA No.1337 with IA Nos.827, 1122, 1216, 1473 in WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the ~~10th November 2016~~ 19 DEC 2016**

Note.

Sub.: **CAMPA/ NCAC – Support to the Project 'Creation of Centre of Excellence on Forest Genetic Resources of India, FRI, Dehradun.**

The subject Project has been approved for funding out of the corpus available with the National CAMPA Advisory Council. In this connection, this Office sanction of even number dated the 21st January 2016 in terms of which an amount of Rs.1,46,25,000.00 representing 50% of the project outlay for the 1st year has been released to the FRI, may kindly be referred to.

2. As stipulated in the sanction, the release of the balance outlay for the 1st year was conditional upon the FRI submitting the Quarterly Progress Reports. The Reports have been received in 2 parts, viz., a Report each covering the periods January- April 2016; and January – June 2016.

3. A copy of the Progress Report(s) in question is enclosed with the request that the comments of the RT Division, Ministry of Environment Forest & Climate Change thereon may kindly be furnished urgently so that the question of further release of funds could be considered, appropriately.

(Rajagopal Prashant)
Asstt Inspector General of Forests
Tel No.: (011) 24695401

To

Dy Inspector General of Forests (RT)
(Dr Suneesh Buxy),
Ministry of Env Forest & Climate Change.

Encl.: a.a.

Ad-hoc
Compensatory Afforestation Fund Management and Planning Authority
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4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

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No.13-17/2012-CAMPA **Dated the ~~10th November 2016~~.**

19 DEC 2016

The Country Representative,
India Country Office, I U C N,
C-4/25 Safdarjung Development Area,
New Delhi – 110 016.

Sub.: **CAMPA / NCAC – Best Practices Guidance for Restoration of Mining Sites.**

Sir,

Please refer to this Office letter number dated the 4th July 2016, following by a presentation on the subject Project, made before the Director General of Forests & Special Secretary to the Government of India, on the 14th July 2016.

2. Extension of completion of the subject Project was sought upto 31st October 2016, and the period is already over. It is requested that the present status of finalization of the Project in question may kindly be informed.

Yours faithfully,

(Rajagopal Prashant)
Asstt Inspector General of Forests
Tel No.: (011) 24695401

Subject: **RE: Best Practices Guidance for Restoration of Mining Sites**
To: "igfc-mef@nic.in" <igfc-mef@nic.in>

Date: 11/16/16 10:25 AM
From: SINHA Priya <Priya.SINHA@iucn.org>

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image001.gif (3kB) image002.jpg (13kB)

Dear Shri Sinha.
A gentle reminder to confirm that proposal for reappropiation among items within the budgeted limit and extension till October 2016 was approved at the meeting under Chairmanship of DGF &SS held on 14th July was approved.
Best Wishes
PRSinha

From: SINHA Priya
Sent: Friday, November 11, 2016 10:51 AM
To: 'igfc-mef@nic.in'
Subject: FW: Best Practices Guidance for Restoration of Mining Sites

From: SINHA Priya
Sent: Tuesday, November 08, 2016 3:16 PM
To: 'igfc-mef@nic.in'
Subject: RE: Best Practices Guidance for Restoration of Mining Sites

A gentle reminder (yellow highlighted)
PRSINHA
Country Rep. IUCN

From: SINHA Priya
Sent: Monday, October 31, 2016 12:09 PM
To: 'igfc-mef@nic.in'
Subject: FW: Best Practices Guidance for Restoration of Mining Sites

Dear Shri Sinha,
May kindly see the mail below requesting for reallocation of budget for Preparation of Guidance on Restoration of Mining Sites.
The revised proposal was discussed in a meeting chaired by DGF&SS on 14th July 2016 and endorsed.
A kind confirmation of endorsement of revised proposal is solicited .
Thanks and Best Wishes
PPRSinha

From: SINHA Priya
Sent: Friday, May 13, 2016 10:27 AM
To: igfc-mef@nic.in
Subject: Best Practices Guidance for Restoration of Mining Sites

E-7095/R
24/11/2016

Dear Shri D.K. Sinha,
IUCN has been assigned a project under CAMPA to document best practices case studies on restoration of mining areas and prepare best practices guidelines on restoration. Copy of the proposal submitted by us and the sanction letter is attached for ready reference.

I am submitting herewith a midterm progress report on the project. As may be seen , work on documenting case studies is complete. Analysis of the case study is underway. Now we will undertake preparation of best practices guidelines. The draft guidelines would

OSD

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be presented in a workshop to be organized in consultation with your office before it is firmed up.
We had indicated in our proposal that the project would be completed within six months of the issuance of the sanction order. However it is taking time due to the complexities involved in the work which includes capturing recent initiatives like star rating of mines and the sustainable mining framework. Also in the budget line some revision between items are required within the overall budget.
Accordingly, a revised budget with revised time line is submitted herewith for your consideration and approval.
We will be submitting the draft final report by the end of October 2016 along with requisite utilization report.
Thanking you
Best Wishes
PRSinha

From: SINHA Priya
Sent: Friday, November 20, 2015 10:44 AM
To: S S GARBYAL; sharad.negi@nic.in
Cc: M. S. NEGI
Subject: Consultation on Best Practices Guidance for Restoration of Mining Sites

Dear Dr Negi,
As you are aware, IUCN has been assigned a project under CAMPA to prepare best practices guidance on restoration of mining sites. We already have collected case studies from across the globe on restoration practices as part of this exercise. Now we propose to hold a consultation with relevant stake holders to capture various dimensions of the issue at hand.
Kindly indicate your convenience sometime in early December and also accept our request to inaugurate it.
I am copying this mail to ADG(FC) and CEO CAMPA for their kind information and needful.
Thanks and Best Wishes,

Priya Ranjan Sinha (Mr)
Country Representative
India Country Office
IUCN (International Union for Conservation of Nature)
C- 4/ 25. Safdarjung Development Area, New Delhi 110016. India
Tel. +91 11 2652 5554, Extn.: 210, Fax +91 11 2652 7742,
www.iucn.org

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निवास/Resi. : 0135-2751679
0135-2224513
फैक्स/FA : 91-0135-2756865
E-mail : dir_fri@icfre.org

डॉ० सविता, भा.व.से.
निदेशक व.अ.सं.
एवं
कुलपति व.अ.सं. सम विश्वविद्यालय
Dr. SAVITA, IFS
Director FRI
and
Vice-Chancellor FRI Deemed University

वन अनुसंधान संस्थान
(भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद्)
(पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार की एक स्वायत्त परिषद्)
डाकघर न्यू फॉरेस्ट, देहरादून—248006
FOREST RESEARCH INSTITUTE
(Indian Council of Forestry Research and Education)
(An autonomous body of Ministry of Environment, Forests & Climate Change Govt. of India)
P.O. New Forest, Dehra Dun—248006

अ०शा०सं० D.O.No 9-108/DGTP-CoFGR/FRI 2016

दिनांक Dated, the Date 9-12-2016

To,

The Inspector General of Forests /
Chief Executive Officer (CEO), Ad-hoc CAMPA
Ministry of Environment, Forest and Climate Change
Indira Paryavaran Bhavan
Jorbagh Road
New Delhi - 110 003

Kind attention: Shri Rajagopal Prashant, AIG (FC)

Sub : Adhoc CAMPA project - National Program for Conservation and Development of Forest Genetic Resources: Pilot Project Proposal to be implemented at FRI, Dehradun – Quarterly Progress Report reg.

Sir,

Please find enclosed two copies of the progress report of the subject cited project, for the period of July – September 2016. The reports of earlier two quarters have already been submitted to your office.

You are requested to kindly release the balance 50 % amount of the first year project outlay at the earliest as many of the activities and procurement processes of the current year are under mid way.

O/o IGF (FC)
Dy. No. 23155/R
Date 16/12/2016

Encl. As above

Yours faithfully

9/12/2016

(Dr. Savita)
Director

15/12

AIG (AP)

OSD CAMPA

National Program for
Conservation and Development of Forest Genetic Resources

Pilot Project
(Implemented at FRI, Dehradun)

on

Creation of Centre of Excellence on Forest Genetic Resources (FGR) of India (CoFGR)

Funded under
Adhoc CAMPA Fund
Ministry of Environment, Forest & Climate Change
(2016-2020)

Progress Report
(July- September 2016)

Submitted by

Forest Research Institute (FRI),
New Forest P.O., Dehradun 248 006.

Project Summary

Title of the Project :	National Program for Conservation and Development of Forest Genetic Resources : Pilot Project Proposal to be implemented at FRI on Creation of Centre of Excellence on Forest Geetic Resources (CoFGR)
Funding Agency :	Adhoc CAMPA Fund Ministry of Environment, Forest & Climate Change, Govt. of India
Project Outlay:	Rs. 861.20 lakh (January 2016 – 31 December 2020)
Project Period :	5 years
Grants released :	1st installment - 146.25 lakh
Date of release :	1st installment on 21st January 2016
Project Executing Authority:	Director Forest Research Institute, Dehradun
Period of present progress report :	Quarterly report (July to September 2016)
	Cumulative progress upto 30th September 2016

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Progress of the Quarter (July – September 2016)

A brief progress of activities for the period of **June to September 2016** as per the action plan of the project has been summarized in the following points:

1. Collection of seed of FGR species

Seeds of following species were collected:

Sl. no.	Species	Site of Seed Collection	Altitude (m amsl)	GPS Co-ordinates
1.	*Schleichera oleosa*	Chilla Range	307.8	29°57'28.7"N, 078°11'19.9"E
		Gohri Range	358	30°04'36.1"N, 078°17'43.7' E
		Kalsi	534	30°31'32.1"N, 077°50'58.3" E
		Narendra Nagar	760.8	30°08'48.0"N, 078°16'56.9 "N
2.	*Fraxinus xanthoxyloides*	Kailashpur, Malari Beat, Joshimath Range	2967	30°42'26.6"N, 79°52'52.4"E

Seed Extraction and Processing

Seeds were extracted from the ripened fruits. Seeds were cleaned and processed for further tests. Initial parameters on seed weight, seed dimensions, seed moisture content, seed germination, etc. were recorded.

Seed Handling

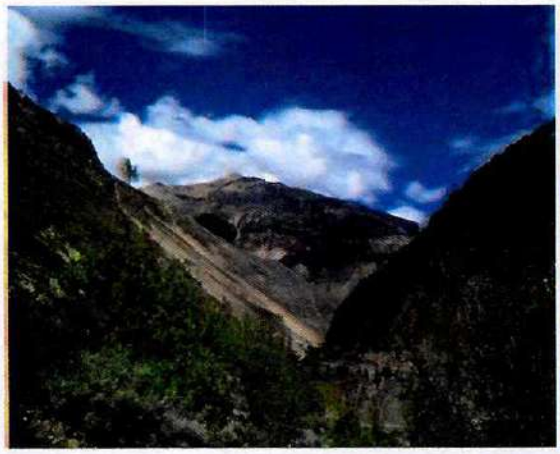
Collected seeds were pre-cleaned and the impurities, foreign materials, soil particles, twigs and leaves which are detrimental to seed viability, were removed. Purity of the seed lot was calculated.

Seed collection

Fruit/ seed handling

Seed cleaning/ Seed extraction   Seed germination

Fig.: Seed collection, Handling, Extraction, Processing and Germination of *Schleichera oleosa*



Populations of *Fraxinus xanthoxyloides*   **Seed collection**

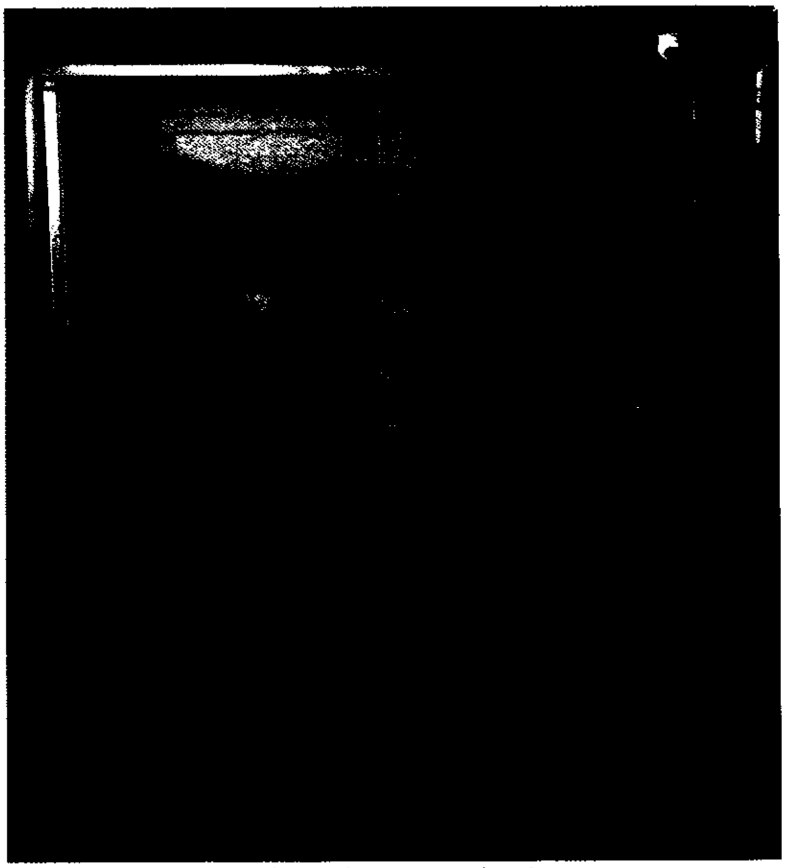
Seed extraction   **Seed germination test on sand**

Fig.: Seed Collection, Extraction, Processing and Germination of *Fraxinus xanthoxyloides*

Seeds of F. *xanthoxyloides* are characterized by physiological dormancy, as a result seeds took about a month to germinate and showed low germination. Seeds have been kept for moist stratification (pre-chilling) in combination of different treatments with GA_3.

Seed Drying and Storage

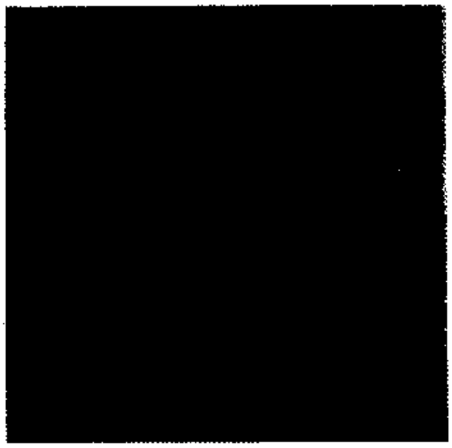
Seeds of *S. oleosa* were kept in storage at ambient room temperature for after-ripening. Seeds were desiccated to lower moisture levels with silica gel and stored under low temperature (5^0C) in Low Temperature Storage Cabinet.



Seed stored in Storage chamber

Quarterly Viability testing of seeds

Germination test were conducted on the stored seeds of different species viz. *Desmodium oojeinensis, Toona ciliata, Aegle marmelos, Hippophae salicifolia, Rhododendron arboreum* and *Holoptelia integrifolia.*



Seed Germination in *Hippophae salicifolia*

Seed Germination in *Holoptelia integrifolia*

Seed Germination in *Desmodium oojeinensis*

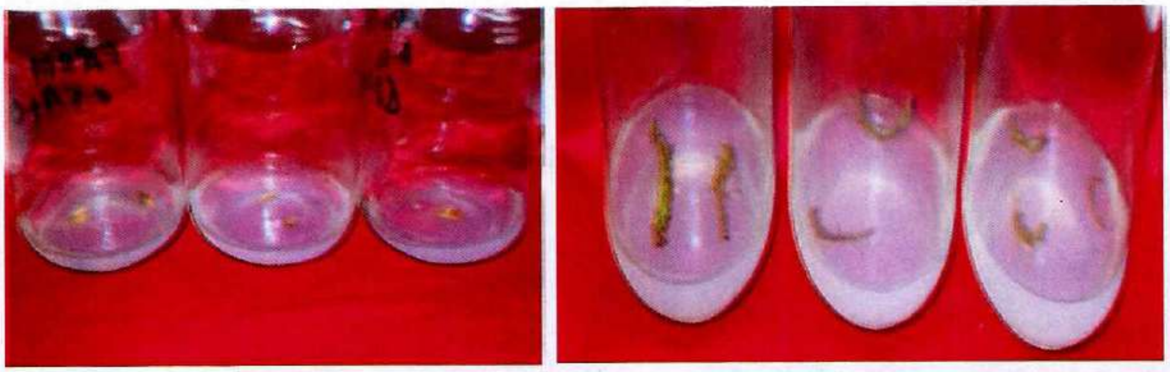
Seed Germination in *Toona ciliata*

Seed Germination in *Aegle marmelos*

Seed Germination in *Rhododendron arboreum*

2. ***In-vitro* storage of FGR species**

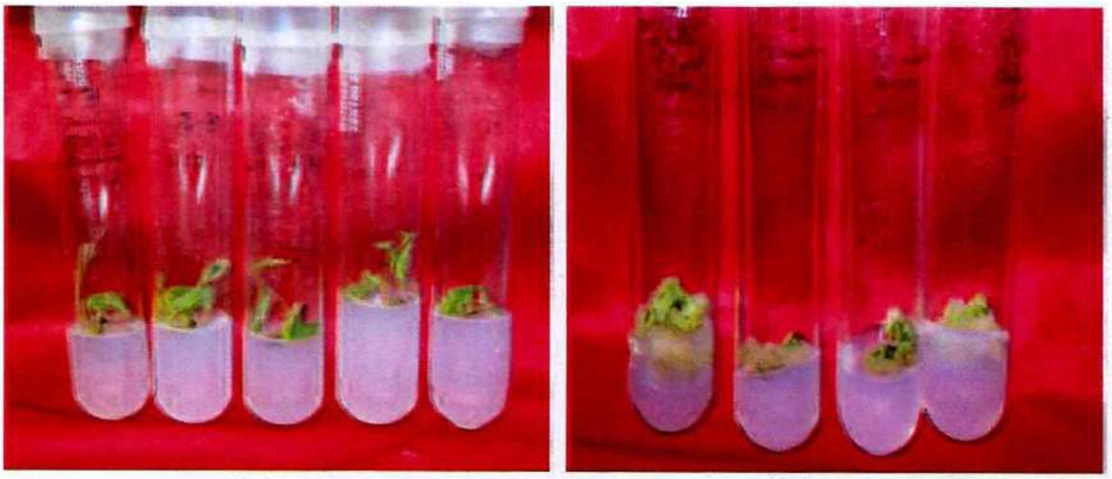
As the prerequisite for the development of any *in vitro* conservation methods for storage of FGR (in this case FGR of very high conservation concern & those having recalcitrant seeds) is the availability of a standardized *in vitro* regeneration protocol. Thus experiments have been initiated to devise *in vitro* regeneration or micropropagation protocols for selected species viz. *Rhododendron arboretum, Taxus contorta, Desmodium oojeinensis, Diploknema butyracea, Quercus semecarpifolia and Q. Floribunda.* The explants for standardization of in vitro protocol are being collected periodically from the selected populations of the natural range of distribution of the species. In-vitro conditions with respect to surface sterilization method, culture media and growth regulators are being optimized for each of the selected species.



(A) **(B)**

Fig.: Culture initiation and callus formation and multiplication of shoot segments of (A) *Rhododendron arboreum* and (B) *T. contorta.*

Fig.: *D. oojeinensis* hypocotyls segments cultured onto different culture media



Epicotyls   Cotyledonary segments

Fig.: ***D. oojeinensis*** **epicotyl and cotyledonary segments cultured onto different culture media**

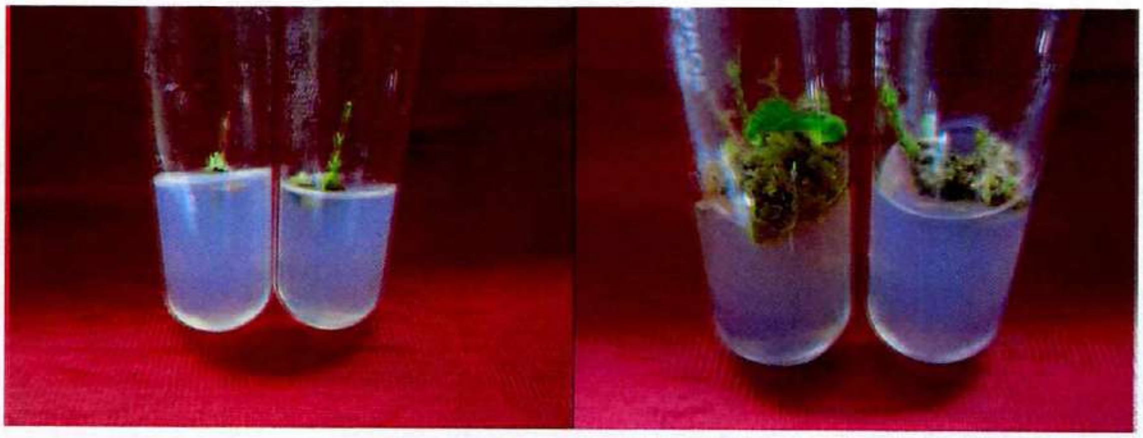


Fig.: Somatic organogenesis from calli originated from hypocotyls of ***D. oojeinensis***

Fig.: ***Diploknema butyracea*** **explant and nodal segments in culture**

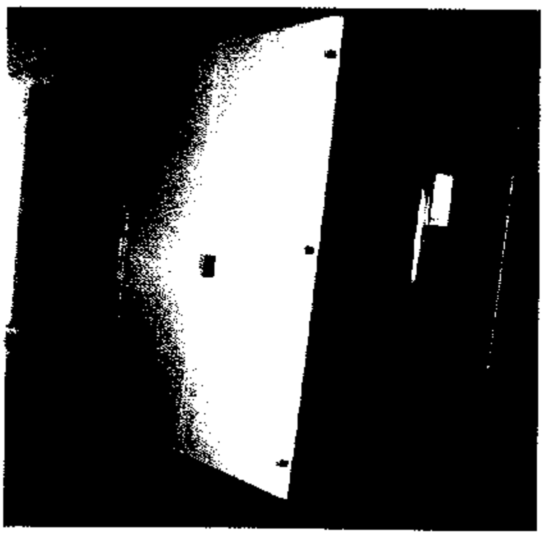
3. <u>Pollen collection</u>

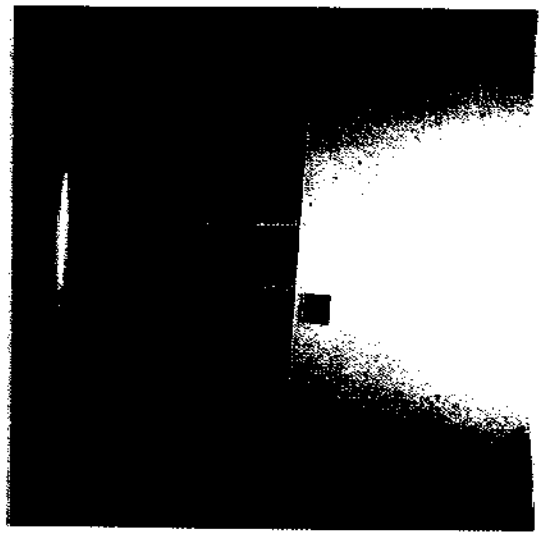
Phenology chart of important species has been prepared. In rainy season most of the plant not flowered hence pollen collection has been started now. Facility to study pollen and their viability has been created. Tours are being conducted for this purpose from September for location of plants in Kumaon and Garhwal region of Uttrakhand.

4. Upgradation of DD Herbarium:-

a) Purchase of Mobile Herbarium Compactors

Sample unit of herbarium compactor was installed by the firm in the systematic Botany Discipline. The Director FRI and other concerned scientists examined the sample unit and suggested some technical modifications. The same was conveyed to the firm for rectification.

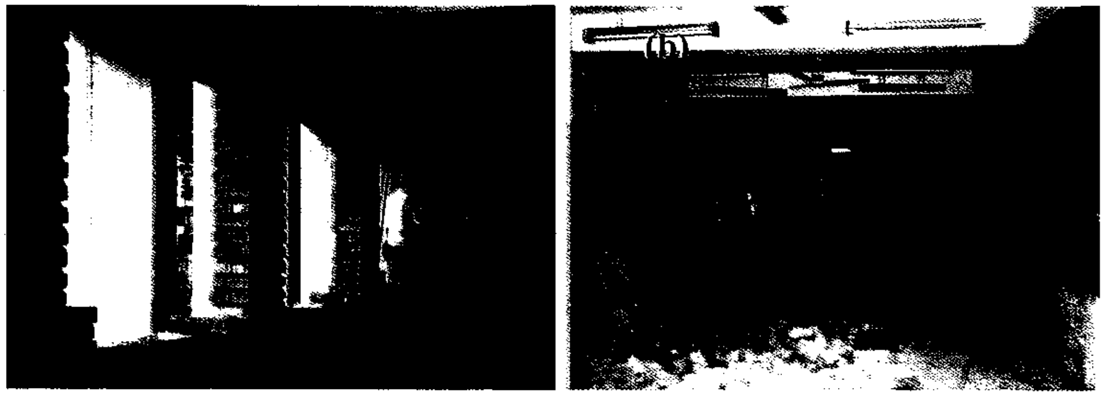




Compactor- Sample Unit

b) Renovation of Herbarium Building

Civil work: After furnishing codal formalities, civil work was initiated by 1st week of September, 2016. Expansion of current facility is being carried out with the conversion of existing Carpological museum hall and adjoining rooms to extended unit of herbarium.



Renovation work in progress

5. Documentation of FGR species

a) Prioritization of FGR Species

i) To streamline the methodology for survey and collection of quantitative data, a brain storming meeting was convened by the Coordinator, FGR project Dr. H.S. Ginwal. Dr. G.S. Rawat, Scientist-G and Dean, Wild life Institute of India and Dr. S. K. Srivastava Scientist and In-charge, Botanical Survey of India, Northern Circle and Sh. Raman Nautiyal, Scientist-E (Statistician) were the expert members of the meeting. Deliberation on survey, prioritization of species and sampling methodology was done with expert members and scientists involved in the project. Survey methodology and priority species of the projects were finalized.

ii) A list of total 250 species (141- tree species, 29 Shrubs, 15 lianas/ woody climbers and 65 RET species) has been prepared with the consultation from expert members/ working plans of the respective divisions/ literary work from respective areas etc. Out of which 50 species have been selected for the preparation of eco-distribution maps.

b) FGR distribution records

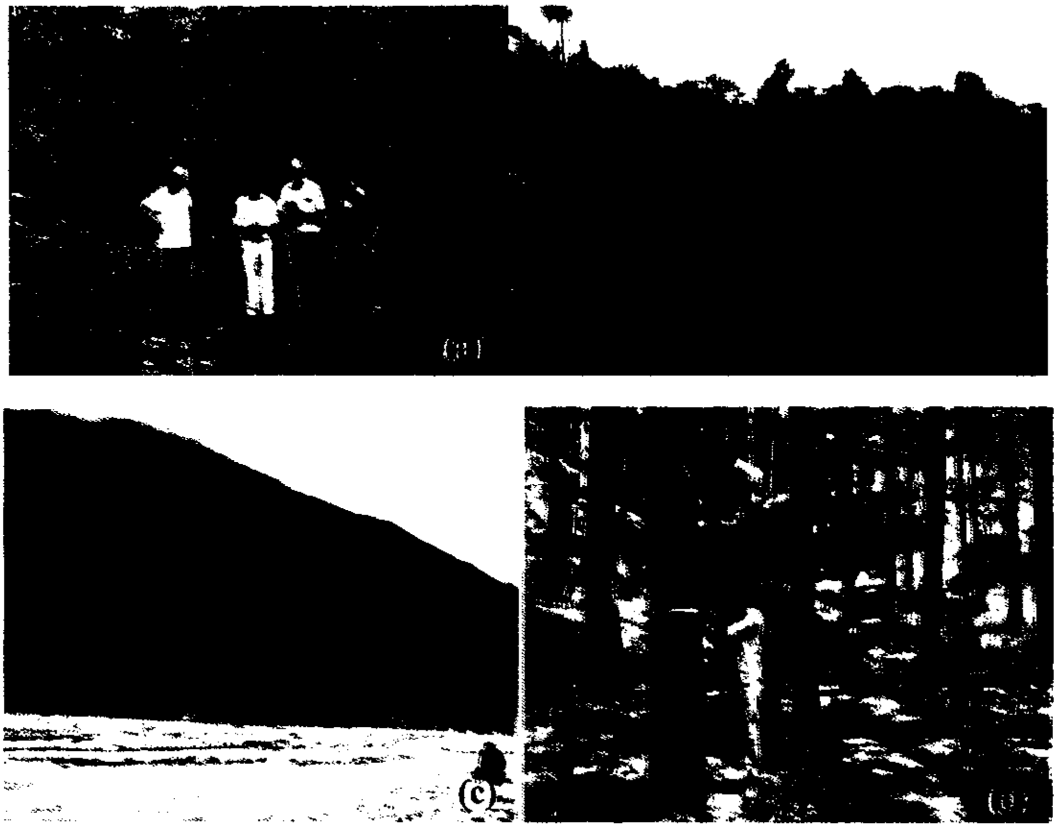
For distribution of selected species, distribution record from different Herbaria to be consulted. During the period, DD Herbarium and BSI Herbarium (Northern Circle) is being consulted. Detailed information about projects species are being collected.

c) Field Survey for distribution and regeneration

Field survey for distribution of prioritized species of the following forest divisions was carried out:

- Chamoli (Kedarnath W.L.S., Valley of flowers W.L.S.)
- East Terai (Kishenpur, Dolly range, Surai range),

• Tehri Forest Division



Collection of field data from (a) Moist deciduous forest of terai (b) mixed forest (c) Sub-alpine birch forest (d) Sub-alpine conifer forest.

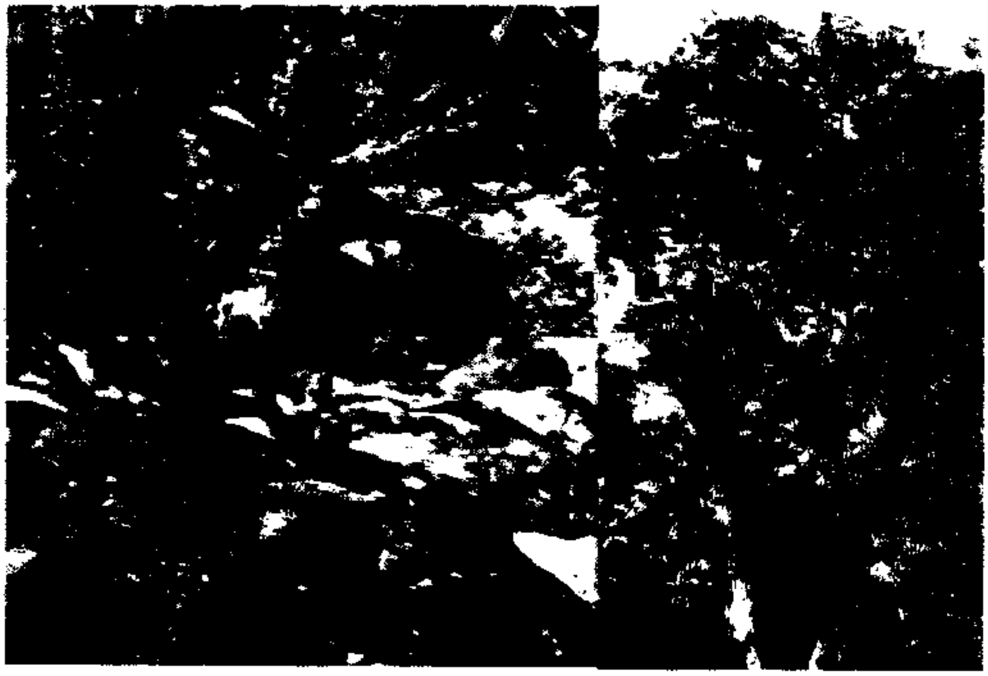
FGR Characterization

Collection of Samples: Samples of six species (*Rhododendron arboreum* var red, *Rhododendron arboreum* var pink, *Texas wallichiana, Quercus semicarpifolia, Myrica esculento and Betula utilis*) have been collected from their natural zone of occurrence and stored at -80^0 C. A total of 30-35 samples/trees were collected from each population in all the species. A total of 9 populations (3 populations of *Rhodadendron arboreum* var red, 1 population of *Rhododendron arboreum* var pink, 1 population of *Taxus wallichiana*, 1 population of *Quercus semicarpifolia* and 3 populations of *Myrica esculenta*) were sampled from Chamoli, Uttarakhand along with their geographical coordinates. The samples of these populations were segregated for chemical examination and DNA fingerprinting. The detail of the sampled populations is given in the following table:

Details of populations collected:

Population	Location	Latitude	Longitude	Altitude
***Rhododendron arboreum* var red**				
RA06	Mohankhal, Nagnath, Kedarnath, Chamoli	N 30°19'38.3"	E 79°12'27.5"	2019 m
RA07	Kedarnath, Chamoli	N 30°05'26.5"	E 79°17'18.5"	2035 m
RA08	Dhanpur range, Kedarnath, Chamoli	N 30°13'44.1"	E 79°12'32.0"	1509 m
***Rhododendron arboreum* var pink**				
RP04	Auli, Joshimath, Chamoli	N 30°31'15.1"	E 79°33'55.3"	2941 m
Texas wallichiana				
TB06	Auli, Joshimath, Chamoli	N 30°31'9.5"	E 79°33'54.3"	2933 m
Quercus semicarpifolia				
QS07	Auli, Joshimath, Chamoli	N 30°31'26.3"	E 79°33'53.8"	2944 m
Myrica esculenta				
ME02	Gairsain, Kedarnath	N 30°05'41.4"	E 79°17'30.0"	2274 m
ME03	Nagnath, Kedarnath, Chamoli	N 30°19'31.8"	E 79°11'46.0"	1801 m
ME04	Dhanpur range, Kedarnath, Chamoli	N 30°13'43.8"	E 79°12'29.6"	1554 m

***Texas wallichiana* collected from Auli, Joshimath,**



Rhododendron arboreum collected from Gairsain, Kedarnath,

Myrica esculenta from Nagnath forest range, Kedarnath,

***Quercus semicarpifolia* forest in Auli, Joshimath, Chamoli**

Genomic DNA extraction: Genomic DNA has been extracted from the following 23 populations. Standardization of protocol for DNA extraction from *Betula utilis* is under progress.

Details of populations from which DNA has been extracted:

Species	Populations
Rhododendron arboreum var red	RA07, RA08
Rhododendron arboreum var pink	RP04
Texas wallichiana	TB06
Quercus semicarpifolia	QS07
Myrica esculenta	ME02, ME03 under progress

Quantitative and Qualitative analysis of Genomic DNA: The concentration and absorbance ratio (A_{260}/A_{280} nm) of the DNA samples were quantified using Biophotometer (Eppendorf-6131, Germany).

Details of populations for which DNA Quantification has been done:

Species	Populations
Rhododendron arboreum var red	RA07
Rhododendron arboreum var pink	RP04
Texas wallichiana	TB06
Quercus semicarpifolia	QS07
Myrica esculenta	ME02

The quality of genomic DNA extracted from genotypes of all the species was analyzed on 0.8% agarose gel.

Gel Photographs showing Genomic DNA extracted from genotypes of different species:

Genomic DNA extracted from *Quercus semicarpifolia*

Genomic DNA extracted from *Texas wallichiana*

Genomic DNA extracted from *Rhododendron arboreum*

Genomic DNA extracted from *Myrica esculenta*

Chemical Characterization:

Literature on chemistry of *Betula utilis* was updated. Biochemical characterization of two populations of *Rhododendron arboreum* (RA03 and RA 05) with respect to the total flavonoid contents (TFCs) was determined in their flowers using spectrophotometric method. TFCs (mg rutin equivalent /g extract) were found to be varying from 38.06 ±0.36 to 214.41± 4.04 (mean value 111.26 ±1.21) and 70.96 ±1.33 to 224.44 ±0.88 (mean value 128.66 ±1.35), respectively. Estimation of TFCs in the flower samples of the population line of RA 4 was continued. Extraction of the stem bark samples from one population line (ME 01) of *Myrica esculenta* using 25% aqueous methanol was completed. Protocol for estimation of total phenol contents (TPCs) in these samples was standardized. Estimation of TPCs using standardized protocol in these samples was initiated and continued.

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Standardization of protocol for estimation of total triterpenoid content in the stem bark samples of *Betula utilis* population was initiated and continued.

FGR Conservation

Preliminary survey of all the species selected for conservation of their genetic resources was completed in both lower and middle Himalaya.

Cumulative Progress upto 30th September 2016

Background Information

Forest Genetic Resources (FGRs) constitute a very important sub-set of biodiversity. Conserving FGR is vital, as they are unique and irreplaceable resources for the future. In India alone, more than 340 million people are estimated to be dependent upon the FGRs for their livelihoods. There is a definite need to address the FGR related issues through a comprehensive FGR conservation and development strategy and implementation plan.
As per present state of knowledge, 18,236 higher plant species (18,159 Angiosperms and 77 Gymnosperms) documented from India so far (*BSI, 2015: Plant Discoveries 2014*). More than 80% of this higher plant diversity is contained in the forest habitats (≈14,500 species). About half of this forest plant diversity constitutes FGRs (≈7,250 species), the remaining being herbaceous flora including soft climbers, twiners, herbs, and grasses. FGRs contain a huge potential in ensuring food and health security of the country's burgeoning human population and its livestock.

To generate understanding and knowledge on FGR, and to develop and strengthen in situ and ex situ FGR conservation programmes, the National CAMPA Advisory Council (NCAC) of Ministry of Environment and Forests & Climate Change, Govt. of India has sanctioned a project entitled "National Program for Conservation and Development of Forest Genetic Resources: Pilot Project Proposal to be implemented at FRI on Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)". The first instalment of the project 146.25 lakhs was received in third week of January 2016.

Progress of Works

As per the action plan of the project, activities were initiated and following four working groups have been created in FRI to achieve the targets of the project:

i. FGR Documentation
ii. FGR Seed and Germplasm Storage
iii. FGR Characterization Cell
iv. FGR Conservation Cell

The targets under the projects have been assigned to each of the working groups on individual scientist basis which is being closely monitored by the Coordinator of the project. The contractual staff required under the project has been appointed and now is in position. All the working groups have started their activities as per the assigned action plan. The brief description of the activities so far taken up has been detailed below:

A. <u>FGR Documentation</u>

6. Upgradation of DD Herbarium:

Purchase of Mobile Herbarium Compactors

Detailed specification for purchase of herbarium compactors were made in consultation with Botanical Survey of India, Northern circle. E –tender for purchase of the compactor was floated in March 2016, unfortunately only one tender was received which was not considered by the purchase committee. The tender was floated again after making certain modifications in the specifications. The whole process of tendering was repeated three times and now finally the supply order has been placed for purchase and installation of compactors in the herbarium of FRI. Sample unit of herbarium compactor was installed by the firm in the systematic Botany Discipline. The Director FRI and other concerned scientists examined the sample unit and suggested some technical modifications. The same was conveyed to the firm for rectification.

Renovation of Herbarium Building

Detailed measurement and estimation of civil and electrical work with the help of Engineering Cell was prepared. Expert engineers were consulted for feasibility of herbarium building for installation of compactors. As per the expert opinion, keeping in view the load of compactors per square meter, these compactors could be installed in the herbarium section at the ground floor only with certain modifications in the present internal structure which are being considered by the engineering cell. These works are being taken up by Engineering Cell, FRI.

After furnishing codal formalities, civil work was initiated by 1st week of September, 2016. Expansion of current facility is being carried out with the conversion of existing Carpological museum hall and adjoining rooms to extended unit of herbarium.

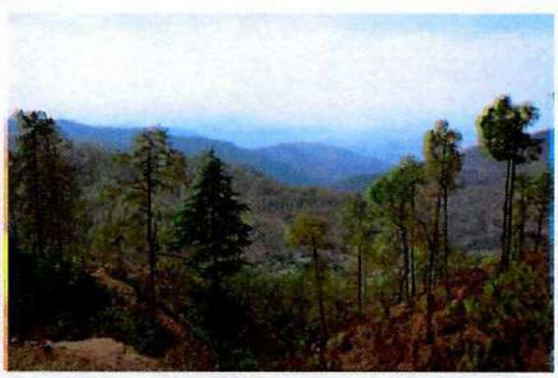
Listing and Prioritization of the FGR Species

A list of total 250 priority species (141- tree species, 29 shrubs, 15 lianas/woody climbers and 65 RET species) has been prepared. Out of which 50 species have been selected for the preparation of eco-distribution maps. The criteria used for the selection of the species were i) indigenous occurrence ii) woody perennial iii) species that are of economic, environmental, scientific or social value iv) threat perception on the species. Distribution of 100 species has been traced form the DD Herbarium

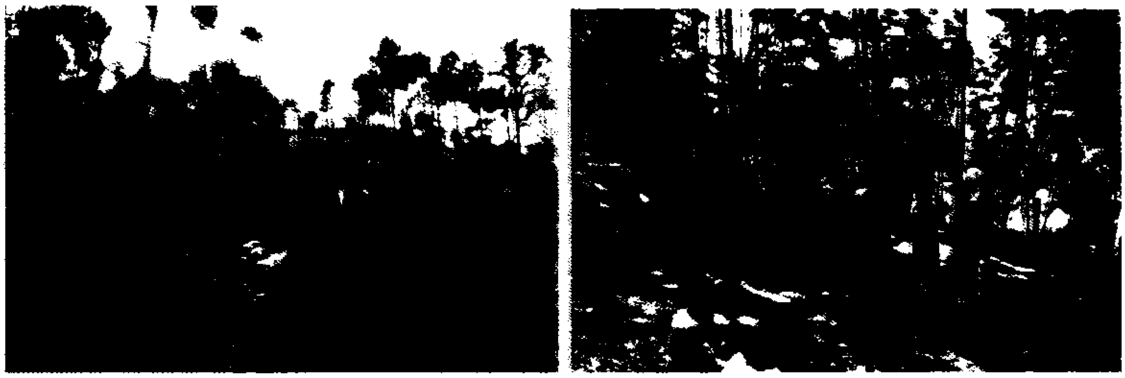
Field Survey for distribution and regeneration

Species wise geographical location for field survey is being collected from the literature survey/ forest working plans and herbaria based information. For smooth conduction of survey work, districts have been allotted to team members. For distribution of species, concerned division and working plan are being consulted. In addition to this, distribution of species is being worked out from the national herbaria of Uttarakhand. Field survey of five districts (6 Forest Divisions) viz. Dehradun (Narendra Nagar, Chakrata) Haridwar, Champawat, Almora, Pithoragarh, Chamoli (Kedarnath W.L.S., Valley of flowers W.L.S.), East Terai (Kishenpur, Dolly range, Surai range) and Tehri Forest Division were carried out. Enumeration of species in strategic locations was carried out and regeneration of priority species was recorded.


Collection of field data from (a) pure chir pine forest and (b) mixed forest from Ranikhet Range of Almora Forest Division

Collection of field data from Pithoragarh Forest Division



Collection of field data from Champawat Forest Division

Development of Eco distribution maps of important FGRs

Development of mapping methodology

For development of mapping methodology and sampling technique, the project team discussed and had a series of meetings and brain storming sessions with the experts of this field from Indian Institute of Remote Sensing, Forest Survey of India, Wild Life Institute of India, Uttrakhand Space Application Centre, Director Rajaji National Park, ICFRE etc. Based on the discussions with the experts and review of literature, following plan of action was prepared for the development of eco-distribution maps of the FGR species.

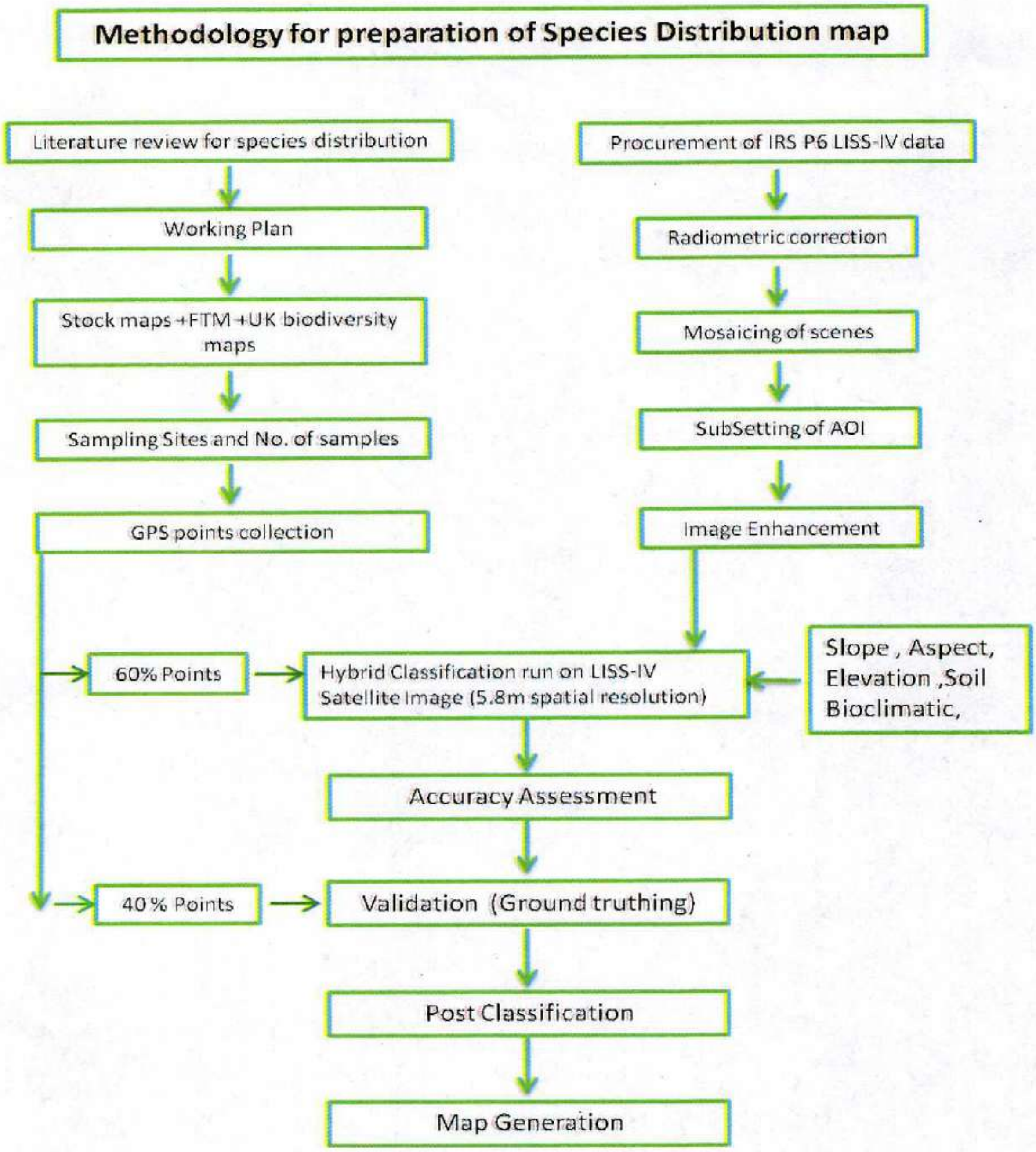


Fig. Flow chart showing the methodology for preparation of species distribution map

Sampling Methodology

To collect GPS points of species, sampling methodology was developed. For image classification, LISS-IV image will be used. LISS-IV has spatial resolution of 5.8m x5.8m, means one pixel of image cover 33.64m^2 on the ground. Therefore, sampling plot size was set as 6m x 6m = 36m^2. Data on plant height, DBH, latitude, longitude and altitude will be recorded on the number of species covered under plot size 36m^2.

Testing of Methodology

Field visits were carried out in the Mohand and Sukhblock of Chilllawalii Range, Rajaji National Park, Dehradun (Uttrakhand). This area is 80 % (approx.) hilly and cover mostly with mix deciduous forest. A total of 80 sample points/GPS locations each of 6 m x 6 m were laid down in a track of 40 kms and various parameters recorded.

Mohand and Sukh Block, Rajaji National Park, Date of data taken 11-12 June, 2016

Fig . Collections of GPS points and other information during field survey

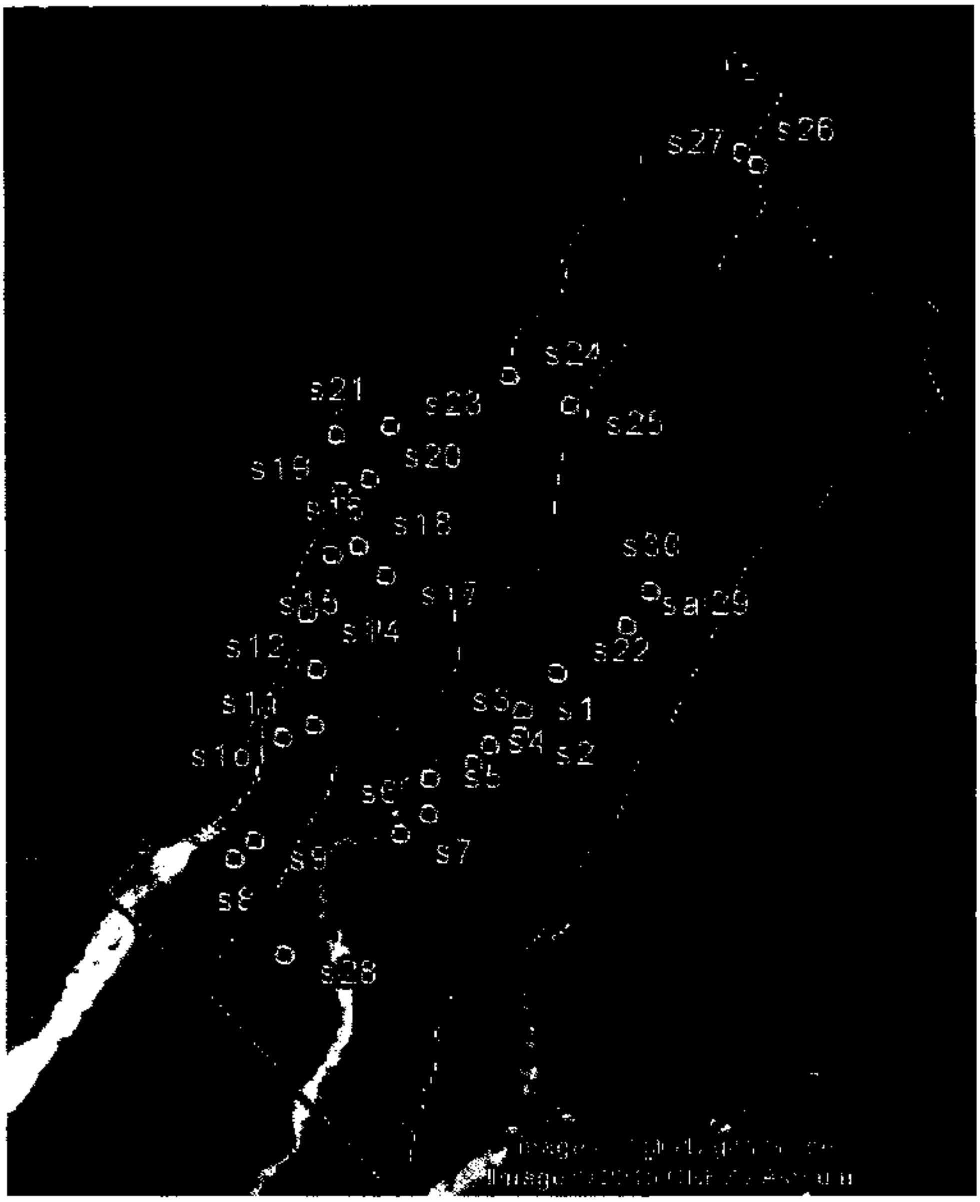


Fig . GPS points of Sal species in Mohand and Sukhblock area

Mapping

After the collection of the GPS points, supervised image classification algorithm run on LANDSAT-8 (freely available satellite data). Only 60% points were used to trained satellite data for showing Sal forest and rest of 30 % points used for accuracy assessment.

Conclusion

The forest area in Mohand and Sukh block of Chillawalli Range, Rajaji National Park works out to be 8.86 square km area under the Sal cover. This estimation is quite similar to the FSI

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Forest Type Report (Satellite Image LISS III used) and working plan (methodology not known to us) for Rajaji National Park. This indicates the reliability and accurateness of the adopted methodology.

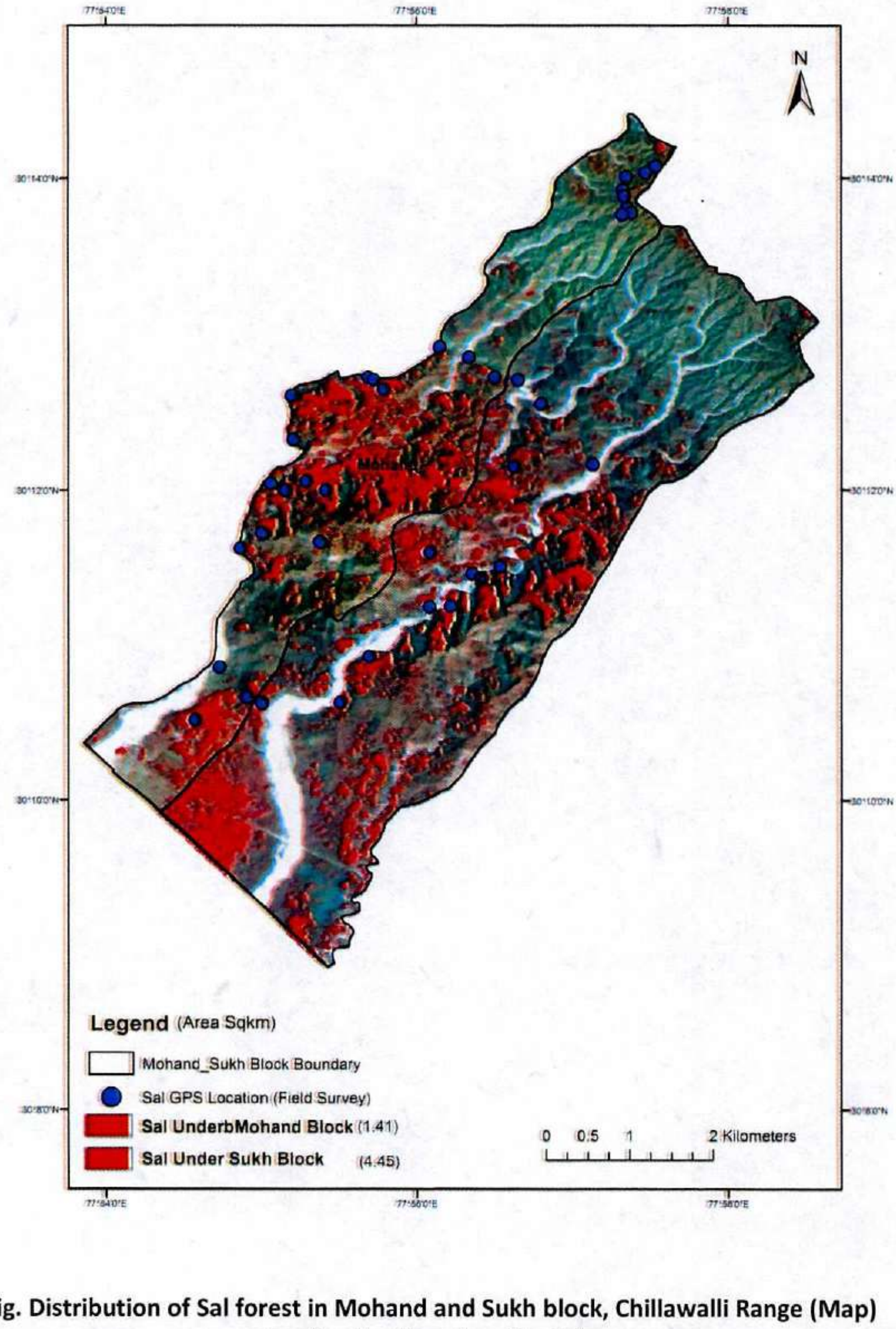

Fig. Distribution of Sal forest in Mohand and Sukh block, Chillawalli Range (Map) using the developed methodology

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B. FGR Seed and Germplasm Storage

Visit to NBPGR New Delhi

A team of scientists from FRI visited National Bureau of Plant Genetic Resources, New Delhi to explore possibility of utilizing the long term storage facility of NBPGR for storage of forestry species and to obtain the information about drying process of seeds, various storage chambers, Cryo preservation cell etc. to establish comparable infrastructure at FRI. The objective was also to explore possibility of training of scientists of FRI on long term seed and germplasm storage. Based on the visit of scientists, process initiated for the training of scientists at NBPGR New Delhi and utilizing the National facility of NBPGR for long term storage of forestry species under this project.

Training at NBPGR New Delhi

As per the request of FRI, National Bureau of Plant Genetic Resources (NBPGR) New Delhi organised a training course on "Techniques for of Conservation of Plant Genetic Resources" from 27th June to 2nd July, 2016. Ten Scientists and research personnel working in various components of CoFGR-CAMPA project participated in the training.

The training was very useful for all the participants and techniques learnt regarding processing and desiccating seeds for medium to long-term conservation will be used under the component

Some glimpses of the training

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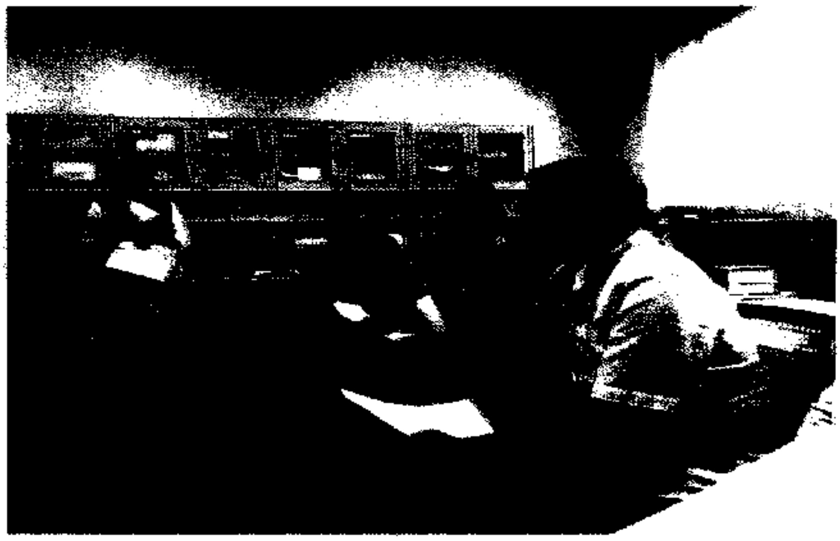


Survey of populations for seed collection

In order to capture sufficiently large genetic diversity in a species, seeds from at least five populations of each species have been planned for their medium term/long term storage. Hence, population survey was conducted in various ranges of some Forest Divisions of Uttarakhand and identified the population of following species for seed collection:

Locations	Species identified
Kansro Forest Range, Dehradun Forest Division	*Adina cordifolia* (haldu) *Aegle marmelos* (bel) *Albizia procera* (siris) *Holoptelia integrifolia* (kanju papri) *Lannea grandis* (jhingan) *Schleichera oleosa (kusum)* *Terminalia bellirica* (bahera)
Rishikesh Forest Range, Dehradun Forest Division	*Aegle marmelos* (bel) *Albizia procera* (siris) *Bombax ceiba* (semal) *Holoptelia integrifolia* (kanju papri)
Gaula Range Forest, Haldwani Forest Division	*Albizia odoratissima* (kali Siris) *Acacia catechu* (khair)
Kishanpur Forest Range, Haldwani Forest Division	*Bombax ceiba* (semal) *Lagerstroemia parviflora* (Dhauri)
Haldwani Forest Range, Central Tarai Forest Division, Haldwani	*Adina cordifolia* (haldu) *Albizia procera* (safed siris)
Chhakata Range, East Tarai Forest Division, Haldwani	*Acacia catechu* (khair) *Adina cordifolia* (haldu) *Holoptelia integrifolia* (kanju papri)
Tanda Range Central Tarai Forest Division, Haldwani	*Acacia catechu* (khair) *Garuga pinnata* (kharpat) *Mallotus philippensis* (rohini) *Toona ciliata* (tun)
Pipalpadav Forest Range Central Tarai Forest Division, Haldwani	*Acacia catechu* (khair) *Bombax ceiba* (semal)
Fatehpur Forest Range, Ramnagar Forest Division	*Adina cordifolia (haldu)* *Aegle marmelos* (bel) *Anogeissus latifolia* (bankuli) *Bombax ceiba* (semal) *Dalbergia sissoo* (shisham) *Holoptelia integrifolia* (kanju papri) *Desmodium oojeinensis* (sandhan) *Schelichera oleosa* (kusum) *Terminalia bellirica* (bahera) *Toona ciliata* (tun)
Bhakhra Forest Range Central Tarai Forest Division, Haldwani	*Aegle marmelos* (bel) *Emblica officinalis (aonla)*

Barhani Forest Range Central Tarai Forest Division, Haldwani	*Acacia catechu* *Aegle marmelos* (bel) *Bombax ceiba* (semal) *Holoptelia integrifolia* (kanju papri) *Mallotus philippensis* (rohini)
Nandhaur Forest Range Tarai East Forest Division, Haldwani	*Acacia catechu* *Adina cordifolia (haldu)* *Dalbergia sissoo* (shisham) *Dioscorea bulbifera* (genthi) *Desmodium oojeinensis* (sandhan) *Schleichera oleosa (kusum)*
Barakoli Forest Range, Sitarganj Tarai East Forest Division, Haldwani	*Acacia catechu* (khair) *Dalbergia sissoo* (shisham) *Dalbergia sissoo* (shisham) *Holoptelia integrifolia* (kanju papri) *Schleichera oleosa (kusum)*
Kaladhoongi Forest Range, Ramnagar Forest Division	*Adina cordifolia (haldu)* *Anogeissus latifolia* (bankuli) *Lannea grandis* (jhingan) *Schleichera oleosa (kusum)*
Almora Forest Range, Almora Forest Division	*Myrica esculenta* (kaphal) *Quercus leucotrichophora* (banj oak) *Toona ciliata* (tun)
Someswar Forest Range, Almora Forest Division	*Quercus glauca* (phaliyant) *Quercus leucotrichophora* (banj oak) *Rhododendron arboreum* (burans)
Ranikhet Forest Range, Almora Forest Division	*Myrica esculenta* (kaphal) *Quercus leucotrichophora* (banj oak)

Collection of seed

Seeds of following species were collected:

Species	**Fruit/pod Qty.**	**Site of Seed Collection**
Aegle marmelos *Terminalia bellirica* *Holoptelea integrifolia*	13 kg fruits 5 kg fruits 500 g	Kansro Forest Range, Dehradun Forest Division
Holoptelea integrifolia	0.500 kg	Timli Forest Range Dehradun Forest Division
Desmodium oojeinensis *Toona ciliata*	20 kg Pods 15 kg fruits	Rajaji Tiger Reserve, Dehradun Forest Division
Aegle marmelos	81 kg fruits	Fatehpur Forest Range, Haldwani
Toona ciliata	60 Kg fruits	Almora Forest Range, Almora Forest Division
Schleichera oleosa	-	Chilla Range

Fraxinus xanthoxyloides	-	Kailashpur, Malari Beat, Joshimath Range


Seed collection of *Desmodium oojeinensis* and *Rhododendron arboreum*

Seed extraction and processing

Seeds was extracted from the fruits, cleaned and processed for further tests. Initial parameters on seed weight, seed moisture content, seed germination, etc. were recorded.


Seed extraction

Seed Handling

Collected seeds were pre-cleaned and the impurities, foreign materials, soil particles, twigs and leaves which are detrimental to seed viability, were removed. Purity of the seed lot was calculated.

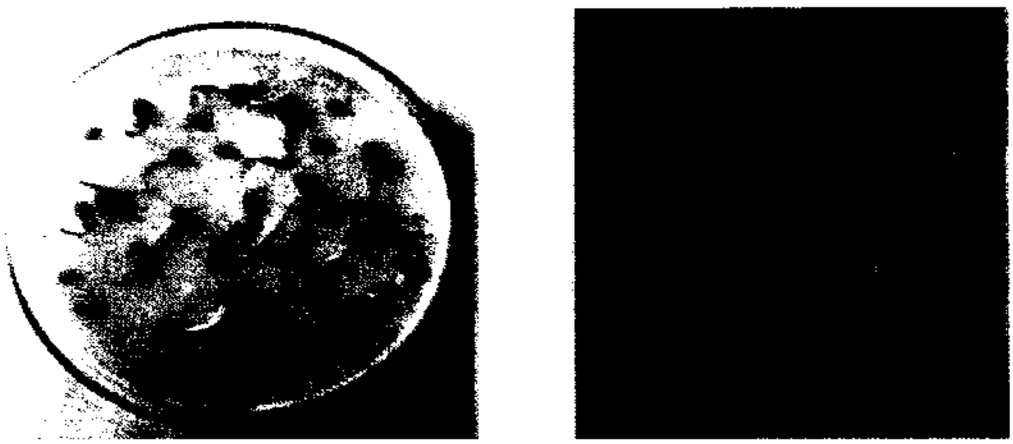
Seeds of F. *xanthoxyloides* are characterized by physiological dormancy as a result seeds took about a month to germinate and showed low germination. Seeds have been kept for moist stratification (pre-chilling) in combination of different treatments with GA_3.

Seed Drying and Storage

Seeds of *S. oleosa* were kept in storage at ambient room temperature for after-ripening. Seeds were desiccated to lower moisture levels with silica gel and stored under low temperature (5^0C) in Low Temperature Storage Cabinet.

Quarterly Viability testing of seeds

Germination test were conducted on the stored seeds of different species viz. *Desmodium oojeinensis, Toona ciliata, Aegle marmelos, Hippophae salicifolio, Rhododendron arboreum* and *Holoptelia integrifolia.*



Seed germination in *Hippophae salicifolia* and *Holoptelia intergrifolia*

Seed germination in *Desmodium oojeinensis* and *Toona ciliate*

Seed germination in *Aegle marmelos* and *Rhododendron arboreum*

***In-vitro* storage of FGR species**

For Developing protocols for *in-vitro* storage of germplasm of FGR species, following activities have been planned:

- Developing protocols for *in-vitro* storage of germplasm of FGR species of very high conservation concern and ones having recalcitrant seeds
- Developing protocols for storage of germplasm of red-listed species of FGR in the form of 'pollens'
- Maintaining minimal growth cultures and embryo cultures

As the prerequisite for the development of any *in vitro* conservation methods for storage of FGR (in this case either FGR of very high conservation concern or those having recalcitrant seeds or both) is the availability of a standardized *in vitro* regeneration protocol. Thus experiments have been initiated to devise *in vitro* regeneration or micropropagation protocols for selected species as given below:

a) *Rhododendron arboreum*
b) *Taxus contorta*
c) *Desmodium oojeinensis*
d) *Quercus floribunda*
e) *Q. Semicarpifolia*
f) *Diploknema butyracea*

a) *Rhododendron arboreum*

Plant sample collection: Mussourie and Chakrata area of Dehradun and Mazgaon (Tehri Garhwal), Uttarakhand.

i) Culture Initiation from nodal explants:

Culture Initiation: nodal explants were cultured in Murashige & Skoog's medium (MS), Driver-Kuniyuki Walnut medium (DKW) and Anderson's Medium (AM) supplemented with different concentrations of plant growth regulators viz. 6-Benzylaminopurine (BAP) and 2, 4 dichlorophenoxyacetic acid (2, 4 D).

***In vitro* response:** Nodal segments cultured on different growth medium combinations did not show any axillary or adventitious bud break or callus formation in cultures. Bacterial and fungal contamination in cultures was also a challenge in the establishment of *in vitro* cultures. Standardization of effective concentration of sterilants, duration of treatments and concentrations of plant growth regulator etc. is further ongoing in order to overcome the problem of microbial contaminations and achieve successful culture establishment

Fig.: Culture initiation of nodal segments of *R. arboreum*

ii) Culture Initiation from leaf explants

Culture Initiation: Small sections of leaves were cultured on MS medium supplemented with different concentrations of BAP and 2, 4-D to initiate callus cultures.

(622)

In vitro **response:** callus formation was initiated in some of the cultures and these are now under multiplication and will be used to induce somatic embryogenesis or organogenesis.

Fig.: Callus formation from leaf explants of *R. arboreum*

b) Taxus contorta

Plant Sample Collection: Deoban, Chakrata area of Dehradun, Uttarakhand.

i) Culture initiation from nodal explants:

Culture initiation: current year growth i.e. green and soft tissue of stem was taken for culture initiation. Nodal explants were cultured in Murashige & Skoog's medium (MS) supplemented with different concentrations of plant growth regulators viz. 6-Benzylaminopurine (BAP) and 2, 4 dichlorophenoxyacetic acid (2, 4 D).

In vitro **response:** Callus formation initiated in some of the cultures. New shoot bud initiation unsuccessful due to contamination and necrosis of cultures.

Fig.: culture initiation of shoot segments of *T. contorta*

Fig.: culture initiation of shoot segments of *T. contorta* on activated charcoal containing medium

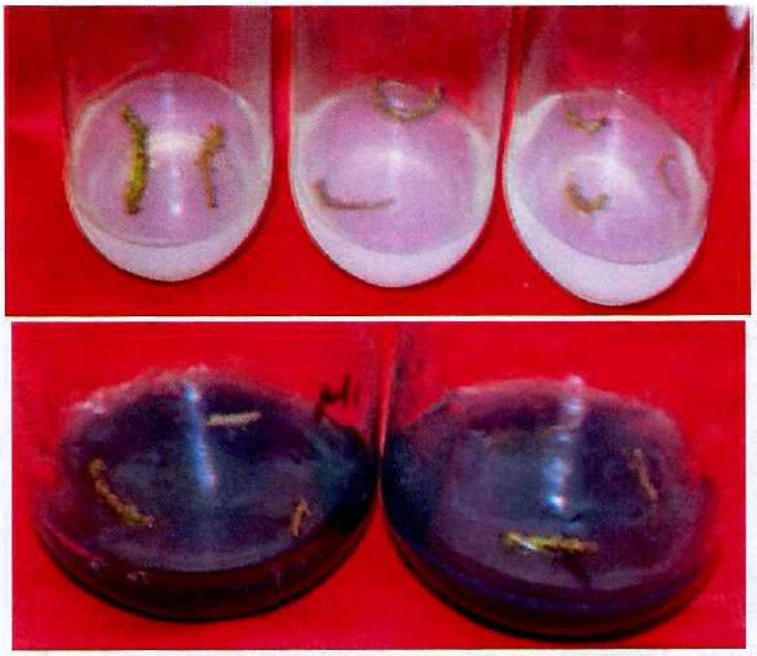


Fig.: Callus formation from shoot explants of *T. contorta*

c) Myrica esculenta

Plant Sample Collection: VMG in Botany Division of FRI

i) Culture Initiation from nodal explants:

Culture initiation: Young current season shoot and leaves were taken as explants. Nodal segments and leaf explants were cultured in Murashige & Skoog's medium (MS) and Woody Plant Medium (WPM) supplemented with different concentrations of plant growth regulators viz. Kinetin, 6-Benzylaminopurine (BAP) and Napthalene acetic acid (NAA).

***In vitro* response:** Excessive release of phenolics was observed in cultures within 24 hours of culture initiation. To overcome this, treatment of explants in 0.5% PVP solution was done prior to culture and in other case 0.5% PVP was added into the culture medium. Incorporation of PVP into the medium however controlled the release of phenolics to some extent. However no *in vitro* axillary bud induction or callus initiation was observed in any of the treatments.

Fig.: culture initiation from nodal segments of *M. esculenta*

d) Quercus semecarpifolia

Plant Sample Collection: Sample collected from Kanatal (Tehri Garhwal).

i) Culture Initiation from nodal segments:

Culture initiation: nodal segments were cultured in Murashige & Skoog's medium (MS) and Woody Plant Medium (WPM) supplemented with different concentrations of plant growth regulators viz. 6-Benzylaminopurine (BAP) and Indole acetic acid (IAA)

***In vitro* response:** The cultures are being observed for any *in vitro* bud induction.

Fig.: culture initiation from nodal segments of *Q. semicarpifolia*

e) Quercus floribunda

Plant Sample Collection: Sample collected from Kanatal (Tehri Garhwal).

Culture Initiation: similar as in *Q. semecarpifolia*

***In vitro* response:** The cultures are being observed for any *in vitro* bud induction.

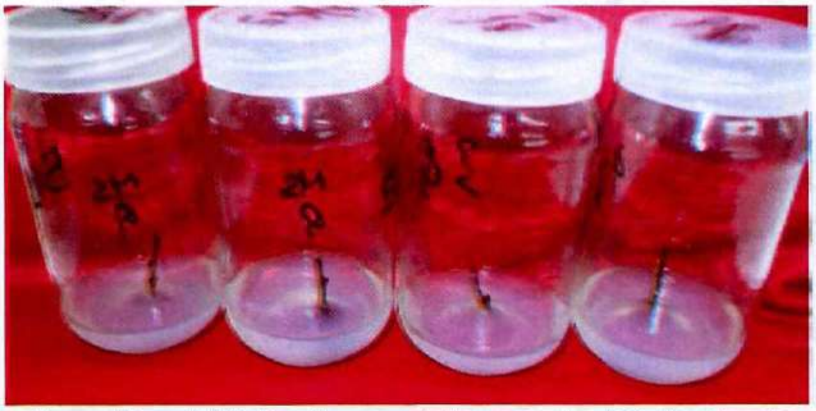


Fig.: culture initiation from nodal segments of *Q. floribunda*

f) Desmodium oojeinensis

Plant Sample Collection: Seeds were procured from Forest tree seed laboratory, Silviculture Division, FRI.

***In vitro* seed germination**

Culture Initiation: surface sterilized seeds were put for germination in petriplates under four different conditions as given in the table:

***In vitro* response:** In all the cases predominant seed browning was observed along with slight emergence of radical which ultimately died after few days.

Fig.: *In vitro* seed germination in *D. oojeinensis*

Hence in the next set of experiments time duration of $HgCl_2$ treatment was reduced to 5 & 7 minutes and seeds were aseptically placed on filter paper bridges in culture tubes containing liquid MS basal medium.

Duration of $HgCl_2$ treatment	Culture medium	Total seeds cultured	Percent germination after 6 days
5 minutes	MS Basal	21	71.4%
7 minutes	MS Basal	21	66.6%

The seeds germinated well in both the conditions and cotyledons emerged after 5 days. Different explants such as hypocotyls, cotyledonary nodes, and epicotyls would be taken from these *in vitro* seedlings and regeneration protocols would be worked upon. Another experiment with time duration of $HgCl_2$ treatment less than 5 minutes is also being carried out.

Fig.: *D. oojeinensis - in vitro* seed germination in liquid MS cultures

Fig.: *D. oojeinensis - in vitro* emergence of cotyledons from seeds surface sterilised with $HgCl_2$ for 5 minutes

QS05	Lokhandi, Chakrata, Dehradun	N 30^{0}45'30.4"	E 77^{0}49'57.8"	2750 m
QS06	Anusuya devi temple, Hans bugyal, Chamoli	N 30^{0}29'34"	E 79^{0}18'40.1"	3135 m
QS07	Auli, Joshimath, Chamoli	N 30^{0}31'26.3"	E 79^{0}33'53.8"	2944 m
Betula utilis				
BU01	Anusuya devi temple, Hans bugyal, Chamoli	N 30^{0}29'36.4"	E 79^{0}28'48.4"	3225 m
Myrica esculenta				
ME01	Anusuya devi temple, Hans bugyal, Chamoli	N 30^{0}29'16.2"	E 79^{0}17'30.0"	1992 m
ME02	Gairsain, Kedarnath	N 30^{0}05'41.4"	E 79^{0}17'30.0"	2274 m
ME03	Nagnath, Kedarnath, Chamoli	N 30^{0}19'31.8"	E 79^{0}11'46.0"	1801 m
ME04	Dhanpur range, Kedarnath, Chamoli	N 30^{0}13'43.8"	E 79^{0}12'29.6"	1554 m

Genomic DNA extraction: Different protocols were tried for DNA extraction from *Rhododendron arboreum* and finally on the basis of concentration (ng/µl) and purity ($A_{260/280}$), the CTAB method given by Doyle and Doyle, 1990 was used for DNA extraction. The same protocol resulted in good yield of genomic DNA from *R. arboreum* var pink, *Texas wallichiana* and *Quercus semicarpifolia*. Genomic DNA has been extracted from the following 26 populations. Standardization of protocol for DNA extraction from *Betula utilis* is under progress.

Details of populations from which DNA has been extracted:

Species	DNA extraction done
Rhododendron arboreum var red	RA01, RA02, RA03, RA04, RA05, RA07, RA08
Rhododendron arboreum var pink	RP01, RP02, RP03, RP04
Texas wallichiana	TB01, TB02, TB03, TB04, TB05, TB06
Quercus semicarpifolia	QS01, QS02, QS03, QS04, QS05, QS06, QS07
Myrica esculenta	ME01, ME02, ME03 under progress

Quantitative and Qualitative analysis of Genomic DNA: The concentration and absorbance ratio (A_{260}/A_{280} nm) of the DNA samples were quantified using Biophotometer (Eppendorf-6131, Germany). Details of populations for which DNA quantification has been done is given in the following table:

Details of populations for which DNA Quantification has been done:

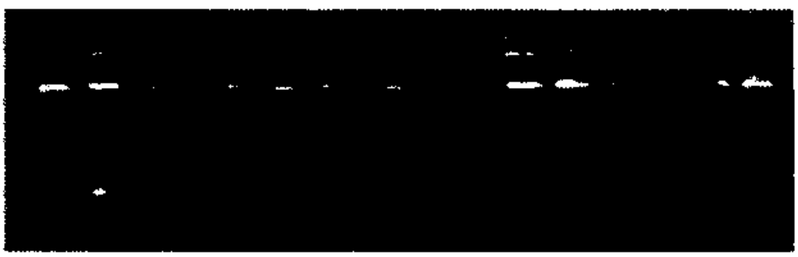
Species	DNA quantification done
Rhododendron arboreum var red	RA01, RA02, RA03, RA04, RA05, RA07
Rhododendron arboreum var pink	RP01, RP02, RP03, RP04
Texas wallichiana	TB01, TB02, TB03, TB04, TB05, TB06
Quercus semicarpifolia	QS01, QS02, QS03, QS04, QS05, QS06, QS07
Myrica esculenta	ME01, ME02

The quality of genomic DNA extracted from genotypes of all the species was analyzed on 0.8% agarose gel.

Genomic DNA extracted from *Quercus semicarpifolia*

Genomic DNA extracted from *Texas wallichiana*

Genomic DNA extracted from *Rhododendron arboreum*



Genomic DNA extracted from *Myrica esculenta*

Fig. Gel photographs showing Genomic DNA extracted from genotypes of different species

Bhojpatra (*Betula utilis*) from Rudranath trekking route, Gopeshwar

Kafal (*Myrica esculenta*) from trekking route of Ansuya Devi temple, Gopeshwar

Chemical Characterization : For chemical marker(s) assisted screening of *Rhododendron arboreum* and characterization of the elite accessions / genotypes desired numbers of flower samples of two population lines grown in Janglat Chowki, Kanasar Village, Charata and Budher, Kanasar Village, Charata were collected in the first quarter. The collected flowers were extracted with acidulated methanol. Some of the extracts were concentrated in vaccum and their yields were determined. Experiments for determining the total flavonoid contents in these extracts using spectrophotometric method were continued in this quarter also.

Further stem bark samples collected from one population line (ME 01) of *Myrica esculenta,* and leaves samples collected from one population line (QS 06) of *Quercus semicarpifolia* were freeze dried and milled for their chemical analyses. Extraction of the stem bark samples of ME 01 using 25% aqueous methanol for estimation of total tannin content was initiated and continued.

Literature on chemistry of *Betula utilis* was updated. Biochemical characterization of two populations of *Rhododendron arboreum* (RA 3 and RA 5) with respect to the total flavonoid contents (TFCs), was determined in their flowers using spectrophotometric method. TFCs (mg rutin equivalent /g extract) were found to be varying from 38.06 ±0.36 to 214.41± 4.04 (mean value 111.26 ±1.21) and 70.96 ±1.33 to 224.44 ±0.88 (mean value 128.66 ±1.35), respectively. Estimation of TFCs in the flower samples of the population line of RA 4 was continued. Extraction of the stem bark samples from one population line (ME 01) of *Myrica esculenta* using 25% aqueous methanol was completed. Protocol for estimation of total phenol contents (TPCs) in these samples was standardized. Estimation of TPCs using standardized protocol in these samples was initiated and continued. Standardization of protocol for estimation of total triterpenoid content in the stem bark samples of *Betula utilis* population was initiated and continued.

D. FGR Conservation

Five priority species have been sort listed for FGR Conservation as per the target of the project. The species are *Cinnamomum tamala, Diploknema butyracea, Rhododendron arboretum, Myrica esculanta* and *Taxus wallichiana.* The survey and review and literature through records was conducted to know distribution and status of prioritized species. Scientists have visited forest areas at Chakrata area for exploring the possibility of field gene banks. Preliminary survey of all the species selected for conservation of their genetic resources was completed in both lower and middle Himalaya. However, a detailed survey of *Taxas wallichiana* and *Rhododendran arboretum* was made in different forest ranges by exploring the areas at Devban, Kanasar range; Bhujkoti, Riknar range; Lokhandi village, Kanasar range of Chakrata Forest Division and some locations of Kedarnath Wildlife Sanctuary. The GPS locations of the intact promising populationswas recorded. Six populations of *Diploknema butyracea* have been located in Distt Pithoragarh at altitudinal range of 780 to 1290 m. Germplasm will be collected at time of seed maturation. Two nursery sites have been tentatively identified in District Pauri Garhwal and Chakrata for multiplication of germplasm. Scientists have also visited Dev Van Forest Nursery to explore the possibility to establish field gene bank and propagation of *Texas wallichiana*.

Species Name	**Population**	**Location**	**Geo-coordinates**
Texas wallichiana	**TWCH1**	Devban, Kanasar range, Chakrata	Lat: N 30^{0}44’52.4” Long: E 77^{0}51’58.3” Alt: 2818 m
	TWCH2	Bhujkoti, Riknar range, Chakrata	Lat: N 30^{0}47’14.2” Long: E 77^{0}55’24.2” Alt: 2693 m
	TWCH3	Near Hans bugyal on rudranath trekking route, Gopeshwar	Lat: N 30^{0}29’34” Long: E 79^{0}18’40.1 Alt: 3135 m
	TWKN1	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30^{0}27’11.5” Long: E 79^{0}14’29.9” Alt: 2577 m
	TWKN2	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30^{0}28’51.9” Long: E 79^{0}11’52.3” Alt: 2937 m

Species Name	**Population**	**Location detail**	**Geo-coordinates**
Rhododendron arboreum var Red	**CHRA-01**	Janglat Chowki, Kanasar range, Chakrata	Lat: N 30^{0}43’43.7” Long: E 77051’52.5” Alt: 2363 m
	CHRA-02	Budher, Kanasar range, Chakrata	Lat: N 30^{0}45’43.5” Long: E 77^{0}47’08.8” Alt: 2442 m
	CHRA-03	Near Nagthala, River range, Chakrata,	Lat: N 30^{0}35’25.1” Long: E 77^{0}56’16.3” Alt: 2161 m
	KNRA-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30^{0}27’11.5” Long: E 79^{0}14’29.9” Alt: 2577 m
	KNRA-02	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30^{0}28’51.9” Long: E 79^{0}11’52.3” Alt: 2937 m
Rhododendron arboreum var Pink	**KNRA(P)-01**	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30^{0}27’11.5” Long: E 79^{0}14’29.9” Alt: 2577 m

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	KNRA(P)-02	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30^{0}28'51.9" Long: E 79^{0}11'52.3" Alt: 2937 m
	GRA(P)-03	Near Hans bugyal on rudranath trekking route, Gopeshwar	Lat: N 30^{0}29'34" Long: E 79^{0}18'40.1" Alt: 3135 m

Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority

Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in IA No.1337 with IA Nos.827, 1122, 1216, 1473 in WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the ~~30th November 2016~~ 20th December 2016**

Note.

Sub.: **CAMPA/ NCAC – Support to the Project 'Creation of Centre of Excellence on Forest Genetic Resources of India, FRI, Dehradun.**

Kind reference is invited to this Office note of even number dated the 19th December 2016 on the subject mentioned above.

2. A further 'Progress Report' for the period July – September 2016 has since been received from the FRI, Dehradun vide letter No.9-108/DGTP-CoFGR/FRI.2016 dated the 9th December 2016. A copy of the Progress Report in question is enclosed with the request that the comments of the RT Division, Ministry of Environment Forest & Climate Change thereon may kindly be expedited.

(Rajagopal Nashant)
Asstt Inspector General of Forests
Tel No.: (011) 24695401

To

Dy Inspector General of Forests (RT)
(Dr Suneesh Buxy),
Ministry of Env Forest & Climate Change.

Encl.: a.a.

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To,
Shri Rajgopal Prashant
Asstt Inspector General of Forests,
Ministry of Environment, Forests and Climate Change

Subject: CAMPA/NCAC –Best Practice Guidance for Restoration of Mining Sites

Reference: Letter no: 10th /19th December 2016

Sir,

With reference to the letter above, I would like to inform that the draft guidance for restoration of mining sites is ready for submission. It is being sent separately for your review. We will thereafter get the document printed.

Thanking you,

Yours Faithfully

PR Sinha
Country Representative, IUCN

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To,
Shri Rajgopal Prashant
Asstt Inspector General of Forests,
Ministry of Environment, Forests and Climate Change

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Country Representative, IUCN

16 AIG (RP) Manual
10/01/2017

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4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 16th January 2017.**

Shri P R Sinha,
Country Representative,
IUCN India Country Office,
C-4/25 Safdarjung Dev Area,
New Delhi – 110 016.

Sub.: **CAMPA / NCAC : Best Practice Guidance for Restoration of Mining Sites.**

Sir,

Please refer to your letter dated NIL, received in this Office on 10th January 2017, on the subject mentioned above. The Draft Guidance for Restoration of Mining Sites has not yet been received. The same may kindly be expedited so that it could be reviewed and our reactions presented/ discussed, for further action in the matter.

Yours faithfully,

(Rajagopal Prashant)
Asstt Inspector General of Forest
Tel No.: (011) 2469540

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30 January 2017

To,
Shri Rajgopal Prashant
Asstt Inspector General of Forests,
Ministry of Environment, Forests and Climate Change

Subject: CAMPA/NCAC –Best Practice Guidance for Restoration of Mining Sites

Reference: Our letter no: 04 January 2017

Sir,

In continuation of this office letter date 04 Jan 17, I am submitting herewith Draft "Best practices Guidance for Restoration of Mining sites".

It is also requested that comments/ Suggestions on draft guidance book may please be communicated. Dn receipt of comments, final printed version after due formatting and editing would be submitted.

Utilization certificate in the prescribed format is being sent separately.

Thanking you,

Yours Faithfully,

PR Sinha
Country Representative, IUCN

Encl: Draft Report – one copy

OSD CAMPA
p' pmp
01/2/17

Draft for review

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IUCN

Guidelines on Sustainable Restoration of Mining Areas

January 2017

Project Team

- Mr P R Sinha
- Ms Shilpi Misra
- Mr Vipul Sharma
- Dr N M Ishwar

Acknowledgements

Table of Contents

1. Introduction

Mining has long been considered as an important activity in meeting the mineral requirements of a country. It plays crucial role in the country's economic and social development. While it brings t significant economic returns, it comes with immense environmental cost. Historically extraction of minerals has always led to environmental degradation as well as social impacts. Mining thus has significant ecological and sociological footprint. Advances in technology now take care of these negative impacts. [1,2,3,4]. Increasingly, mining companies are making efforts to reduce the environmental impact of mining and minimize ecological footprint of their activities throughout the mining cycle, including restoration of ecosystems post the mining operations[5].

According to the Ministry of Mines, Government of India, since Independence the country has produced as many as 87 minerals, which includes 4 fuels, 10 metallic, 47 non-metallic, 3 atomic and 23 minor minerals[6]. As per the Indian Minerals Yearbook 2014, there were 3699 reporting mines (excluding atomic & minor minerals and petroleum (crude & natural gas) in India located in its 22 states. It has also been recognized that almost all of these minerals are located in ecologically rich and sensitive areas especially forested areas with diversity of plant and animal species and in river systems (Map 1).

The distribution of mineral resources and the ever increasing need for its extraction to meet the demands of development has often resulted in the diversion of forest land for mining requirements. It has been reported that between 1980 to 2005 close to 0.1 million ha of forest land has been diverted across India for mining[7]. In addition to forest diversion, iron ore mining often occurs in areas of important rivers and water sheds as and their operations lead to significant pollution of our water table.

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[1] Rankin. W.J.. *Minerals. metals and sustainability: meeting future material needs.* 2011, Collingwood. Vic.: CSIRO Pub.
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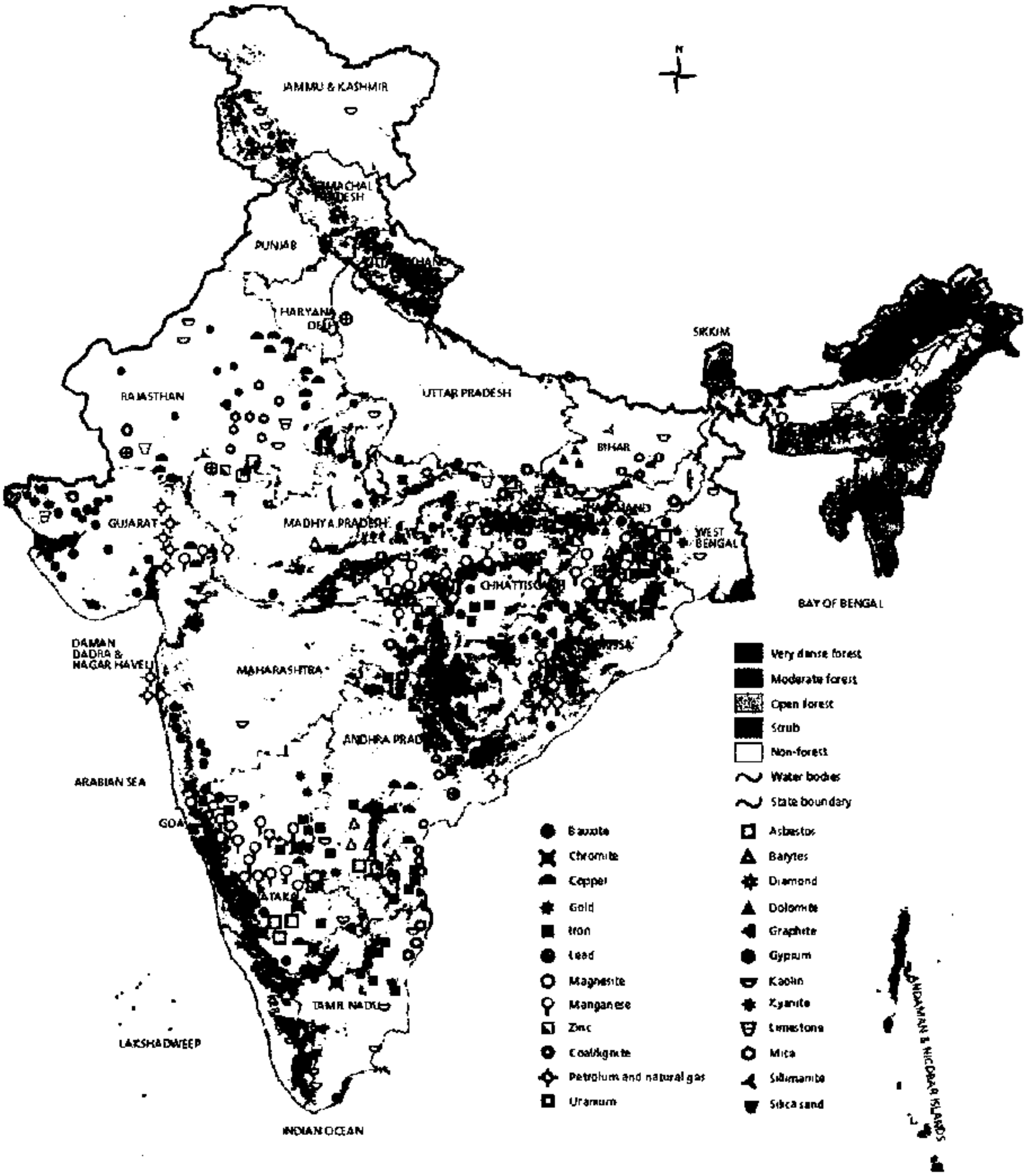
[3] Rajaram, R.. *Chapter 3: Issues in Sustainable Mining Practices, in Sustainable Mining Practices -- A Global Perspective*, V. Rajaram and S. Dutta, Editors. 2005. A. A. Balkema Publishers. a member of Taylor & Francis Group: Leiden. The Netherlands. p. 45-89.
[4] Rajaram. R. and K. Parameswaran. *Chapter 1: Introduction. in Sustainable Mining Practices -- A Global Perspective.* V. Rajaram and S. Dutta. Editors. 2005. A. A. Balkema Publishers. a member of Taylor & Francis Group: Leiden. The Netherlands. p. 1-11.
[5] ICMM., *Good practice guidance for mining of biodiversity.* 2006, ICMM Pub
[6] http://mines.nic.in/writereaddata/UploadFile/National_Mineral_Scenario.pdf
[7] Anon. CSE Media briefing Mining in India. 2012.

Map 1. The mineral deposit and forest resources map of India.



Source – Anon 2001, Environmental Atlas of India, Central Pollution Board, New Delhi

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Over the years, these environmental and societal costs have led to a rise in number of issues for the mining sector. Significant and more complex among them are a) the abandonment of mines that were not scientifically closed at the end of their life and b) ecologically inappropriate restoration of mined out areas. The complexity in understanding these issues alone and varying standards in mine closure has raised questions against the Indian mining sector its sustainability.

2. IUCN and the Mining Sector

IUCN has been working globally as well as in India with large mining companies and supporting them technically in addressing biodiversity conservation issues. Since 2000 and formalized in 2003, IUCN and the International Council on Mining and Metals (ICMM) launched a joint dialogue on mining and biodiversity. This engagement has helped in mainstreaming biodiversity concerns into the life cycle of mines among leading global players in the extractive mining sector.

Similarly, IUCN's Business and Biodiversity Programme has been working with the cement and aggregates sector since 2007 to better integrate biodiversity into a company's decision-making and operational process. Specifically, IUCN has been engaging with global company, LafargeHolcim to develop and pilot Biodiversity Management and Monitoring Tools[8]. as well as with a number of industry associations to promote and disseminate biodiversity management in the sector.

IUCN is also working with the World Business Council for Sustainable Development (WBCSD), Cement Sustainability Initiative to facilitate the consultation process for the Concrete Sustainability Council's (CSC) certification scheme. CSC is a global effort by 25 major cement producers, who believe that there is a strong business case for pursuing sustainable development in their business.

IUCN has also build on action-based relationship with business that goes beyond their Corporate Social Responsibility obligations, addressing the root causes of environmental degradation. As part of this partnership, IUCN has led the process setting standards between 2012 and 2014 for the Aluminum Stewardship Initiative (ASI). In December 2014, leaders from the aluminum value chain unveiled a new comprehensive standard that aims to improve the industry's environmental, social and governance performance throughout its entire value chain, including plans to reduce its greenhouse gas emissions.

With regards to mining for minerals and for oil and gas exploration (including associated infrastructure and activities) in areas of Outstanding Universal Value recognized as World Heritage Sites, IUCN position is that such mining operations should not be permitted within these sites. If the operations are proposed outside the boundaries of World Heritage sites, IUCN recommends that it should not, under any circumstances, have negative impacts on their Outstanding Universal Value of the World Heritage Site[9].

[8] https://www.iucn.org/theme/business-and-biodiversity/resources/browse-sector/cement-and-aggregates
[9] https://www.iucn.org/sites/dev/files/import/downloads/iucn_advice_note_on_mining_in_wh_sites_final_060512__2_.pdf

3. Mining and its Impacts on the Environment

The mining of metals and minerals encompasses a range of activities that includes primary (extraction) and secondary (milling, processing, refining, and waste disposal) phases[10]. Table 1, summarizes the methods of underground and/or surface extraction and the nature of the associated land/natural resource disturbances. It is often the waste production and its disposal cause the most extensive and long-lasting disturbance to land in mining areas. The disposal of rocks and overburden, the construction of impoundments (dams) for the tailings and the disposal of slags from the smelting and refining stages can involve large areas of land. Such waste production has been further enhanced significantly during the more recent modern and globalization[11] times in mining wherein the development of lower grade ore bodies has become a necessity and the increased waste production has had greater environmental impacts, and land disturbance.

Table 1. Main types of metal and industrial minerals mining and the associated disturbance (adapted from Cooke, 1999 [12]).

Mining method	Brief description	Disturbance
Shallow underground mining	Seams up to 60 m deep.	Surface spoil heaps; subsidence and collapsed old workings often left derelict
Deep underground mining	Seams deep underground, accessed through shafts	Subsidence; surface waste disposal — spoil heaps, tailings, and slurry lagoons usually remain after closure
Strip mining (opencast, opencut)	Horizontal or sloping seams usually up to 60 m below surface, taken out from surface.	Removal of vegetation and stockpiles of overburden-rock, subsoil, and topsoil. Temporary if using progressive backfilling; mineral processing and waste disposal facilities may be left after closure
Dredge mining	Alluvial and mineral deposits throughout bulk of mined materials; mining ponds created with floating dredger and concentrator	Removal of vegetation and stockpiling of topsoil and tailings from concentrator, usually progressively backfilled
Open-pit mining	Ore body near surface usually steeply dipping seam or pipe. Ore taken out by blasting or hydraulically	Little waste left to backfill; steep faces and pit floor left; also rock dumps and waste disposal facilities such as tailings lagoons remain after closure

[10] Barbour, A.K. 1994. Mining non-ferrous metals. In Mining and its environmental impact. Edited by R.E. Hester and R.M. Harrison. Issues in Environmental Science and Technology. Royal Society of Chemistry, Letchworth. England. pp. 1–15
[11] Mining Annual Review. 1995. Mining annual review. Mining Journal Ltd London
[12] Cooke, J.A. 1999. Mining. *In* Ecosystems of disturbed ground. *Edited by* L. Walker. Ecosystems of the World. Elsevier. Amsterdam, pp. 381–400.

Mining has the potential to affect biodiversity throughout the life cycle of a project, both directly and indirectly. Direct or primary impacts from mining can result from any activity that involves land clearance (such as access road construction, exploration drilling, and overburden stripping or tailings impoundment construction) or direct discharges to water bodies (riverine tailings disposal, for instance, or tailings impoundment releases) or the air (such as dusts or smelter emissions). Direct impacts are usually readily identifiable. Indirect or secondary impacts can result from social or environmental changes induced by mining operations and are often harder to identify immediately. Cumulative impacts occur where mining projects are developed in environments that are influenced by other projects, both mining and non-mining[5] (Table 2).

Table 2. Potential impacts across the life-cycle of mines on the natural environment and biodiversity.

Mining activities	Impacts
Exploratory phase ➢ clearing of wide areas of vegetation ➢ construction of access roads	➢ substantial environmental impacts, especially if access roads cut through ecologically sensitive areas, ➢ extensive clearing of vegetation leads to land degradation and soil erosion
Extraction phase ➢ staging areas that would house project personnel and equipment ➢ creation of overburden, waste rock piles and mine tailings ➢ use of heavy machinery, usually bulldozers and dump trucks, dredges, or hydraulic jets of water (a process called 'hydraulic mining') typically used to extract the ore ➢ transfer of ore to mineral ore extraction facility ➢ beneficiation of ore using various chemicals, leach piles containing residual chemicals ➢ erosion of tailings by wind and water	➢ substantial physical disturbance to landscape ➢ loss of biodiversity ➢ disturbance to stream bed ➢ transportation of ore using heavy machinery leads to fugitive dust emissions, emissions from blasting ➢ beneficiation generates large quantities of waste ➢ high-volume toxic wastewater streams, development of metal bearing and acidic soils leading to acid rock drainage ➢ metal leaching to groundwater ➢ fugitive emissions from mine tailings ➢ surface water pollution from mine tailings ➢ displacement of people

Biological Diversity

The Convention of Biological Diversity (CBD) defines Biological diversity as the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

As part of IUCN dialogue with the International Council for Mining and Metals (ICMM) since 2000, a lot of valuable materials and evidence has been accumulated on the impacts of mining (across its life cycle) on biodiversity. Figure 1 illustrates the interactions between the project development phase of a mine and biodiversity, while Figure 2 illustrates the potential impacts during the operational phase of the mines on biodiversity. These two figures have been reproduced from the IUCN – ICMM publication[5].

Figure 1. Examples of potential impacts during the development phase of mining on biodiversity.

[redacted]

POTENTIAL IMPACTS	**MINING ACTIVITIES**	**Exploration and construction**	Early stages of exploration	Exploration drilling	Access road construction	Land clearance (for construction, etc.)	Obtaining construction materials	Construction related infrastructure	**Construction of ancillary infrastructure**	Roads, rail & export infrastructure	Pipelines for slurries or concentrates	Energy/power & transmission lines	Water sources, wastewater treatment	Transport of hazardous materials
Impacts on terrestrial biodiversity														
Loss of ecosystems and habitats				●	●	●	●			●	●	●		●
Loss of rare and endangered species				●	●	●	●	●		●	●	●		●
Effects on sensitive or migratory species				●	●	●	●	●		●	●	●		●
Effects of induced development on biodiversity					●	●		●		●				●
Aquatic biodiversity & impacts of discharges														
Altered hydrologic regimes					●	●	●	●		●		●	●	●
Altered hydrogeological regimes				●			●							
Increased heavy metals, acidity or pollution				●		●	●	●		●		●	●	●
Increased turbidity (suspended solids)				●	●	●	●	●		●	●	●	●	●
Risk of groundwater contamination				●			●	●		●	●		●	●
Air quality related impacts on biodiversity														
Increased ambient particulates (TSP)				●	●	●	●	●		●		●		●
Increased ambient sulfur dioxide (SO_2)								●				●		●
Increased ambient oxides of nitrogen (NO_x)								●				●		●
Increased ambient heavy metals												●		
Social interfaces with biodiversity														
Loss of access to fisheries						●	●			●	●	●		
Loss of access to fruit trees, medicinal plants						●	●	●		●	●	●		
Loss of access to forage crops or grazing					●	●	●	●		●	●	●		
Restricted access to biodiversity resources						●	●			●	●	●		
Increased hunting pressures				●	●	●	●	●		●		●		●
Induced development impacts on biodiversity					●	●	●	●		●		●		●

Figure 2. Examples of potential impacts during the operational phase of mining on biodiversity.

[redacted]

POTENTIAL IMPACTS	**MINING ACTIVITIES**	**Ore processing and plant site**	Plant site, materials handling, etc.	Extraction and waste rock storage	Rock blasting and ore removal	Mine dewatering	Placer and dredge mining	Ore stockpiling	Pyrometallurgical processing	Hydrometallurgical processing	Use and storage of process chemicals	Tailings containment/disposals
Impacts on terrestrial biodiversity												
Loss of ecosystems and habitats			●	●			●					●
Loss of rare and endangered species			●	●			●					●
Effects on sensitive or migratory species			●	●	●				●	●		●
Effects of induced development on biodiversity												
Aquatic biodiversity & impacts of discharges												
Altered hydrologic regimes			●	●	●	●	●			●		●
Altered hydrogeological regimes				●	●	●				●		●
Increased heavy metals, acidity or pollution			●	●	●	●	●	●		●	●	●
Increased turbidity (suspended solids)			●	●	●		●	●		●		●
Risk of groundwater contamination			●	●	●	●		●		●	●	●
Air quality related impacts on biodiversity												
Increased ambient particulates (TSP)			●	●	●			●	●			●
Increased ambient sulfur dioxide (SO_2)									●			
Increased ambient oxides of nitrogen (NO_x)									●			
Increased ambient heavy metals			●	●	●			●	●			●
Social interfaces with biodiversity												
Loss of access to fisheries			●	●								●
Loss of access to fruit trees, medicinal plants			●	●								●
Loss of access to forage crops or grazing				●		●		●		●		●
Restricted access to biodiversity resources				●								●
Increased hunting pressures			●									
Induced development impacts on biodiversity												

The final stage in a mines life-cycle is that of mine closure that occurs as a result of the total extraction of the mineral reserves within the physical limits of a deposit or unworkability of the deposit due to technical/economic reasons. The legacy of abandoned mines and their associated adverse environmental and safety problems have led to an increased emphasis on mine closure planning in recent years. Both in the developed and developing countries, mine closure issue has been a challenging and herculean task and requires good planning, monitoring and execution as well financial commitments and hence to be exercised correctly[13].

In order to address these challenges, the Central Government; issued the following notifications *vide* No. GSR 329 (E) dated 10.04.2003 and No. GSR 330 (E) dated 10.04.2003 amended the Mineral Concession Rules, 1960 and Mineral Conservation and Development Rules, 1988. As per these notifications and the amendments all the existing mining lessees are required to submit the "Progressive Mine Closure Plan" along with prescribed financial sureties within 180 days from date of notification. Further, the mining lessee is required to submit "Final Mines Closure Plan" one year prior to the proposed Closure of the mine. The Indian Bureau of Mines has provided the necessary formats for the "Progressive Closure Plan" and "Final Closure Plan" (Annex 1).

The objectives of mine closure typically includes minimizing long-term environmental liability, attaining regulatory compliance and maintaining geotechnical stability, while closing as quickly and cost effectively as possible and to return land to a safe and stable condition for post-mining uses. Post mining site restoration and rehabilitation are the final and most crucial stages in a mining closure plan and requires site specific detailed planning. However, comprehensive mine closure for abandoned mines, operating mines and future mines continues to remain a major challenge for every mining nation in the world.

3.1 National issues related to mining sector

In India, immense growth in the mining industry has been seen. However, this sector is facing many challenges:

- use of low grade technology for mining by small scale miners,
- less investment in exploration, pre-mining surveys related to biodiversity, geotechnical surveys,
- improper management of mining activities and related degradations,
- mine abandonment without any proper environmental mitigation measures,
- lack of funds or investment in mining restoration or rehabilitation,
- inadequate and unscientific ways of doing mining and post closure restoration and rehabilitation,
- no involvement of public in decision making,
- lack of stringent and properly structured laws which can properly scientific restoration a mandate

[13] Tripathy, D.P.(2004) Planned Mine Decommissioning, Closure and Reclamation of a Mine Site, Proceedings of International Seminar on Technology Update in Mining & Mineral Industries, MEAI, October 16-17, Bangalore, Editors. Prof. Ramlu, M.A. et al, pp.345-355.

In recognition of this, in 2005, a high level committee was set up under the chairmanship of Shri Anwarul Hoda, Member, Planning Commission[14]. The committee reviewed the National Mineral Policy and recommended that apart from introducing best practices in implementation of environment management, there was also a need to take into account the global trends on sustainable developments in the mining sector. The High Level Committee specifically studied the impact of mineral development with the need to develop principles in mining, best practices, and reporting standards which may be measured objectively. The committee recommended development of an Sustainable Development Framework (SDF) specially tailored to Indian context taking into account the work done and being done by the International Council of Mining and Metals (ICMM) and the International Union for the Conservation of Nature and Natural Resources (IUCN). The SDF was to comprise principles, reporting initiatives and good practice guidelines as well as rating standards for systematic and scientific management and restoration of mines.

Planned decommissioning, closure and reclamation planning have in recent years become a legal necessity in India since 2003 as pragmatic business approach and an environmental responsibility are viewed as an integrated part of mining cycle. There is still lack of expertise in this field. Closure and rehabilitation costs must be directly or indirectly borne by the state. Studies on environmental impacts of mining post closure are very rare. Hence considerable efforts are needed to be directed towards environment and safety risk assessment of mines after mine closure.

[14] http://www.mines.nic.in/writereaddata/UploadFile/SDF_Overview_more.pdf

4. On Restoration Guidelines – Needs and Objectives

Mining leases are given to companies on short/long-term lease with the legal safeguard that the land will be restored after mining; this condition is a prerequisite for lease extension (MMDR Act 2015). However these safeguards are often violated (with few exceptions) and land is usually abandoned without proper management. Such negligence poses serious threat not only to biodiversity but public health especially in the case of open cast mining. In absence of any proper waste disposal strategy, toxic dust blowing from overburdened dumps (OBD) degrade air quality and leaching of toxic elements into groundwater and water bodies degrade water quality of surrounding areas. Toxic runoff from mine sites also degrades fertile land and damage livelihoods. Thus ecologically sound restoration of mined out areas (as outlined in the mine closure plans) has become essential not only for conservation of biodiversity but also for public health and livelihoods and could potentially reduce the negative impacts of mining on the environment.

The Importance of mine closure plans

The goal of mine site reclamation/restoration/rehabilitation and closure has been to return the site to a condition that most resembles the pre-mining condition.

Hence, mine reclamation and closure plans must describe the following things in sufficient detail:

- how the mining company will restore the site to a condition that most resembles pre-mining environmental quality;
- how it will prevent – in perpetuity – the release of toxic contaminants from various mine facilities (such as abandoned open pits and tailings impoundments);
- how funds will be set aside to insure that the costs of reclamation and closure will be paid for

Definitions - Restoration, Reclamation and Rehabilitation

The terms reclamation, rehabilitation, and restoration are all used to describe mine closure activities that attempt to alter the biological and physical state of a site. The terms are sometimes used interchangeably, and are closely linked, but refer to distinct steps in the preparation of the site for another use:

Reclamation is the physical stabilization of the terrain (dams, waste rock piles), landscaping, restoring topsoil, and the return of the land to a useful purpose.

Restoration is a process of rebuilding the ecosystem that previously existed at the mining site before it was disturbed for mineral extraction. Mine site restoration has evolved now from simply vegetating the area to using native plant species which can mimic and get acclimatized with the site as time passes.

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Rehabilitation involves the establishment of a stable and self-sustaining ecosystem, but not necessarily the one that existed before mining began. In many cases, complete restoration may be impossible, but successful remediation, reclamation, and rehabilitation can result in the timely establishment of a functional ecosystem.

Internationally, there seem to be three schools of thought on the overall objectives of restoration of mines;

- "What the affected community wants, the affected community gets" – that is, the key focus is on providing the end product requested by the affected communities, rather than focusing on the previous status quo.
- "Restoration to previous land use capability" – the original thought process as mining often occurs in areas of high natural resources
- "No net loss of biodiversity" – the fooal point in the ICMM/IUCN dialogue sponsored guidelines for mining and biodiversity, and of many mining corporate policies.

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5. Scope and Structure of this Document

Drawing upon the examples and expertise available in the country and abroad, it was proposed by IUCN India to develop a *Best Practices Guidance on Management and Restoration of Mining Sites in India* in order to advice the stakeholders on the possibilities of sustainable restoration of mining sites. Towards meeting this output, a consultation meeting with government officials, mining companies, representatives of mining companies and restoration experts from educational institutions was organized on 8th of December 2015 by IUCN. This meeting, while enabling of sharing of lessons and challenges also provided inputs on the design the "Best practices for mining area restoration" document. In addition, targeted field visits to successfully restored mined sites as well as discussions with relevant stakeholders that included officials, researchers, and mining experts was also completed. These formed the basis for the guidance document.

In addition to the guidance document, an annotated bibliography of published papers and reports both nationally and internationally on issues related to mining and restoration that includes the conservation and biodiversity in mining areas was also agreed to.

The overall purpose for the document is to strengthen the knowledge base with respect to the conceptualization, and management of restoration of mining sites in India. It is envisaged that the outcomes would guide both government as well as industry on the subject of restoration. This will be a positive step forward on by government and industry collectively contributing in achieving India's commitment towards Aichi Targets.

The structure of the guidance document is as follows: a brief narrative on the policy framework on restoration/rehabilitation of mines is followed by showcasing successful case studies both nationally and internationally on mine closure and restoration. Based on this, final two sections provide suggestions and recommendations for companies on the structure for a scientifically robust restoration plan for rehabilitation of mines. It is envisaged that these proposed restoration/rehabilitation guidelines would form part of the sections 3 and 4 of the mining closure plans (Annex 1).

Consistent with industry-leading practice, these guidelines are based on the principle that planning for an effective restoration of mined areas is a central component to the mine closure plan and should be an integral part of mine development and operations planning and should start *"up front"* as part of mine feasibility studies.

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On mining closure plans

The Central Government of India *vide* Notification No. GSR 329 (E) dated 10.04.2003 and No. GSR 330 (E) dated 10.04.2003 amended the Mineral Concession Rules, 1960 and Mineral Conservation and Development Rules, 1988 respectively. As per these amendments all the existing mining lessees are required to submit the "Progressive Mine Closure Plan" along with prescribed financial sureties within 180 days from date of these notifications. Further, the mining lessees were required to submit "Final Mines Closure Plan" one year prior to the proposed closure of the mine. In these notifications it has been enumerated that the "Progressive Closure Plan" and "Final Closure Plan" should be in the format and as per the guidelines issued by the Indian Bureau of Mines. These notifications acknowledges that the Mine closure encompasses rehabilitation process as an ongoing programme designed to restore physical, chemical and biological quality disturbed by the mining to a level acceptable to all concerned. It is further elaborated that the aim would be to leave the mined area in such a way that rehabilitation does not become a burden to the society after mining operation is over. As Mine closure operation is a continuous series of activities starting from day one of the initiation of mining project, these notifications inform that progressive mine closure plan will be an additional chapter in the present mining plan and will be reviewed every five years in the Scheme of Mining. As progressive mine closure is a continuous series of activities, it is obvious that the proposals of scientific mining have had included most of the activities to be included in the progressive mine closure plan.

The Indian laws recognize that closure planning is a progressive process and that Mine Closure Plans are living documents that could undergo ongoing review, development and continuous improvement throughout the life of a mine. The level of information required needs to recognise the stage of mine development (i.e. exploration, planning and design/approvals, construction, operations, decommissioning, post-closure maintenance and monitoring), with detail increasing as the mine moves towards closure. It is also acknowledged that not all technical information will be available at the early stages of development, however knowledge gaps relating to closure specific technical information are expected to be listed in the initial Mine Closure Plan and then refined/ developed in future iterations. At al it is envisaged that the plans are based on reliable science-based and appropriate site-specific information, and that ecologically sustainable restoration can be achieved.

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6. Best Practices – National Case Studies

This section provides a summary of key case studies from mining companies who have proactively been involved in afforestation efforts for over more than two decades. Often, such afforestation efforts have not been just limited to the mining lease areas but also outside these mining lease areas.

a) Sanquelim Iron Ore Mine –Mine reclamation in Goa, India

The Sanquelim Group of Mines belonging to M/s Sesa Sterlite Limited (Sesa Goa Limited) in North Goa District of Goa State covers an area of ca. 203 Ha. Major mining operations were discontinued in late nineties as it was found to be uneconomical to mine the low grade ore found in the reserves. During this period there was no formal legislation in place for systematic mine closure planning. Yet the company proactively carried out a systematic and scientific mine closure plan. The reclamation activities mainly comprised of three main aspects *viz.* extensive afforestation, converting some parts of the pits into water bodies to harvest rainwater and the utilization of existing building infrastructure for benefit of community.

The mine pits were systematically back filled by forming benches making it feasible for carrying out afforestation. After the dumps were stabilized, company selected one of the reclaimed mine pits to experiment with different afforestation techniques using native horticulture and forest species. Technical expertise and guidance from various organisations like Goa University, State Agriculture Department, State Forest Department, Rubber board were taken at the time of implementation. It has been recorded that the company planted more than 750,000 saplings on the Sanquelim iron ore mine. Along with afforestation a major part of mine pit were converted into water bodies by harvesting rainwater. In order to value add to the water bodies, the company approached National Institute of Oceanography to find out the possibility of growing or cultivating fresh water fish in the rain water filled mine pit.

The success of the reclamation techniques led to enlarging the scope of the afforestation in other mine pits within the Sanquelim mine under biodiversity plantations and the development of the *Sanquelim Mine Management Plan* that was prepared in consultation with the local Forest Department. As part of this plan, mature *Acacia* plantations were proposed to be clear felled and make way for plantations of various native species and to improve the biodiversity of the mined out areas.

Plate 1. Placing of geotexitle, Sanquelim mines, Goa, India © M/s Sesa Sterlite Limited (a Vedanta ltd. company)

Geo-textile

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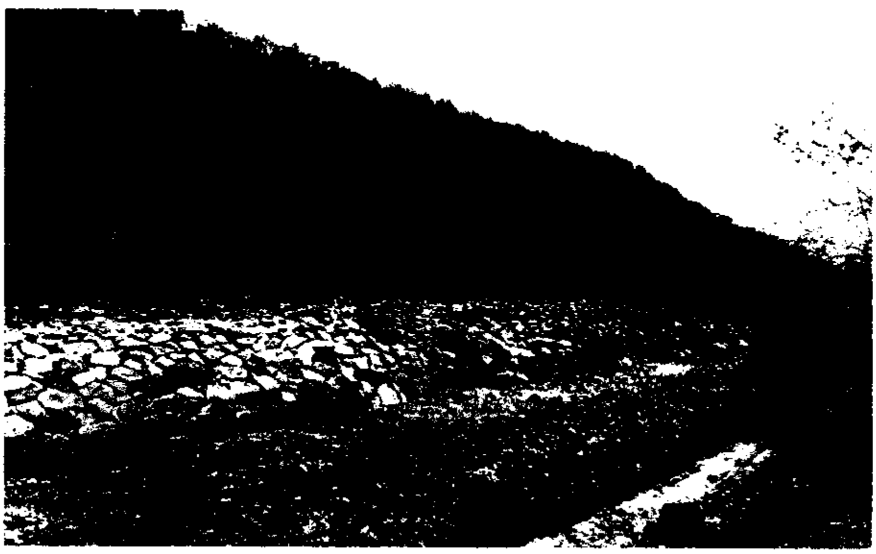
b) Singareni Collieries Company Limited (SCCL) – an eco-friendly coal mining in Telangana

The Singareni Collieries Company Limited (SCCL) is the sole coal mining company in South India. Originally established as the Hyderabad (Deccan) Company in 1886, SCCL saw an increase in production levels from a mere 5.3 million tonnes in 1973-74 to 35 million tonnes in 2004-5. Until 1975 SSCL was mining coal through underground operations, when the company opened its first opencast mine in 1975. Since then, the number of opencast mines has increased to 12, and underground mines have increased from 26 to 54.

The company has undertaken several innovative measures to improve green cover and quality of environment in and around its mining areas. These include development of green belts, bioengineering of overburden dumps through plantation of suitable species, development of medicinal plant plantations, bringing wasteland under industrial plantation, establishment of Bamboosetum, improvement of adjoining reserve forest and habitat management of water resources. Apart from this special research projects have been started on carbon sequestering studies to assess the carbon sinks in SCCL mining areas that is being undertaken in collaboration with ICFRE.



Toe walls and Garland drains at the mining site, SCCL, Telangana, India © Vipul Sharma, IUCN

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c) Noamundi Iron Mine, Jharkhand

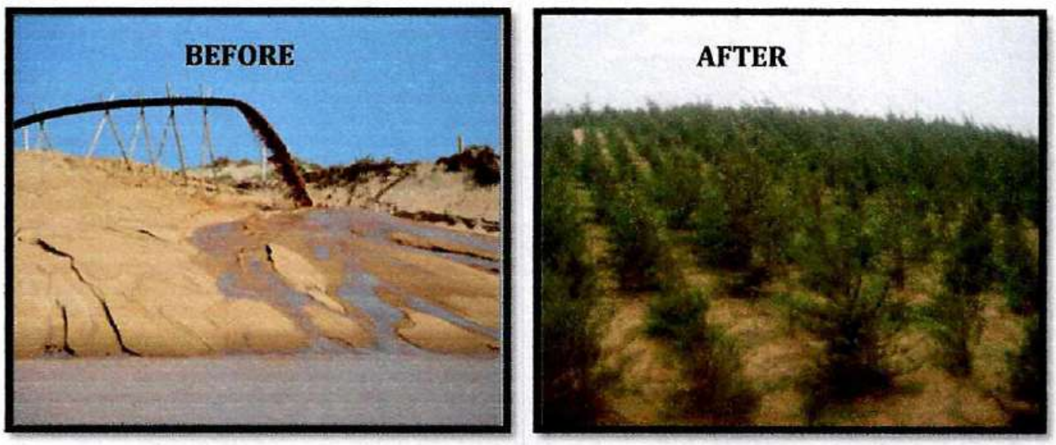
Owned by Tata Steel Limited and covering an area of over 1160 ha in West Singhbhum District of Jharkhand, the company has a fully-fledged Environment Management Department that looks into mind closure and rehabilitation. The innovative approaches and good practices followed by them include reclamation and rehabilitation of mined out area by afforestation in 126 ha that has been developed into a scenic park with a capacity of raising 1.5 to 2.0 lakh saplings every year and contains different varieties of plants.

d) Tummalapenta Limestone Mine, Andhra Pradesh

A limestone mine owned by UltraTech Cement Ltd., it falls in the Kurnool District of Andhra Pradesh with an extent of over 844 ha. The mine is highly mechanized opencast working with deep hole drilling and blasting. The good practices in terms of mine restoration/reclamation are development of a green belt, properly maintained check dams and garland drains around the topsoil dumps as well as mine pits to arrest the silt & act as trap drain for rainwater. They also have rain water harvesting pits at different locations and waste dump sites are afforested to prevent pollution during stormy winds.

e) Srikurmam Mineral Sand Mines, Andhra Pradesh

This mine belongs to M/s. Trimex Sands Pvt. Ltd. which is involved in mining, concentration and separation of heavy minerals in Srikakulam district, Andhra Pradesh. A key to their success ini mining rehabilitation has been the concurrent mining, backfilling and afforestation of the mined out land with a time gap between mining and backfilling being only 3 to 4 months. Around 80% of the mined out land backfilled and afforested so far.



Srikurmam Mineral Sand Mines © FIMI

f) **Sukinda Chromite mines, Jharkhand**

These Tata Steel mines operate over a mining lease area of 406 ha. They have been successful in developing a demonstration plot under the guidance of Regional MoEFCC office and have used this experience in establishing the standard operating procedures for its future reclamation and rehabilitation plans. These chromite mines also were the first Indian mine to roll out the Sustainable Development Framework[15].

Another innovative approach has been to develop Vetiver plantations on dump slopes under the guidance of IIT, Kharagpur. Besides this, the plantation program is being carried out as per the approved Mining plan & progressive mine closure plan as envisaged in the EIA report. They have also collaborated with IUCN to conduct a biodiversity study and awareness programs like "spot the species", "identification of leaves" and "environment cum mineral awareness program".

g) **Vyasankare Iron Ore Mine, Karnataka**

Operated by MSPL Ltd., in Bellary, Karnataka the mine has adopted a scientific and systematic mining approach. The company had a target of 1 million plants in 1976, which was achieved in 1998. They have done a transformation of 190 ha of land to a totally rehabilitated lush green area rich with flora and fauna. Inactive dumps have been terraced and fixed with coca-coir matting in 15.7 ha of area, with seeds broadcasting and plantation on them. The float mined out area has been fully reclaimed by plantation over an area of 130.04 ha and a portion of area is planted with fruit bearing trees.

h) ***Dongri Buzurg Mine, Maharashtra***

*Operated by the Mangane*se Ore India Ltd., the company in collaboration with National Environmental Engineering Research Institute (NEERI) embarked an R&D program for rejuvenation of mine spoil dumps through an integrated biotechnological approach (IBA). Massive afforestation work has been carried out and about 43 ha have been covered by plantations.

i) **Mainpat and Kawardha Bauxite Mines, Chhattisgarh**

Operated by the Bharat Aluminum Company Ltd. (BALCO) in Chhattisgarh, the company has adpted a scientific approach towards environment management by completing a baseline study as well as preparing a Wildlife Conservation Plan in consultation with Chief Conservator of Forest (CCF), Chhattisgarh. It has also adopted a strict regime of reclamation of mined out areas by simultaneously backfilling them. It is ensured that the top soil scraped is properly managed and then spread over the

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[15] http://www.tata.com/media/releasesinside/Tata-Steels-Sukinda-chromite-mine-becomes-first-Indian-mine-to-roll-out-the-Sustainable-Development-Framework

reclaimed areas for carrying out plantations. Native species of flora are used for reclamation to enrich the biodiversity and conserve the green cover.

j) Kiriburu Iron Ore Mines, Jharkhand

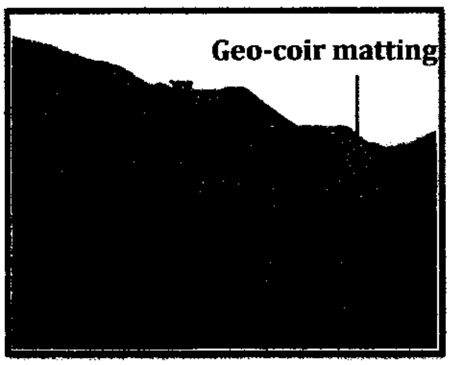
Operated by SAIL in Jharkhand, the company has a policy of stacking and preserving their top soil separately outside the ore boundary. Top soil is spread out over the waste dump and plantations are raised over it. The top soil is mixed with manure and applied to the roots of the saplings for faster growth. Recently, they have also prepared a Lake Garden using a large quantity of top soil.

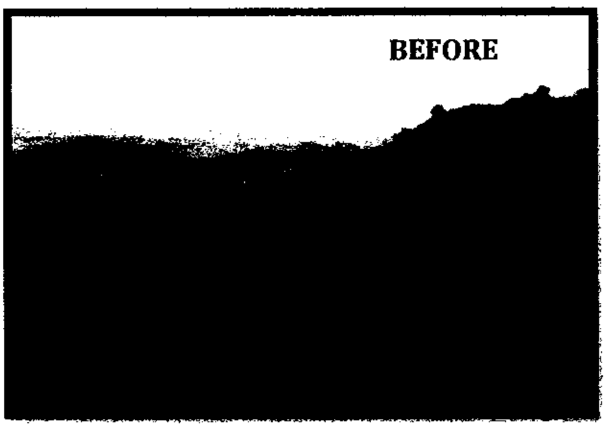
i) Narrain Iron ore mines Karnataka

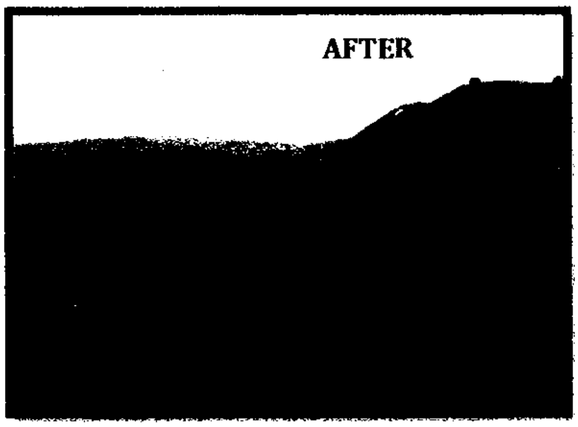
Operated by M/s Sesa Sterlite Ltd., they have implemented R&R plans for enrichment of encroached areas. To avoid material flow from dumps and subsequent channelization into water sources, these encroachments were required to be rehabilitated in terms of stabilization/backfilling followed by plantation or geo-coir matting along with additional protective measures like retaining wall, garland drain etc.

BEFORE **AFTER**

Narrain Iron ore mines of M/s Sesa Sterlite Ltd. (Chitradurga, Karnataka) © FIMI







Dump management by BRH Iron Ore Mines of M/s RMML (Bellary, Karnataka) © FIMI

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k) Sandur Manganese and Iron Ore Mines, Karnataka

They have stabilized its dump areas using two techniques; firstly by simple plantation over the dumps, while the other technique involved spreading a geo-coir mat over the dump, to prevent dump slope failure followed by thin layer of top soil to facilitate effective plantation. Another advantage of the second technique is that the coir mat after degradation acted as a manure for effective growth of plants. This has now turned the dumps into small patches of forest with native species.

Restoration work done by Forest Research Institute (FRI), Dehradun

The Forest Research Institute has been associated in the restoration of mined lands for over 33 years in different parts of the country. The Institute has successfully demonstrated restoration model in following mined out areas, namely Rock Phosphate mine in Doon Valley, Uttarakhand; Limestone mine in Mussoorie hills, Uttarakhand; Iron ore mine in Bolani, Odisha; Road metal and masonry stone mines Gurgaon, Haryana; Uranium Mines Jaduguda; Coal mine spoils at Tetulmari, Sijua area of BCCL, Dhanbad; Coal mine spoils at Northern Coalfields Limited, Singrauli.

The restoration approaches followed by the Institute includes amelioration of substratum quality by application of top soil spread, mulching using various plant materials, mechanical stabilization by construction of check dams, gabion structures, retaining wall etc., biological stabilization by using pioneering species of grasses, shrubs, and trees. Selection of species is based on species capability of colonizing degraded sites, species capability of fixing atmospheric nitrogen as well as conserve the soil, species which can attract birds, butterflies and other faunal population, species capable of producing fuel, fodder, fiber etc. for local population.

7. International Case Studies

Worldwide restoration works have been undertaken by several international mining companies. One of the key multi stakeholder international collaborative platforms between over 75 companies, financial institutions, government agencies and civil society organizations is the Business and Biodiversity Offsets Programme (BBOP). BBOP explores the concept of establishing biodiversity offsets to compensate for significant residual, biodiversity impacts that can occur with development projects. Under BBOP the members have developed best practice in following the mitigation hierarchy (avoid, minimize, restore, offset) to achieve no net loss or a net gain of biodiversity.

What is Biodiversity Offset?

A biodiversity offset is a way to demonstrate that an infrastructure project can be implemented in a manner that results in no net loss or a net gain of biodiversity.

The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity".

To be an offset, these conservation outcomes should be quantifiable, since the purpose of a biodiversity offset is to demonstrate a balance between a project's impacts on biodiversity and the benefits achieved through the offset. This involves measuring both the losses to biodiversity caused by the project and the conservation gains achieved by the offset.

a) Restoring the Botanical Richness of the Jarrah Forest after Bauxite mining in South Western Australia

Alcoa has the World's largest bauxite mining portfolio and their strategic sustainability target calls for all their mining locations with substantive biodiversity values and land holdings to develop a biodiversity action plan. The company to lessen the impact on mining has set minimum environmental footprints for each of their mines that they aim to achieve by 2020. In 2014 alone the company has rehabilitated 1,008 hectares (2,491 acres) of mined land.

Alcoa World Alumina Australia operates two bauxite mines at Willowdale and Huntly in the Darling Range of southwestern Western Australia. A third mine at Jarrahdale operated from 1963 to 1998 and has now been completely decommissioned and rehabilitated. This rehabilitation work was over three decade improvement program for re-establishment of young jarrah forests with plant species richness equal to the surrounding native forest structure. The company has been rehabilitating its bauxite mines since 1966 and currently approximately 550 ha are mined and rehabilitated annually. They have a policy of areas cleared for mining and infrastructures are fully rehabilitated. The technology of rehabilitation has seen continuous improvement over the years from plantations of exotic pine trees to a sophisticated state-of-the-art rehabilitation program[16].

In the Jarrah forest restoration, the objective of **Alcoa** was to reestablish all preexisting land use of the forest such as conservation, timber production, water production and recreation. Practices to preserve seed viability in the soil and to separate the seed-rich topsoil from the remaining overburden were soon developed. The first milestone was to achieve 80% of forest species richness. Many innovative practices and technologies in the areas of seed treatment, seed application, topsoil handling, mine planning, and native plant propagation were developed and implemented. The rehabilitation process starts with shaping the mine pit to produce a landscape that blends with the surrounding forest. Soil is returned to the mine pit and the pit is ripped using a bulldozer pulling a winged tine - ripping breaks up compacted ground which reduces the risk of erosion and improves tree growth. Seeds of local plants are spread throughout the rehabilitated mine pit. Attempts were made to establish species using broadcast seed, but monitoring of the re-vegetated areas showed that some species were not germinating, despite their inclusion in the seed mix[17].

Part of the Huntly mine in 1980.
The South Dandalup dam is in the background.

The same view in 2001.
The mining and infrasrtucture has been successfully rehabilitated.

[16] http://www.alcoa.com/sustainability/en/pdf/archive/corporate/2014_Sustainability_Highlights_Report.pdf
[17] http://alcoa.p1.inter.alcoa.com/australia/en/pdf/Community/Rehab_Bro_2.pdf

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b) The Dents Run AML/AMD Ecosystem Restoration Project, Pennsylvania, USA

The Dents Run Restoration Project is one of the most comprehensive Abandoned Mine Land (AML) and Watershed Restoration Projects undertaken by the Pennsylvania AML program to date[18]. The Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation worked with various partners to develop and implement a comprehensive watershed restoration plan. Partners included federal, state and local government agencies, private foundations, the coal industry and local grassroots organizations.

The project encompassed many pollution discharges that were extremely acidic with highly elevated metals concentrations. The rehabilitation plan included alkaline materials addition, materials handling technologies and surface and groundwater best management practices (BMPs). The project provided an opportunity to examine mine drainage improvement using alkaline addition and water handling techniques on AML sites. Three hundred twenty (320) acres of scarred landscape was re-vegetated with grasses and other ground cover suitable to the local wildlife, including the growing elk herd.

Ten (10) high-walls, totaling approximately 30,850 linear feet, were reclaimed. Project activity included the mining of 543,000 tons of limestone which was used as alkaline addition material to the backfill on the additional reclamation sites. The limestone was mixed with 1,450 acre-feet, or approximately 6 million tons of spoil material. A total of 5,500 cubic yards of abandoned coal refuse material was removed and was used in a cogeneration facility. Twenty-three (23) mine openings were reclaimed and five (5) wet seals were installed at selected openings to direct drainage to treatment systems. Fourteen (14) different point-source discharges, or in some cases diffuse seepage areas, were addressed through the construction of passive treatment systems. Two larger discharge areas are being treated actively by lime dosers.

c) Biodiversity Offset Case Study: Compañia Minera Antamina's Polylepis Initiative

The Antamina mine is among the world's largest copper and zinc mines located in the Andean mountains in Ancash, Peru. In 2004, the company began a voluntary biodiversity conservation program to restore endangered *Polylepis* forests in the area around the mine. While the program, has been examined for its potential to serve as a case study for biodiversity offsets, it is important to note that it was not originally designed as a biodiversity offset intervention[19].

In 1998, ANTAMINA commissioned an Environmental Impact Assessment to be performed for the then proposed mine. Biodiversity Baseline studies of the flora and fauna at the Antamina Mine was hence completed. In 2003, ANTAMINA management became interested in a voluntary conservation project in

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[18] https://clu-in.org/download/issues/mining/DENT_run_nomination.pdf
[19] http://www.forest-trends.org/documents/files/doc_539.pdf

the region of the mine. While *Polylepis* habitat is not directly impacted by the Antamina mine, it is the most important type of habitat for biodiversity conservation in the region. Based on consultation with technical advisors and conservation groups, ANTAMINA decided that a project to restore endangered *Polylepis* habitat would provide an ideal blend of biodiversity conservation and local community benefits. The *Polylepis* restoration program contributed to the development of a connective conservation corridor between two Protected Areas; Huascarán National Park (a UNESCO World Heritage Area and Biosphere Reserve) and the Huayhuash Reserve Area. The project did not specifically offset impacts to other impacted ecosystems, such as grasslands (regardless of their degraded status) and lakes, or ecosystems under risk of impacts, such as nearby rivers. These ecosystems are addressed by other ANTAMINA programs, however, the company monitored the status of restored forests and the resident populations of species of concern. This should include bird species known to be endemic or specialists for *Polylepis* forest habitat.

d) Business and Biodiversity Offsets Programme (BBOP), BBOP Pilot Project Case Study, Potgietersrust Platinums Limited (PPRust), South Africa

A very good example of the usefulness of the BBOP methodology specifically with regards to the calculation of biodiversity losses and potential gains using the 'habitat hectares' method. The area has opencast mining of platinum ore (pit ~400 ha), concentrator complex (~50 ha), waste residue facilities (1,412 ha), tailings dam (300 ha) and infrastructure (100 ha). This project is an expansion of the existing mine. The impact area is situated in the northern savanna area of South Africa. The mine is open cast and as such requires the complete removal of all vegetation / overburden in order to access the ore body. Specialist studies conducted prior to mining indicated that most of the area on which the mine was planned was already disturbed due to agricultural activities (trampling and dryland crop production, overgrazing and fuel wood collection). These activities resulted in a low baseline diversity and natural mitigation for some of the impacts to be caused by the development[20].

Prior to an offset being considered, the mitigation hierarchy was followed to avoid, minimize and reduce residual impacts. BBOP principles were applied for the offset activities. The proposed offset is located 8 km to the west of the impact area. The offset area has similar environmental characteristics to the impact area although a larger proportion is mountainous. It has been subjected to much less subsistence farming; as a result it is much more wooded than the impact area. The offset activities include planting 5,398 ha of Makhado Sweet Bushveld, Central Sandy Bushveld and Waterberg Mountain Bushveld in the Savanna Biome, building a wildlife reserve with re-stocking of indigenous ungulate component, improved protection, active range management and rehabilitation.

[20] http://www.forest-trends.org/documents/files/doc_3121.pdf

e) **BBOP Pilot Project Case Study the Ambatovy Project, Madagascar**

The Ambatovy Project site in Madagascar is a large-tonnage nickel project with an annual design capacity of 60,000 tonnes of nickel and 5,600 tonnes of cobalt. The Project was permitted in December 2006. The Project's expected lifecycle is 27 years, although operation beyond this is very likely. The Ambatovy Project has six components: the mine, the slurry pipeline, the processing plant (including refinery), the tailings management facility, the harbour extension and the resettlement site. The main impacts to biodiversity are located at the mine footprint with the clearing of near-primary forest. The Project has designed and implemented a Biodiversity Management Programme to mitigate and monitor the residual impacts associated to development, whilst pursuing its impact avoidance and reduction approach. The mitigation measures cover flora, fauna and aquatics[21],[22].

The Ankerana off-site offset area covers 11,600 hectares (ha) of endangered forest, with similar abiotic and biotic conditions to those found at the mine site. The project is spearheading the establishment of Analamay-Mantadia forest corridor between the mine area forests and the nearby Ankeniheny-Zahamena Corridor; the forest corridor aims at long term landscape level connectivity for the protection of mine area biodiversity through partnerships with government, NGOs and local communities. The project is supporting the site management plan design and implementation of the Torotorofotsy Ramsar wetland ecosystem in conjunction with government and local NGOs; these efforts aim to ensure the permanency of legal and managerial commitments in partnership with government and a local NGO. The project aims to create a replacement, multifunctional forest on the footprint during progressive reclamation with an established, integrated managerial structure by mine closure.

[21] http://www.forest-trends.org/documents/files/doc_3118.pdf
[22] http://www.vahatra.mg/volume3/mn03_01.pdf

8. International Organizations Working Towards Sustainable Mining

In the international arena, ***ICMM i.e. the International Council on Mining and Metals*** play a very significant role in terms of improving sustainable development performance in the mining and metals industry. ICMM was established in 2001 through a multi-stakeholder initiative- the Mining, Minerals and Sustainable Development (MMSD) project. This project was set out to examine the role that mining and metals could play in the transition to sustainable development.

ICMM
International Council on Mining & Metals

Presently, ICMM has 23 mining and metal companies as their members with 34 national and regional mining associations. All the ICMM member companies commit to a set of 10 principles, six supporting position statements and transparent and accountable reporting practices. All member companies have to report publicly on their progress against the framework, and these reports must be verified by independent third parties.

ICMM has also been associated with IUCN since 2003. One of the priority areas of IUCN is business engagement to promote green economy and sustainable development. In this regard IUCN - ICMM or ICMM alone have launched several publications which can act as a guide for the mining and metal industries:

a) Good Practice guidance for mining and biodiversity (http://www.icmm.com/en-gb/publications/mining-and-biodiversity-good-practice-guidance)
b) Good Practices for the Collection of Biodiversity Baseline Data (https://www.icmm.com/en-gb/publications/good-practices-for-the-collection-of-biodiversity-baseline-data)
c) Integrating Mining and Biodiversity Conservation - Case studies from around the world (http://www.icmm.com/en-gb/publications/integrating-mining-and-biodiversity-conservation-case-studies-from-around-the-world)
d) Biodiversity performance review - Executive summary (https://www.iucn.org/sites/dev/files/content/documents/icmm_iucn_bioper_inbrief_11_14_.pdf)
e) Mining and Biodiversity- A collection of case studies – 2010 edition (http://www.icmm.com/en-gb/publications/mining-and-biodiversity-a-collection-of-case-studies---2010-edition)
f) Planning for Integrated Mine Closure: Toolkit (http://www.icmm.com/en-gb/publications/planning-for-integrated-mine-closure-toolkit).

The ***Cement Sustainability Initiative (CSI)*** is a global effort by 25 major cement producers with operations in more than 100 countries who believe there is a strong business case for the pursuit of sustainable development. Collectively these companies account for around 30% of the world's cement production and range in size from very large multinationals to smaller local producers.

Over its 10-year history, the CSI has focused on understanding, managing and minimizing the impacts of cement production and use by addressing a range of issues, including: climate change, fuel use, employee health and safety, airborne emissions, concrete recycling and quarry management. To date the CSI remains one of the largest global sustainability programs ever undertaken by a single industry sector.

In 1999, under the auspices of the WBCSD, 10 leading cement companies commissioned the Battelle Memorial Institute, a US-based not-for-profit consulting firm, to conduct independent research into how the cement industry can meet these sustainability challenges. Battelle's final report, Toward a Sustainable Cement Industry, was released in April 2002[23].

The report listed eight major topics that will shape the cement industry's path toward a more sustainable future in the next 20 years. Out of these eight topics two directly focus on ecology and these include;

a) Resource productivity: improving eco-efficiency through improved practices in quarrying, energy use and waste recovery and reuse

b) Ecological stewardship: improving land use and landscape management practices

[23] http://www.wbcsd.org/Projects/Cement-Sustainability-Initiative/Resources/Toward-a-Sustainable-Cement-Industry

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9. General Approach and Principles for Sustainable Restoration Plans in Mining Sites[24]

The mine restoration plan should be developed with an ultimate goal to ensure that mine operations have minimal impact on their environment and to mitigate the residual impacts of mining by perusing proactive ecological restoration. Some of the key considerations while developing a restoration/rehabilitation plans include;

General considerations for developing mine Restoration Plan:

- It should not be in conflict with, but should always complement and go beyond legal compliance.
- Post mine closure land use should be assessed before initiating mining operations for preparing a restoration plan.
- It needs to be based on a clear set of objectives reflecting the legislative requirements (as the highest priority), and encompassing the local social, economic, biodiversity and environmental (including pollution) considerations for the future use of the site.
- It should ensure that the site is left in a safe and stable condition (includes the stability of slopes, roads and raw materials piles and infrastructure).
- Stakeholders should be involved in identifying the post mine closure land use. The plan should address stakeholder expectations, and be aligned with, or leverage from, the stakeholder view, experience, culture and customs.
- A comprehensive baseline assessment of flora and fauna, landscape integration, human activities and cultural heritage should be done and based on baselines identification of the impacts and measurement of the changes that may arise as a result of mining activity should be assessed.
- It should be developed prior to the commencement of operation at the new mine site. For operating mining sites, the plan should be aligned with existing mining closure plan.
- A robust monitoring mechanism should be put in place for monitoring and reporting the implementation of plan.

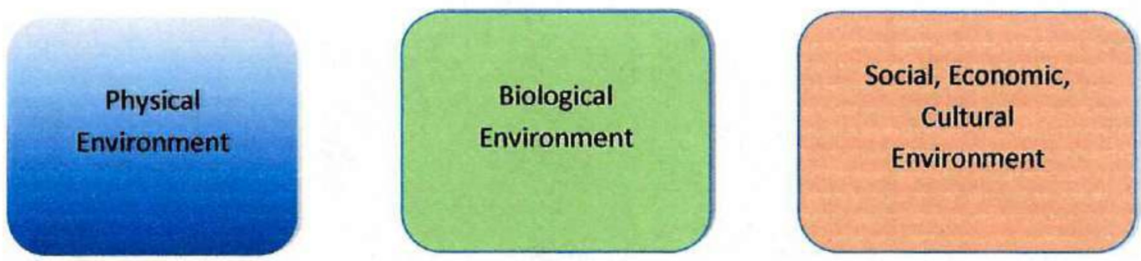
Restoration programmes should not be pursued in isolation from Mine closure plans and other forms of management.

[24] This section concentrates only on the restoration/rehabilitation aspects of mined out areas rather than the administrative processes for obtaining project approval.

Suggested Objectives of Restoration Plans:

- Avoid and /or reduce further impacts on biodiversity and associated ecosystem services during operations;
- Provide for the progressive reclamation of mine-altered sites in a manner which restores biodiversity and associated ecosystem services;
- Attempt to achieve a long term gain in targeted biodiversity components from pre-mine conditions
- Provide for community engagement and benefit as part of the mine closure process.

It is recommended that ecological restoration plan shall be grouped to address three key interlinked ecosystem components.



Priorities for Ecological Restoration and Enhancements:

The restoration plan needs to have specific actions plans and mitigation measures on the following priority impacts and concerns that typically impacts restoration and biodiversity during the life cycle of mines:

1. Direct impact on loss of forest and non-forest land and associated biodiversity.
2. Impact on water resources and wetland ecosystems.
3. Impacts of mine dumps on terrestrial and aquatic habitats and associated species.
4. Effects of dust and noise pollution on habitat quality and select faunal groups.
5. Accidental road mortality on target faunal groups
6. Impacts on species of high conservation significance (highly threatened species) existing within the mine lease.
7. Livestock impacts on forest ecosystems (e.g. tree lopping, trampling, feeding on tree saplings, over grazing)
8. Secondary impacts associated with the mine labor force and others e.g. un-managed wood harvest, trapping/snaring/poaching wildlife.
9. Influence of mining on ecologically sensitive areas of state, national and international importance for conservation values of biological diversity.

Duration of the Plan and Budgets

Typically the restoration plan should have a long-term approach with around 20 year time frame, broken down into smaller parts of five years with its independent set of objectives and indicators. These plans should have scope to allow for modification when unexpected and/or new information comes to light.

10. Steps Towards the Design of a Sustainable Mine Restoration Plan

Restoring biological communities to an earlier condition is often a not possible, is usually labour-intensive and costly. Thus it is imperative that goals are defined, suitable criteria for measuring success are applied, and all procedures are robust, both practically and scientifically. Failure to monitor steps and rates of progress in a restoration programme may result in loss of significant information that could avoid further mistakes or enable successful programmes to be repeated.

Following are the suggested steps while detailing a sustainable restoration/rehabilitation plan

Step 1: ***Assessment of status of biodiversity and ecosystems***: It is of utmost importance that a comprehensive assessment of flora and fauna in and around the mining site be carried out to develop a baseline. This field assessment should also be informed by secondary information including various published sources i.e. forest department working plans, published studies and others.

Step 2: ***Identification of species and habitats with special conservation status***: Subsequent to baselines assessment, the identification of species with special conservation status shall be carried out. The following criteria should be used for assessing the special conservation status shall include following:

- Species listed in schedule 1 and Part II schedule II of Indian Wildlife Protection Act 1972.
- Species falling under Vulnerable (VN), Endangered (EN) and Critically Endangered (CR) of IUCN Red listing of species.
- Globally threatened ecosystems/habitats

Step 3: ***Identify prescriptions for impact mitigation and restoration***: It is recommended to engage a qualified biodiversity expert for identifying the prescriptions for impact mitigation and restoration. The prescriptions in the restoration plan should be divided in three key interlinked ecosystem components. The guidance for defining prescriptions under each of these ecosystem components are provided below. Depending upon the site conditions the relevant prescriptions can be derived.

- **Physical Environment (Air & Water):**
  - Optimize Re-Vegetation Program: Re-vegetation of disturbed areas, long-term inactive stockpiles, dumps and margins of active mines using plant species of native shrubs and trees which have been reported to be effective at mitigating and or tolerating dust and other airborne pollutants.
  - Rainwater and Storm Water Management: Optimize rainwater and storm water collections and recycling for dust suppression, afforestation maintenance, landscaping and any domestic use. Develop Check dams and Engineered Wetlands as rainwater harvesting structures.

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- **Biological Environment:**
  - Wildlife Corridors and connectivity: Retention and enhancement of forested corridors through the mine connecting to larger secure forested areas outside the mine is critical to optimized restoration of biodiversity and associated ecosystem services within the leasehold and adjoining areas.
  - Stabilization at Dumps & Subgrade Storage Areas:
    - All slopes to be left without disturbance for >1month should be laterally scarified and terraced. Stockpiles that are to remain for at least one growing season should be seeded with grass.
    - All overburden and dump sites which is to be left inactive for more than four growing seasons, but which will be disturbed at a later date shall be subject to seeding and shrub/tree planting/transplants. Prior to their follow-up disturbance, any shrub and tree recruitment to the site can be salvaged for use elsewhere in mine site restoration.
    - Strive to maintain the angle of repose less than 28 degrees. This can be achieved by scientific design of the dump decks by leaving sufficient terrace on the decks. Maintain the backward sloping not less than 30 degrees and deck drains with catch drains at predetermined intervals help in stabilizing the dump.
    - Water channels should be constructed at predefined intervals for safe disposal of the water from the decks. Thereafter the water so collected can be allowed to pass through the garland drains into the settling ponds provided for the purpose to avoid flowing of silt.
    - Toe walls should be constructed in such a way that runoff from the dumps will be retained within the toe wall and water flows out of it.
    - The dumping should be planned in such a way that the dumping progresses in retreating manner (from the final boundary of the dump yard planned) so as to attain the final profile for taking up stabilization through the biological reclamation of slopes during the active stage of the dumping itself.
  - Re-contouring and Terrace Development
    - Re-contouring should strive to recreate the previous landscape contour to the extent feasible. Backfill mine pit voids should be done as much as possible.
    - Create geotechnical stable terraces (e.g. 5 -10 m wide) on all fill slopes as frequently as practical but at least one every 100m if possible.
    - Ensure geotechnical review and approval of design and frequency of all constructed terraces on mine dumps and steep fill sites.
    - Where feasible and perceived to be of benefit to wildlife movement, create terrace access ramps 1/3 or ½ terrace width between terraces going both directions every 200 m.

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- Topsoil Handling and Soil Amendments:
  - Review all current topsoil stripping, handling, storage, protection/conservation procedures to ensure best practice at all newly opened sites and stabilization of any existing storage areas.
  - Wherever possible transfer topsoil from areas being stripped immediately to areas being reclaimed rather than long term topsoil storage locations.
  - As a minimum, replicate pre-disturbance topsoil depths to the extent possible. Supplement topsoil depths where this significantly compromises a site-specific restoration objective.
  - Use excess woody debris scattered on slopes to help control erosion.
- Re-vegetation programme
  - Collection and propagation of local native seeds and cuttings should commence as soon as possible to serve the needs of progressive restoration.
  - Pioneer native grass species that readily colonize disturbed areas should make up at least 50% of the seed mix.
  - Grass seeds will be sown on slopes to be reclaimed just prior to the onset of monsoon, or sooner if water is available. 15 cm layer of top soil is a recommended minimum for grass establishment.
  - Only local native species should be used in the three-tiered re-vegetation programme (Tree-Shrub/Climber-Grass). Among the tree species, the dominant forest local tree should be planted on the low to moderate slopes and top ridges and plateau
  - Nursery propagation and transplant of locally native herbaceous species on dumps and other steep to moderate slopes should be undertaken
  - A plan for post plantation care should be developed and implemented.

- Control of Weeds and Invasive Species: Continuous monitoring of restored and enhanced sites for weeds/ invasive species and device a practical, environmentally friendly management program as required. Non-native introduced tree species identified on site should be replaced with native species and/ or targeted for use by the community for fuel wood, timber and or fodder.

- Direct offsite Habitat Enhancements: To the extent that the Mine cannot be fully restored as a result of creation steep rock faces and material removal within the mine pit, securing and restoring offsite habitat offsets may be perused.

- **Socio Economic Environment:**
  - Community Education: Extension education and training programs focusing on restoration, biodiversity conservation, anti-poaching, low impact grazing practices, ecosystem services and sustainable living/livelihood options shall be provided to the work force/colony, students and local communities. These programs can be delivered through activities like formal and informal forums, training, and audiovisual aids and other communication materials.

  - Regional Planning Support: Involve local community in regional land use planning initiatives, which support retention, restoration and or enhancement of biodiversity and native vegetation re-establishment outside the mine leasehold area wherever possible.

  - Community CSR: Undertake, promote and or support community awareness programs on use of the native fruit trees, common trees and forest trees, water conservation, water stewardship, water access, riparian management, and waste management.

Step 4: ***Formulation of Ecological Restoration Plan:*** The final restoration site plan should provide a rationalized mosaic of different habitat types: semi-closed to open forest, dense to open scrub, seasonal and permanent wetlands. The reclamation species assemblages used in each case will be diverse and driven by desired faunal restoration targets. For existing mine, the mine closure plan shall be revised and approved as required to address integration of restoration prescriptions. For new mines, the mine closure plan shall have an integral mine restoration plan based on these guidelines.

- **Performance Objectives**
  - Identify species-specific flora and fauna, re-colonization objectives and include in the reclamation plan to support this.
  - Special consideration should be given to faunal species important in pollination, dispersal and germination of indigenous flora, help maintain ecological balance, as well as locally uncommon species and or those with preference for habitats with limited distribution.
  - Floral and faunal biodiversity performance indicators should be identified. As a general guide, the more of these species will be shown to occupy restored portions of the mine leasehold the stronger the indication that ecosystem function and services will return to pre-mining condition.
  - Biodiversity and ecosystem restoration performance targets will be set which use the routine seasonal occupation (for migratory species) and or presence of certain species as desired goals.

- **Scheduling of activities:**
    - Active habitat restoration and enhancement activities should be commenced on every disturbed site within 3 months of the conclusion of mining activities at those sites and be a continuous process until the restored sites are self-maintaining. The schedule for program implementation will be flexible and adaptive where the achievement of desired performance targets is being frustrated by unanticipated factors.

Annex 2 has a suggested table for contents for a sustainable mine restoration/rehabilitation plan

Restoration - Indicators of success

According to the Society for Ecological Restoration International Science and Policy Working Group, an ecosystem has recovered and is restored when;

- It contains sufficient biotic and abiotic resources to continue its development without further assistance or subsidy.
- It is suitably integrated into a larger ecological matrix, landscape, or contiguous ecosystems, with which it interacts in terms of biotic and abiotic flows and cultural interactions.
- It contains a characteristic assemblage of the species that occur in the reference ecosystem and that provide appropriate community structure.
- It consists of indigenous species to the greatest practicable extent.
- All functional groups necessary for the continued development and/or stability are represented or, if they are not, the missing groups have the potential to colonize by natural means (corridors, river systems, row of trees).
- The physical environment of the restored ecosystem is capable of sustaining reproducing populations of the species necessary for its continued stability or development along the desired path.
- Potential threats to the health and integrity of the restored ecosystem from the surrounding landscape have been eliminated or reduced as much as possible.
- The restored ecosystem is self-sustaining to the same degree as its reference ecosystem, and has the potential to persist indefinitely under existing environmental conditions.

Nevertheless, aspects of its biodiversity, structure and functioning may change as part of normal ecosystem development, and may fluctuate in response to normal periodic stress and occasional disturbance events of greater consequence. As in any intact ecosystem, the species composition and other attributes of a restored ecosystem may evolve as environmental conditions change.

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No. 55011-01-2009-CPAM
Government of India
Ministry of Coal

Shastri Bhavan,
New Delhi, the 11th January, 2012

To

1. The Chairman, Coal India Limited, Kolkatta
2. The Chairman-cum-Managing Director, CMPDIL, Ranchi
3. The Chairman-cum-Managing Director, NLC, Neyveli.
4. The Chairman-cum-Managing Director, SCCL, A.P.

SUBJECT: **GUIDELINES FOR PREPARATION OF MINE CLOSURE PLAN -REG.**

Sir,

I am directed to state that it has been decided by the Government that all coal (including lignite) mining operations in India shall be governed as per the guidelines listed in the Annexure to this letter, as modified from time to time for preparation of Mine Closure Plan (MCP), which shall be incorporated in the Project Report / Mining Plan henceforth, for a new mine. The Mine Closure Plan (progressive and final) shall be approved along with the approval of Mining Plan/ Feasibility Report / Project Report as applicable.

2 (i) All coal mine owners shall adopt a Mine Closure Plan for each of their mines comprising progressive closure plan and final closure plan duly approved by the competent authority.

(ii) All coal mine owners, who are operating coal mines without the approval of any Mine Closure Plan are required to obtain a Mine Closure Plan approved as per these guidelines within a period of one year or two years in advance of mine closure whichever is earlier from the day these guidelines come into effect.

(iii) All coal mine owners, who have already been accorded approval of Mining Plans/Project Reports without the Mine Closure Plans as per these guidelines, are also required to prepare and obtain the approval of Mine

5. The details of the final Mine Closure Plan along with the details of the updated cost estimates for various mine closure activities and the Escrow Account already set up shall be submitted to the Ministry of Coal for approval at least five years before the intended final closure of the mine.

6. Implementation of the approved Mine Closure Plan shall be the sole responsibility of the mine owner. It is estimated that major expenditure on final mine closure plan will be incurred during last five years of the project life. Upto 20% of the deposited amount from the Escrow Account can be released every year starting from 4th year before the proposed mine closure date. The balance amount will remain as security. The Coal Controller's Organization shall release the fund from the Escrow Account based on the progress made in the closure activities for the mine.

7. The Government may at any time require certain activities to be included in the mine closure plans, which it may consider necessary for the safety and conservation of environment or in compliance with any modification/ amendment in the relevant legislation.

8. *Statutory obligations:* The legal obligations, if any which the lessee is bound to implement like special conditions imposed while execution of lease deed, approval of mining plan, conditions imposed by the Ministry of Environment and Forests, State of Central Pollution Control Board or by any other organisation describing the nature of conditions and compliance position thereof should be indicated here (the copies of relevant documents may be attached as Annexure).

9. It is to be clearly understood that the funds so generated are towards the security to cover the cost of closure in case the mine owner fails to complete the relevant closure activities. The prime responsibility of mine closure shall always lie with the mine owner, and in case these funds are found to be insufficient to cover the cost of final mine closure, the additional fund shall be recovered from the mine owner by the Government.

ANNEXURE

GUIDELINES FOR PREPARATION OF FINAL MINE CLOSURE PLAN

1. Introduction

The name of the mine owner, the location and the extent of lease area, the type of lease area (forest, non-forest etc), the present land use pattern, the method of mining and coal-processing operations, should be given in the mines closure plan.

1.1 Reasons for closure: The reasons for closure of mining operations such as exhaustion of mineral, lack of demand, uneconomic operations, natural calamity, directives from statutory organization or court etc. should be specified.

1.2 Statutory obligations: The legal obligations, if any, which the mine owner is bound to comply with such as special conditions imposed while execution of lease deed, approval of mining plan, directives issued by the Ministry of Coal, conditions imposed by the Ministry of Environment and Forests, State Central Pollution Control Board or by any other organization describing the nature of conditions and compliance position thereof should be clearly indicated in the Plan (the copies of relevant documents to be attached as Annexures).

1.3 Closure plan preparation: The decision on mine closure should have the approval of the Board of Directors of the mining company or of any other equivalent competent authority. Copy of such approval should be incorporated in the final mine closure plan.

2.0 Mine Description

2.1 Geology: Briefly describe the topography and general geology indicating rock types available, including toxic elements, if any, at the mine site.

3.3 Air Quality Management: Describe the existing air quality status. The corrective measures to be taken for prevention of pollution of air should be described.

3.4 Waste Management: Describe the type, quality and quantity of overburden, coal/lignite rejects etc. generated and their disposal practice. If no utilization of waste material is proposed, the manner in which the waste material will be stabilized should be described. The protective measures to be taken for prevention of siltation, erosion and dust generation from these waste materials should also be described. If toxic and hazardous elements are present in the waste material, the protective measures to be taken for prevention of their dispersal in the air, environment, leaching in the surface and ground water etc. should be described. As far as possible, reclamation and afforestation shall proceed concurrently with the mine activity. The quantity of waste material required to be re-handled or back-filled in the final voids should be specified. All efforts should be made and reflected (in the Project Report/Mining plan) to keep land requirement bare minimum for external over burden dumping to minimise land degradation. This may necessitate increase of dump height to the maximum extent keeping in view the safety requirement with special emphasis on stability analysis. After back-filling of quarry voids, the left out void may be allowed to be filled with water. This will help to recharge and stabilize the water table in the neighbourhood and the local populace will benefit from it.

3.5 Top Soil Management: The topsoil available at the site and its utilization should be described.

3.6 Management of Coal Rejects from Washery: The steps to be taken for proper functioning of the slurry pond, handling of coal rejects and its utilization, periodic desilting, arrangement for water re-circulation, measures to prevent water pollution from slurry ponds, arrangement for surplus water overflow etc. shall be given.

iv. Continued engagement of employees in the rehabilitated status of mining lease area and any other remnant activities.

v. Envisaged expectation of the society on closure of mine.

4. Time Scheduling for abandonment

The details of time schedule of all abandonment operations as proposed in paragraphs 3 above should be described. The manpower and other resources required for completion of the proposed job should be described. The schedule of such operations should also be supplemented by bar charts etc.

5. Abandonment Cost:

5.1 Cost is to be estimated (at the time of preparation of Project Report/Mining Plan) based on the activities such as barbed wire fencing all around the working area, dismantling of structures/demolition and cleaning of sites, rehabilitation of mining machinery, plantation, physical/biological reclamation, landscaping, biological reclamation of left out OB dump, filling up of decoaled void, post environmental monitoring for 3 years, supervision charges for 3 years, power cost, protective and rehabilitation measures including their maintenance and monitoring, miscellaneous charges etc.

5.2 It has been estimated that typically closure cost for an open cast mine will come around rupees six lakhs per hectare of the total project area and it would be rupees one lakh per hectare for underground project area at current price level (August 2009) and these rates will stand modified based on the whole sale price index as notified by Government of India from time to tome.

In case of the Mine Closure Plans which have already been approved earlier on the basis of lease hold area, the project proponents are required to re-calculate the closure cost on the basis of total project area and submit a certificate stating that amount in Escrow account would be deposited as per the recalculated amount.

agreement shall be executed before the grant of permission by the Coal Controller to open the mine.

7. **Responsibility of the Mine owners**

It is the responsibility of the Mine owners to ensure that the protective measures contained in the mine closure plan including reclamation and rehabilitation works have been carried out in accordance with the approved mine closure plan and final mine closure plan.

The owner shall submit to the Coal Controller a yearly report before 1st July of every year setting forth the extent of protective and rehabilitative works carried out as envisaged in the approved mine closure plans (Progressive and Final Closure Plans).

8. **Provision for Mine Closure**

The mine owner shall be required to obtain a mine closure certificate from Coal Controller to the effect that the protective, reclamation and rehabilitation works in accordance with the approved mine closure plan/final mine closure plan have been carried out by the mine owner for surrendering the reclaimed land to the State Government concerned.

*****

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Annex 2: Suggested Table of Contents of Restoration Plan

MINE RESTORATION PLAN

TABLE OF CONTENTS

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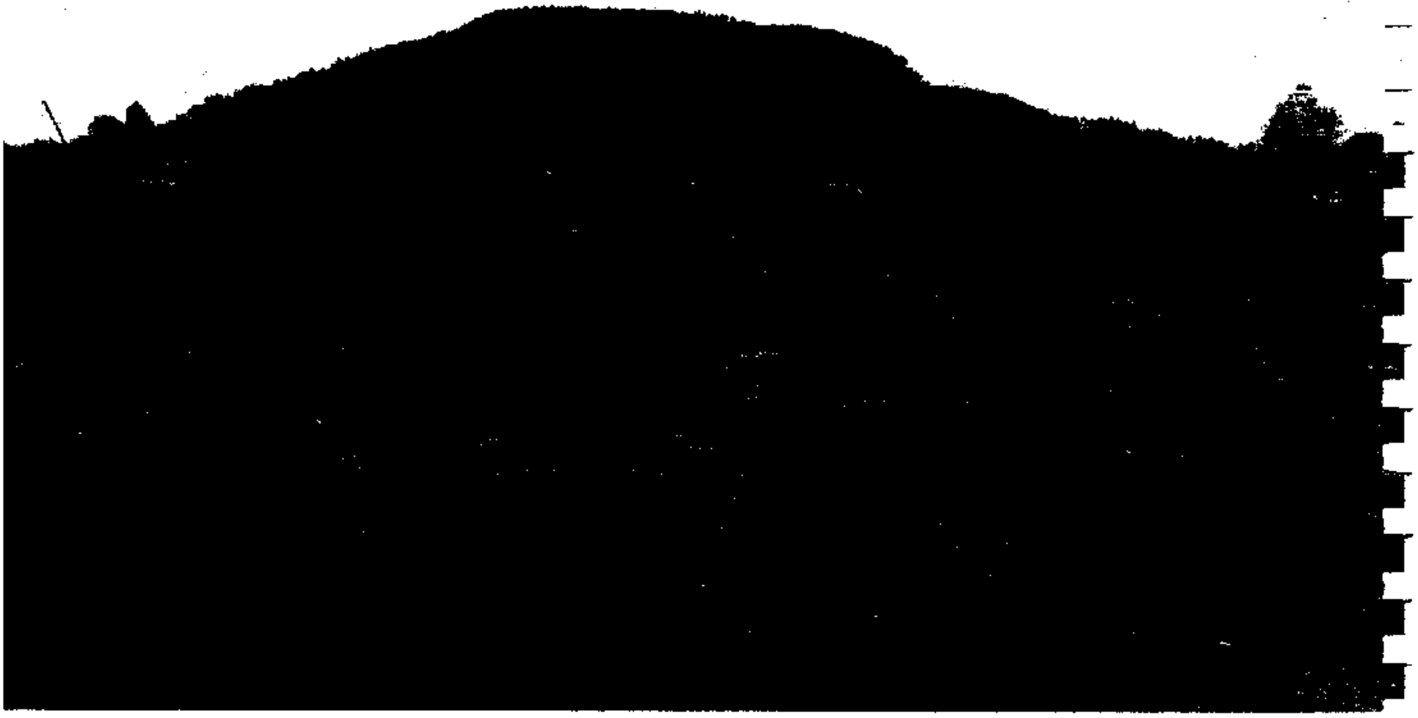

Contact details

172

Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority
Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in
IA No.1337 with IA Nos.827, 1122, 1216, 1473 in
WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

NO.13-17/2012-CAMPA **Dated the 7th February 2017.**

The Country Representative,
IUCN India Country Office,
C 4/25 Safdarjung Devlopment Area,
New Delhi – 110016.

Sub.: **CAMPA/ NCAC – Best Practice Guidance for Restoration of Mining Sites.**

Sir,

With reference to your letter dated the 30th January 2017 on the above subject, this is to convey that it has been decided to hold a preliminary meeting in the context of the draft guidance book which has been forwarded to us. The meeting will be held at 11 AM on Wednesday, the 22nd February 2017 in the Office of Shri D K Sinha, Inspector General of Forests (Forest Conservation), Ministry of Environment Forest & Climate Change, Government of India; Chief Executive Officer, Ad-hoc Compensatory Afforestation Management nad Planning Authority; and Member Secretary, National CAMPA Advisory Council.

2. You are requested to make it convenient to attend the meeting.

Yours faithfully,

(Rajagopal Prashant)
Asstt Inspector General of Forests
Tel No.: (011) 24695401

773

Subject: RE: CAMPA/NCAC-Best Practice Guidance for Restoration of Mining Sites.
Date: 02/08/17 04:12 PM
From: SINHA Priya <Priya.SINHA@iucn.org>
To: "adhoc-campa-mef@nic.in" <adhoc-campa-mef@nic.in>
Cc: "aigfcsection@gmail.com" <aigfcsection@gmail.com>, "igfc-mef@nic.in" <igfc-mef@nic.in>

Dear Shri Prashant,

Vide mail below, I have received intimation that a meeting to review the draft guidance book on Restoration of Mining Sites has been scheduled on 22nd February at 11 A.M. In this regard , I wish to inform that I will be at Bangkok for a meeting from 22-24th February. Thereafter I will be at Dehradun to attend 1977 batch IFS meet from 27th Feb-2nd March.

In view of above I request you to please consider rescheduling this meeting any time on 15th-17th Feb or in March after 3rd , I shall be grateful.

In case it is not possible, then Dr N.M. ISHWAR, Project Coordinator IUCN-India and Mr. Vipul Sharma, Programme officer can attend the review meeting on 22nd itself and provide all necessary clarification as may be required.

Thanking you ,
Best Wishes
PRSinha

From: adhoc-campa-mef@nic.in [mailto:adhoc-campa-mef@nic.in]
Sent: Wednesday, February 08, 2017 10:15 AM
To: SINHA Priya
Subject: CAMPA/NCAC-Best Practice Guidance for Restoration of Mining Sites.

--

Ad-hoc CAMPA, Ministry of Environment, Forest & Climate Change,
Block-3, 4th Floor, Hall No.1,
CGO Complex, Lodhi Road, New Delhi - 110 003.
Phone : 011-24368006
Telefax : 011-24368007
E-mail : adhoc-campa-mef@nic.in

Subject: **statement**
To: adhoc-campa-mef@nic.in

Date: 02/08/17 03:15 PM
From: Ad-hoc CAMPA <adhoc-campa-mef@nic.in>

31.03.2015.xls (85kB) adhoc-campa-mef.vcf (81bytes)

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Ad-hoc CAMPA, Ministry of Environment, Forest & Climate Change,
Block-3, 4th Floor, Hall No.1,
CGO Complex, Lodhi Road, New Delhi - 110 003.
Phone : 011-24368006
Telefax : 011-24368007
E-mail : adhoc-campa-mef@nic.in

(774)

Subject: RE: CAMPA/NCAC-Best Practice Guidance for Restoration of Mining Sites.
To: "adhoc-campa-mef@nic.in" <adhoc-campa-mef@nic.in>
Cc: [redacted]igfcsection@gmail.com" <aigfcsection@gmail.com>, "igfc-mef@nic.in" <igfc-mef@nic.in>

Date: 02/08/17 04:12 PM
From: SINHA Priya <Priya.SINHA@iucn.org>

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Vide mail below, I have received intimation that a meeting to review the draft guidance book on Restoration of Mining Sites has been scheduled on 22nd February at 11 A.M. In this regard, I wish to inform that I will be at Bangkok for a meeting from 22-24th February. Thereafter I will be at Dehradun to attend 1977 batch IFS meet from 27th Feb-2nd March.

In view of above I request you to please consider rescheduling this meeting any time on 15th-17th Feb or in March after 3rd, I shall be grateful.

In case it is not possible, then Dr N.M. ISHWAR, Project Coordinator IUCN-India and Mr. Vipul Sharma, Programme officer can attend the review meeting on 22nd itself and provide all necessary clarification as may be required.

Thanking you,
Best Wishes
PRSinha

From: adhoc-campa-mef@nic.in [mailto:adhoc-campa-mef@nic.in]
Sent: Wednesday, February 08, 2017 10:15 AM
To: SINHA Priya
Subject: CAMPA/NCAC-Best Practice Guidance for Restoration of Mining Sites.

--
Ad-hoc CAMPA, Ministry of Environment, Forest & Climate Change,
Block-3, 4th Floor, Hall No.1,
CGO Complex, Lodhi Road, New Delhi - 110 003.
Phone : 011-24368006
Telefax : 011-24368007
E-mail : adhoc-campa-mef@nic.in

O/o IGF (FC)
Dy. No. E. 56094/R
Date 09/2/2017

Kindly fix up date as 3rd March 2017 at 11.00 AM in my office room and inform
9/2

AIG(RP)

OSD

ey

775

Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority
Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in
IA No.1337 with IA Nos.827, 1122, 1216, 1473 in
WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

NO.13-17/2012-CAMPA **Dated the 10th February 2017.**

The Country Representative,
IUCN India Country Office,
C-4/25 Safdarjung Devlopment Area,
New Delhi – 110016.

Sub.: **CAMPA/ NCAC – Best Practice Guidance for Restoration of Mining Sites.**

Sir,

With reference to your letter dated the 8th February 2017 on the above subject, this is to convey that Inspector General of Forests (Forest Conservation), Ministry of Environment Forest & Climate Change, Government of India; Chief Executive Officer, Ad-hoc Compensatory Afforestation Management and Planning Authority; and Member Secretary, National CAMPA Advisory Council has decided to have the presentation on the subject proposal, in his Office (Level IV, Agni Wing, Indira Paryavaran Bhavan, Aliganj, Jor Bagh Road, New Delhi 110003) at 1100 hrs on Friday, the 3rd March 2017.

2. Kindly confirm your convenience so that appropriate arrangements in this behalf are made.

Yours faithfully,

(Rajagopal Prashant)
Asstt Inspector General of Forests
Tel No.: (011) 24695401

776

Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority

Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in IA No.1337 with IA Nos.827, 1122, 1216, 1473 in WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 10th February 2017.**

Note.

Sub.: **CAMPA / NCAC – Support of FRI Project on Creation of Centre of Excellence on Forest Genetic Resources of India.**

Reference is invited to this Office notes of even number dated the 19th December 2016, and 20th December 2016, forwarding the progress reports received from the FRI Dehradun in respect of the above Project, and soliciting comments on the same.

2. The release of further instalments is pending for want of the comments of the RT Division on the above Project. The Project proponents are, in the meanwhile, reminding hard for release of the next instalment(s) as the progress of the Project is held up owing to want of funds.

3. It is requested, therefore, that the comments of the RT Division, MoEF&CC as sought for in the above notes may kindly be expedited so that the release of further instalments could be processed.

(Rajagopal Prashant)
Asstt Inspector General of Forests
Tel No.: (011) 24695401

To

Dy Inspector General of Forests (RT)
(Shri Suneesh Buxy)
Ministry of Env Forest & Climate Change.

IUCN India Country Office
C-4/25, Safdarjung Development Area
New Delhi 110016
India

Tel. +91 11 2652 7742
Fax +91 11 2652 7742
priya.sinha@iucn.org
www.iucn.org/india

777

01 February 2017

To,
Shri Rajgopal Prashant
Asstt Inspector General of Forests,
Ministry of Environment, Forests and Climate Change

Subject: CAMPA/NCAC –Assistance to IUCN – Developing a Tool kit for Restoration of Mining Sites.

Ref: MoEFF&CC letter No. 13-17/2012-CAMPA Dated 22nd Sep 2015

Sir,

Vide above letter vender reference an amount of Rs 28,75,000.00 (Twenty eight lac seventy five thousand) was sanctioned for preparing "Guidelines for Restoration of Mining Sites". The draft-guidelines have been submitted vide our letter date 30th January 2017.

Out of the above sanctioned amount, Rs 4,05,770 (four lac five thousand seven hundred seventy only) has remained unutilized (please see the attached statement).

It is requested that, account details to remit this amount may please be communicated. After remitting the balance amount, utilization certificate will be submitted.

Thanking you,

Yours Faithfully

PR Sinha
Country Representative, IUCN

OSD (WM)

Project Title Developing a Tool kit for Restoration of Mining Sites

Reporting Period Sep 2015-Oct 2016

Donor Repoerting	BUDGET ITEMS	Revised Total Budget	Exp_Sep-Dec 2015	Exp_Jan-Sep 2016	Exp_Oct 2016	Total Jan-Oct 16	G.Total Sep 15-Oct 16	Balance	% Spending
		INR	INR	INR	INR	INR	INR	INR	
DR01639.01	Staff/ Consultancy charges	13,00,000	8,64,567	1,18,796	3,12,698	4,31,494	12,96,060	3,940	100%
DR01639.02	Research and produce publication	3,00,000	1,81,428	40,000	75,247	1,15,247	2,96,675	3,325	99%
DR01639.03	Consultative workshop with stakeholders	6,00,000	3,03,217	0		0	3,03,217	2,96,783	51%
DR01639.04	Printing and dissemination	1,00,000		0	1,00,000	1,00,000	1,00,000	0	100%
DR01639.05	Travel	2,00,000		1,16,131	35,074	1,51,205	1,51,205	48,795	76%
	Sub total	**25,00,000**	**13,49,211**	**2,74,927**	**5,23,018**	**7,97,945**	21,47,157	**3,52,843**	86%
DR01639.06	Supervision and cordination (15%)	3,75,000	2,02,382	41,239	78,452	1,19,691	3,22,073	1,72,618	86%
	TOTAL BUDGET	**28,75,000**	**15,51,593**	**3,16,166**	**6,01,470**	**9,17,636**	24,69,230	**4,05,770**	86%

778

772

Dr. Suneesh Buxy, IFS
Dy. Inspector General of Forests (RT)
E-mail – digfrt-mef@nic.in
Tel :- 011-24695233

Government of India
Ministry of Environment, Forests & Climate Change
Agni Wing, 3rd Floor, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi – 110003

F. No. 17-15/2015-RT **Dated: 09.02.2017**

66098
23-2-2017

To

The Director,
Forest Research Institute,
P.O. New Forest- Dehradun

Sub: CAMPA/NCAC- Support to the Project 'Creation of centre of Excellence on Forest Genetic Resources of India, FRI, Dehradun–reg.

Madam,

Please refer to the subject mentioned above. In this context, I am directed to request you to kindly submit Power Point Presentation with main points and achievements with objectives for further needful action in the matter regarding further release of funds.

2. This is for your kind information and further necessary action please.

Yours faithfully

9/2

(Dr. Suneesh Buxy)
Dy. Inspector General of Forests (RT)

Copy to:-

IGF(FC), MoEFCC for information.

23/2

AIGF(RP)

OSD UMM

180

Dr. Suneesh Buxy, IFS
Dy. Inspector General of Forests (RT)
E-mail – digfrt-mef@nic.in
Tel :- 011-24695233

Government of India
Ministry of Environment, Forests & Climate Change
Agni Wing, 3rd Floor, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi – 110003

F. No. 17-15/2015-RT

Dated: 02.03.2017

OFFICE MEMORANDUM

Sub: **CAMPA Project- National Program for Conservation and Development of Forest Genetic Resources: Pilot Project proposal to be implemented at FRI, Dehradun–reg.**

Please refer to your note no. 13-17/2012-CAMPA dated 19.12.2016 on the subject mentioned above. In this context, the Power Point Presentation received from FRI, Dehradun is enclosed herewith for further necessary action please. It is suggested that committee may be formed to see annual program and achievements in ICFRE & MoEF under project mentioned above. Achievements are field related so comments of RT Division is infructuous.

2. This is for your kind information and further necessary action please.

Encl:- As above

(Dr. Suneesh Buxy)
Dy. Inspector General of Forests (RT)

To:-

Shri R. Prashanth, AIGF (FC), MoEF&CC, New Delhi

OSD
CAMPA

Gmail

Pinky Thakur <thakurpinky2@gmail.com>

Fwd: Adhoc CAMPA project - National Program for Conservation and Development of Forest Genetic Resources: Pilot Project Proposal to be implemented at FRI, Dehradun

nisheeth saxena <nisheethsaxena3@gmail.com> Wed, Feb 22, 2017 at 2:49 PM
To: Pinky Thakur <thakurpinky2@gmail.com>

---------- Forwarded message ----------
From: <ginwalhs@icfre.org>
Date: Wed, Feb 22, 2017 at 1:15 PM
Subject: Adhoc CAMPA project - National Program for Conservation and Development of Forest Genetic Resources: Pilot Project Proposal to be implemented at FRI, Dehradun
To: nisheethsaxena3@gmail.com
Cc: savita savita <savvysavita@hotmail.com>, ginwalhs@rediffmail.com

Sir,
I am directed to submit you the power point presentation on the progress of the FRIs subject cited CAMPA-CoFGR Project till Dec 2017. It is requested to kindly release the balance amount of the first year project outlay, as many of the activities and procurement processes are under mid way. The detail of the project is given below :

Project Outlay:	Rs. 861.20 lakh (January 2016 – 31 December 2020)
Project Period :	5 years
Grants released :	1st installment - 146.25 lakh
Date of release :	1st installment on 21st January 2016

<u>Second installment was due to be released on 1st July 2016 : Rs. 146.25 lakh</u>

<u>Third installment is also now due for release on 1st January 2017</u>

Kind regards,

Dr. H.S.Ginwal
Scientist G
Division of Genetics and Tree Propagation
Forest Research Institute
Dehradun 248195 (Uttarakhand), India
Tel. No. 091 135 2224382

Urgent 22/2

N.K. RE 22/2 TO

Pl. put up with PPT rules.

With Regards,

Mheeth Saxena
Sr. AIGF (FC)
MoEF&CC

Co-FGR-Progress-MoEF 22-02-2017.ppt
18217K

783

National Program for Conservation and Development of Forest Genetic Resources : Pilot Project on Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)

(Pilot Project : 2016 - 2020)

under
Adhoc CAMPA Fund
Ministry of Environment, Forest & Climate Change

Progress
(January-December 2016)

Forest Research Institute (FRI)
Dehradun 248 006.

Project Summary

e of the Project :	National Program for Conservation and Development of Forest Genetic Resources : Pilot Project to be implemented at FRI on Creation of Centre on Excellence on Forest Genetic Resources (CoFGR)
Agency :	Adhoc CAMPA Fund Ministry of Environment, Forest & Climate Change, Govt. of India
utlay:	Rs. 861.20 lakh (January 2016 – 31 December 2020)
roject Period :	5 years
rants released :	1st installment - 146.25 lakh
ate of release :	1st installment on 21st January 2016
roject Executing Authority:	Director Forest Research Institute, Dehradun

22/2

TO

What Constitutes FGR ?

"The heritable materials maintained within and among tree and other woody plant species that are of actual or potential economic, environmental, scientific or social value"

[*FAO, 2014: The State of the World's Forest Genetic Resources*]

The scope of FGRs is, thus, limited to the woody elements of higher plants (Trees, Shrubs, Lianas, Woody Perennials).

Pilot Project : Objectives / Envisaged Outputs after 5 Years

- Establishment of Centre of Excellence (CoE-FGR)
- Comprehensive inventory with population and threat status of 250 FGRs of Uttrakhand in place.
- Priority list of FGRs, based on assessment of their conservation status. Eco-distribution maps of 50 priority FGRs in place
- Seed of 90 species of FGRs collected with passport data and deposited in Seed Banks for medium and long-term conservation and use in FGR improvement programs.
- Evaluation and molecular characterization done for 5 important FGRs of commercial importance for various traits

- Genetic diversity & population structure of 5 important FGRs studied & their *in situ* conservation measures put in place.
- Germplasm of a minimum of 10 important FGRs conserved the form of Field Gene Banks.
- comprehensive computerized database on FGRs of rakhand

Establishment of Centre of Excellence (CoE-FGR)

- A Centre of Excellence (CoE-FGR) on Forest Genetic Resources created in FRI with the involvement of three divisions :
  1. Genetics and Tree Propagation
  2. Botany Division
  3. Silviculture Division
- Four Working Groups Created to execute the activities of the project
  1. FGR Documentation
  2. FGR Seed and Germplasm Storage
  3. FGR Characterization Cell
  4. FGR Conservation Cell

Working Group 1 : FGR Documentation

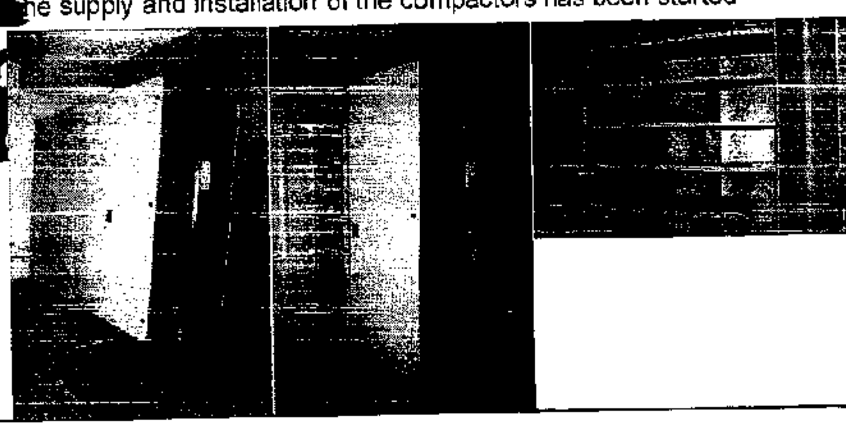
Team	Targets
Dr. Anup Chandra, Sc. F Dr. H.B. Naithani, Taxonomist Dr. M. S. Bhandari, Sc. C Dr. Ranjana Negi, Sc. C Dr. P.K. Verma, RO	Up gradation of DD Herbarium: Procurement of Mobile Herbarium Compactors Renovation of Herbarium Building Listing and Prioritization of the 250 FGR Species Field Survey to document species diversity/ distribution and their populations Development of Eco distribution maps of 50 species

Up gradation of DD Herbarium

Procurement of Mobile Herbarium Compactors

Through the repeated tendering the order has been placed for purchase and installation of compactors in the herbarium of FRI.

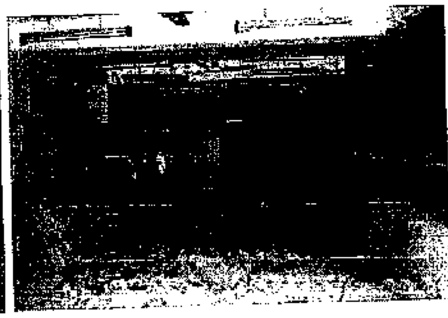
The supply and installation of the compactors has been started



Up gradation of DD Herbarium

Renovation of Herbarium Building

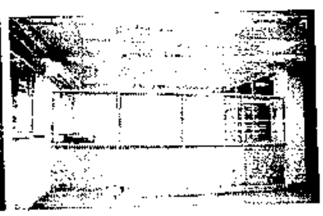
Expert engineers were consulted for feasibility of herbarium building for installation of compactors. Keeping in view the load of compactors per square meter, compactors are being installed in the ground floor with certain modifications in the present internal structure.

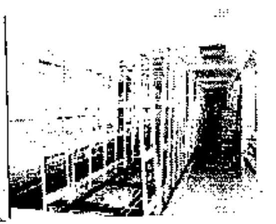
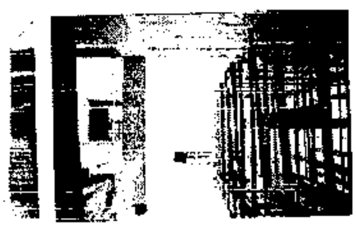
View of Herbarium Building and Herbarium hall


ted Herbarium Building


Entrance of Herbarium hall


Scanning Chamber & Digitization chamber


canning Chamber & Digitization chamber



Installation of Herbarium compactors

Prioritization of the FGR Species

Brain storming meetings were convened for the prioritization of the species involving the following experts :

Dr. G. S. Rawat, WII Dehradun

Dr. S. K. Srivastava, OIC, Botanical Survey of India

Dr. H. B. Naithani, Lead Taxonomist FRI

Dr. Anup Chandra, Taxonomist FRI

A list of total 250 priority species (141- tree species, 29 shrubs, 65 RET, 15 lianas/woody climbers and 65 RET species) has been prepared. Out of which 50 species have been selected for the preparation of eco-distribution maps.

The criteria used for the selection of the species were i) indigenous occurrence ii) woody perennial iii) species that are of economic, environmental, scientific or social value iv) threat perception.

Distribution of 100 species has been traced from the DD Herbarium, consultation, working plans of the respective divisions.

Field Surveys for distribution and regeneration

1. Species wise geographical locations for field survey is being collected from the literature survey/ forest working plans and herbaria.

2. Districts have been allotted to team members for surveys. For distribution of species, concerned division and working plan are being consulted. Distribution of species is also being worked out from the national herbaria of Uttarakhand.

3. Field survey of five districts (6 Forest Divisions) viz. Dehradun (Narendra Nagar, Chakrata) Haridwar, Champawat, Almora, Pithoragarh, Chamoli (Kedarnath W.L.S., Valley of flowers W.L.S.), East Terai (Kishenpur, Dolly range, Surai range) and Tehri Forest Division have been carried out. Enumeration of species in strategic locations was carried out and regeneration of priority species was recorded.

Documentation of FGR Diversity

- Prioritized FGR Species:- 250 species
  - 65 *RET*
  - 141 *Trees*
  - 29 *shrubs*
  - 15 *Lianas*
- ...ing Methodology:-Brainstorming meeting with experts.
- ...xtraction of FGR Records:-
  - DD Herbarium, FRI
  - BSI Herbarium, Dehradun
  - Garhwal University & Kumaon University
  - Forest working plans
  - Regional and local flora
- ...vey for FGR documentation: (Total Forest Division-44, Covered – 13 ...) In Uttrakhand
  - Champawat Forest division- 4 ranges
  - Almora Forest Division– 1 range
  - Chakrata Forest Division- 2 ranges
  - Kalsi Soil Conservation Division- 1 range
  - Pithoragarh Forest Division (Thal, Didihaat, Saandev)
  - Dehradun Forest Division
  - Uttarkashi Forest Division (Uttarkashi, Niti, Auli)
  - Chamoli (Kedarnath W.L.S., Valley of flowers W.L.S.)
  - Terai East Forest Division (Kishenpur, Dolly range, Surai range, khatima)
  - Tehri Forest Division
  - Badkot Forest Division (Yamnotri)
  - Khatima Forest Division
  - kedarnath Forest Division-Mohan khal

Development of Eco distribution maps of important FGRs

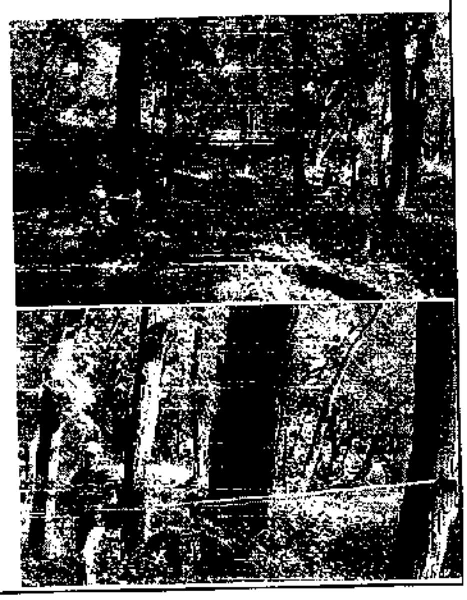
...mpling methodology was developed after ...h consultation with IIRS, FSI, WII, and ...AC

...ology was tested in the Mohand and ... block of Chilllawalii Range, Rajaji ...l Park, Dehradun (Uttrakhand).

...a is 80 % (approx.) hilly with mix ...us forest.

More than 80 sample points/GPS locations each of 6 m x 6 m were laid down in a track of ...0 kms and various parameters recorded.

Adopted methodology resulted in approx. 80 % accuracy in Sal forest mapping



Development of Eco-distribution map

Collected GPS points of tree species with specific distance on the field. More than 80 points collected shown in (Fig-1), in which 40 points recorded as Sal tree Species shown in

Fig -1

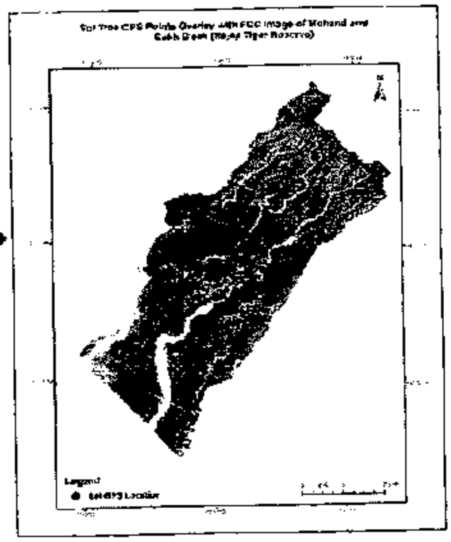
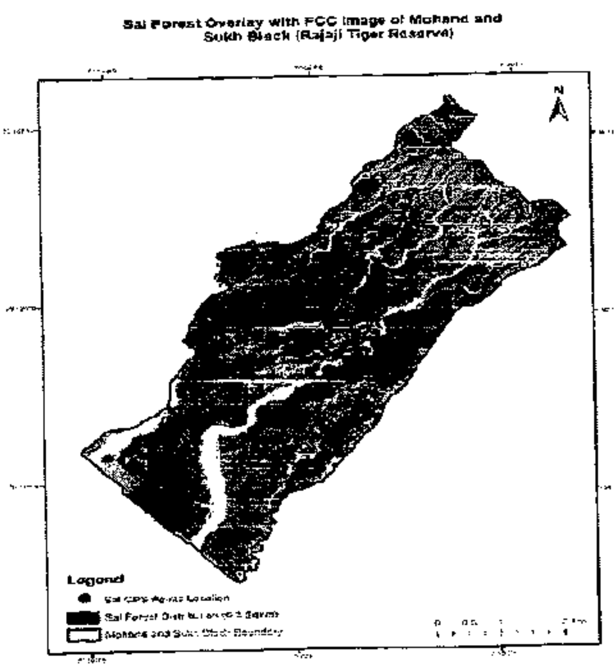


Fig -2

Development of Eco-distribution map

Output of test methodology in Sal forest of Mohan and Sukh block (Rajaji Tiger Reserve)



Working Group 2 : FGR Seed and Germplasm Storage

B.	Team	Targets
B1	Dr. Manisha Thapliyal, Sc. E Dr. Ajay Thakur, Sc. E Dr. Devender Kumar, Sc. D	Seed extraction, cleaning, grading, data recording, packing, labeling with passport data, etc. and putting the seeds under medium and long term storage. [*Target = 90 species*]
B2	Dr. Shambhavi Yadav, RO	Minimum moisture content and periodic seed viability and vigour trials on stored seed along with working out half-life of the seeds in storage, and developing biological models to predict risks associated with seed storage [*Target = 20 species*]
B3		Developing protocols for storage of FGR germplasm in the form of 'pollens' for red-listed species [*Target = 10 species*]
B4		Developing protocols for storage of germplasm of FGR species of very high conservation concern and those having recalcitrant seeds *in vitro*, minimal growth cultures and embryo culture [*Target = 10 species*]

Signing MOU with NBPGR New Delhi

A team of scientists from FRI visited National Bureau of Plant Genetic Resources, New Delhi and explored possibility of utilizing the long term storage facility of NBPGR.

Consent of NBPGR has been obtained up for utilizing their long term storage facility. An MOU has been drafted in consultation with NBPGR. The MOU is with ICAR for final approval.

Training at NBPGR New Dehi

On the request of FRI, National Bureau of Plant Genetic Resources (NBPGR) New Delhi organised a training course on "Techniques for of Conservation of Plant Genetic Resources" from 27th June to 2nd July, 2016. Ten Scientists and research personnel working in various components of CoFGR-CAMPA project

Survey of populations for seed collection

In order to capture sufficiently large genetic diversity in a species, seeds from at least five populations of each species have been planned for their medium term/long term storage.

Hence, population survey was conducted in various ranges of some Forest Divisions of Uttarakhand and identified the population of following species for seed collection:

Locations	Species identified
Kaladhoongi Forest Range, Ramnagar Forest Division	*Adina cordifolia* (haldu) *Anogeissus latifolia* (bankuli) *Lannea grandis* (jhingan) *Schleichera oleosa* (kusum)
Almora Forest Range, Almora Forest Division	*Myrica esculenta* (kaphal) *Quercus leucotrichophora* (banj oak) *Toona ciliata* (tun)
Someshwar Forest Range, Almora Forest Division	*Quercus glauca* (phaliyant) *Quercus leucotrichophora* (banj oak) *Rhododendron arboreum* (burans)
Ranikhet Forest Range, Almora Forest Division	*Myrica esculenta* (kaphal) *Quercus leucotrichophora* (banj oak)

Locations	Species identified
Kansro Forest Range, Dehradun Forest Division	*Adina cordifolia* (haldu) *Aegle marmelos* (bel) *Albizia procera* (siris) *Holoptelia integrifolia* (kanju papri) *Lannea grandis* (jhingan) *Schleichera oleosa (kusum)* *Terminalia bellirica* (bahera)
Rishikesh Forest Range, Dehradun [illegible]vision	*Aegle marmelos* (bel) *Albizia procera* (siris) *Bombax ceiba* (semal) *Holoptelia integrifolia* (kanju papri)
[illegible] Range Forest, Haldwani Forest [illegible]	*Albizia odoratissima* (kali Siris) *Acacia catechu* (khair)
[illegible] Forest Range, Haldwani [illegible] Division	*Bombax ceiba* (semal) *Lagerstroemia parviflora* (Dhauri)
Haldwani Forest Range, Central Tarai Forest Division, Haldwani	*Adina cordifolia* (haldu) *Albizia procera* (safed siris)
Chhakata Range, East Tarai Forest Division, Haldwani	*Acacia catechu* (khair) *Adina cordifolia* (haldu) *Holoptelia integrifolia* (kanju papri)
Tanda Range Central Tarai Forest Division, Haldwani	*Acacia catechu* (khair) *Garuga pinnata* (kharpat) *Mallotus philippensis* (rohini) *Toona ciliata* (tun)
Bhakhra Forest Range Central Tarai Forest Division, Haldwani	*Aegle marmelos* (bel) *Emblica officinalis* (aonla)

Pipalpadav Forest Range Central Tarai Forest Division, Haldwani	*Acacia catechu* (khair) *Bombax ceiba* (semal)
Fatehpur Forest Range, Ramnagar Forest Division	*Adina cordifolia (haldu)* *Aegle marmelos* (bel) *Anogeissus latifolia* (bankuli) *Bombax ceiba* (semal) *Dalbergia sissoo* (shisham) *Holoptelia integrifolia* (kanju papri) *Desmodium oojeinensis* (sandhan) *Schelichera oleosa* (kusum) *Terminalia bellirica* (bahera) *Toona ciliata* (tun)
[illegible]hani Forest Range [illegible]al Tarai Forest Division, Haldwani	*Acacia catechu* *Aegle marmelos* (bel) *Bombax ceiba* (semal) *Holoptelia integrifolia* (kanju papri) *Mallotus philippensis* (rohini)
Nandhaur Forest Range Tarai East Forest Division, Haldwani	*Acacia catechu* *Adina cordifolia (haldu)* *Dalbergia sissoo* (shisham) *Dioscorea bulbifera* (genthi) *Desmodium oojeinensis* (sandhan) *Schleichera oleosa (kusum)*
Barakoli Forest Range, Sitarganj Tarai East Forest Division, Haldwani	*Acacia catechu* (khair) *Dalbergia sissoo* (shisham) *Dalbergia sissoo* (shisham) *Holoptelia integrifolia* (kanju papri) *Schleichera oleosa (kusum)*

Seeds of following species were collected and processed :

Sl. no.	Species	Site of Seed Collection
1.	*Alnus nepalensis*	Kiskot Village, Champawat Range
2.	*Aristolochia elegans*	Jauljivi, Pithoragarh FD
3.	*Bischafia javanica*	Jauljivi, Pithoragarh FD
4.	*Pyrus pashia*	Narayanswami, Pithoragarh Range
		Champawat Range
5.	*Pinus wallichiona*	Tanta Village, Dharchula Range
6.	*Cedrus deadara*	Patal-Bhuwneswar, Gangolihaat
7.	*Carpinus viminea*	Chopta-Mandal Forest
8.	*Albizia julibrissin*	Arakot, Chamba
9.	*Acacia catechu*	Thano range
10.	*Dalbergia sissoo*	Thano range
11	*Aegle marmelos* *Terminalia bellirica* *Haloptelea integrifolia*	Kansro Forest Range, Dehradun Forest Division
12	*Haloptelea integrifolia*	Timli Forest Range, Dehradun Forest Div
13	*Desmodium aajeinensis* *Taona ciliata*	Rajaji Tiger Reserve, Dehradun
14	*Aegle marmelos*	Fatehpur Forest Range, Haldwani
15	*Taona ciliata*	Almora Forest Division
16	*Schleichera aleosa*	Chilla Range

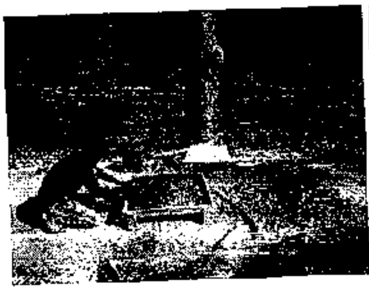
Seed collection of *Desmodium oojeinensis* and *Rhododendron arboreum*

Seed extraction

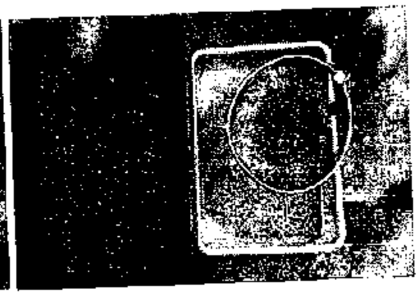
Seed Handling and Testing

Seed Extraction and Processing :

Seeds were extracted from the ripened fruits. Initial parameters on seed weight, seed dimensions, seed moisture content, seed germination, etc. were recorded. Seed extraction has been done from 12 species: *Schleichera oleosa, Fraxinus xanthoxyloides, Aristolochia elegans, Bischofia javanica, Carpinus viminea, Cedrus deodara, Pinus wallichiana, Alnus nepalensis, Pyrus pashia, Acacia catechu, Albizzia julibrissin and Dalbergia sissoo.*



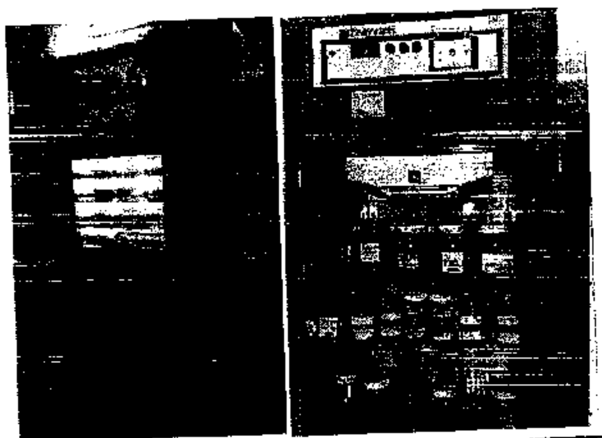
Albizia julibrissin



Alnus nepalensis

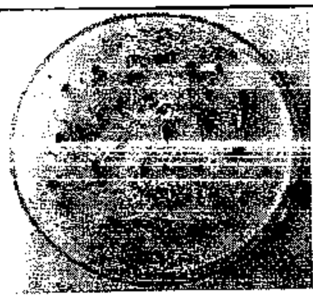
Seed Drying and Storage

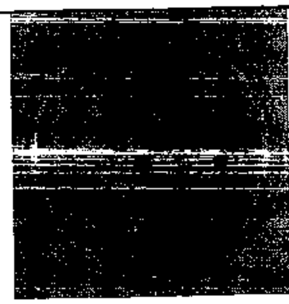
Dried seeds of *Aristolochia elegans, Bischofia javanica, Carpinus viminea, Cedrus deodara,* Pinus *wallichiana, Pyrus pashia, Dalbergia sissoo, Acacia catechu, Albizia julibrissin* and *Alnus nepalensis* were stored under controlled environmental condition.



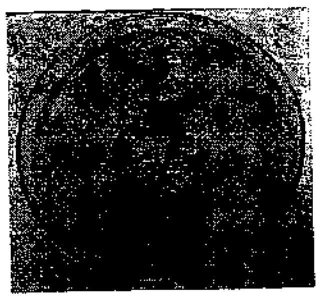
Quarterly Viability testing of seeds

Germination test are being conducted quarterly basis on the stored seeds of different species viz. *Desmodium oojeinensis*, *Toona ciliata*, *Aegle marmelos*, *Hippophae salicifolia*, *Rhododendron arboreum* and *Holoptelia integrifolia*, *Aristolochia elegans*, *Bischofia javanica*, *Pinus wallichiana*, *Pyrus pasia*, *Dalbergia sissoo*, *Acacia catechu*, *Albizia julibrissin*. Seed germination of the remaining species is in progress.





Seed germination in *Hippophae salicifolia* and *Holoptelia integrifolia*

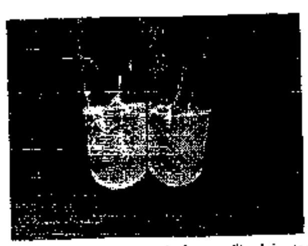


Seed germination in *Desmodium oojeinensis* and *Toona ciliata*

In-vitro storage of FGR species

In this case either FGR of very high conservation concern or those having recalcitrant seeds or both is the availability of a standardized *in vitro* regeneration protocol.

Experiments have been initiated to devise *in vitro* regeneration protocols for selected species viz: *Rhododendron arboreum*, *Taxus contorta*, *Desmodium oojeinensis*, *Quercus floribunda*, *Q. Semecarpifolia*, *Diploknema butyracea*, *Q. Floribunda*, *Hippophae salicifolia* and *Acacia catechu*.



Somatic organogenesis from calli originated from hypocotyls of *D. oojeinensis*

Working group 3 : FGR Characterization

Name of Investigators	Targets
H.S.Ginwal, Sc. G person) Santan Barthwal, Sc. E V.K. Varshney, Sc. F mit Pandey, Sc. F R.K. Meena, Sc. C	Evaluation and molecular characterization of FGRs, specifically for biochemical traits, and screening for disease and pests towards enhancing productivity. [*Target = 5 species*]
	Genetic diversity studies of FGRs of conservation concern and high commercial value with germplasm collected from across the range of distribution of the species. [*Target = 5 species*]

Selection of species

Six species have been prioritized for molecular characterization and genetic diversity estimation :

1. *Rhododendron arboreum* (Burans)
2. *Texas wallichiana* (Thuner)
3. *Quercus semecarpifolia* & *Q. lanuginose* (Kharsu oak and Rianj Oak)
4. *Betula utilis* (Bhojpatra)
5. *Myrica esculenta* (Kafal)
6. *Diploknema butyracea* (butter tree)

2801

Survey and Sampling

- Distinct populations of each species were identified from literatures and through the assistance of forest department.
- Random sampling method have been adopted for collection of leaf samples.
- Leaf samples were collected for **30 individuals per population** and each individuals are at least 100 m apart.
- So far **47 populations** belonging to six species have been sampled.

Populations Sampled

Species Name	Population Code	Location detail	Geo-coordinates
rpifolia	QS-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30°27'11.5" Long: E 79°14'29.9" Alt: 2577 m
			Lat: Long: Alt:
	QS-03	Devban, Kanasar range, Chakrata	Lat: N 30°44'52.4" Long: E 77°51'58.3" Alt: 2818 m
			Lat: Long: Alt:
	QS-05	Near Lokhandi village, Kanasar range, Chakrata	Lat: N 30°45'30.4" Long: E 77°49'57.8" Alt: 2750 m
			Lat: Long: Alt:

cont.

Species Name	Population Code	Location detail	Geo-coordinates
ecarpifolia	QS07	Auli, Joshimath	Lat: N 30031'26.3" Long: E 79033'53.8" Alt: 2944 m
			Lat: Long: Alt:
	QS09	Raditop	Lat: N 30045'20.2" Long: E 78012'32.4" Alt: 2569 m
			Lat: Long: Alt:
	QS11	Bhukkitop	Lat: N 30050'28.4" Long: E 78039'37.2" Alt:

Species Name	Population Code	Location detail	Geo-coordinates
dendron *eum* var Red	RA-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30°27'11.5" Long: E 79°14'29.9" Alt: 2577 m
	RA-03	Janglat Chowki, Kanasar range, Chakrata	Lat: N 30°43'43.7" Long: E 77051'52.5" Alt. 2363 m
	RA-05	Near Nagthala, River range, Chakrata, Dehradun	Lat: N 30°35'25.1" Long: E 77°56'16.3" Alt: 2161 m
	RA07	Kedarnath, Chamoli, Uttarakhand	Lat: N 30°05'26.5" Long: E 79°17'18.5" Alt: 2035 m
	RA09	Chinapani, Champawat	Lat N29°17'25.13' Long: E 80°6'28.04" Alt:1726 m

cont.

Species Name	Population Code	Location detail	Geo-coordinates
...dendron arboreum	RA10	Siutal, Champawat, Uttarakhand	Lat: N29°17'40.75" Long: E 80°11'2.10" Alt: 1769 m
	RA12	Devdhula, Didihaat, Pithauragarh, Uttarakhand	Lat: N29°48'59.09" Long: E 80° 13'6.64" Alt: 1691 m
Rhod... dendr...			
	RP02	Chopta, Chamoli	Lat: N 30°28'51.9" Long: E 79°11'52.3" Alt: 2937 m
	RP04	Auli, Joshimath	Lat: N 30031'15.1" Long: E 79033'55.3" Alt: 2941 m

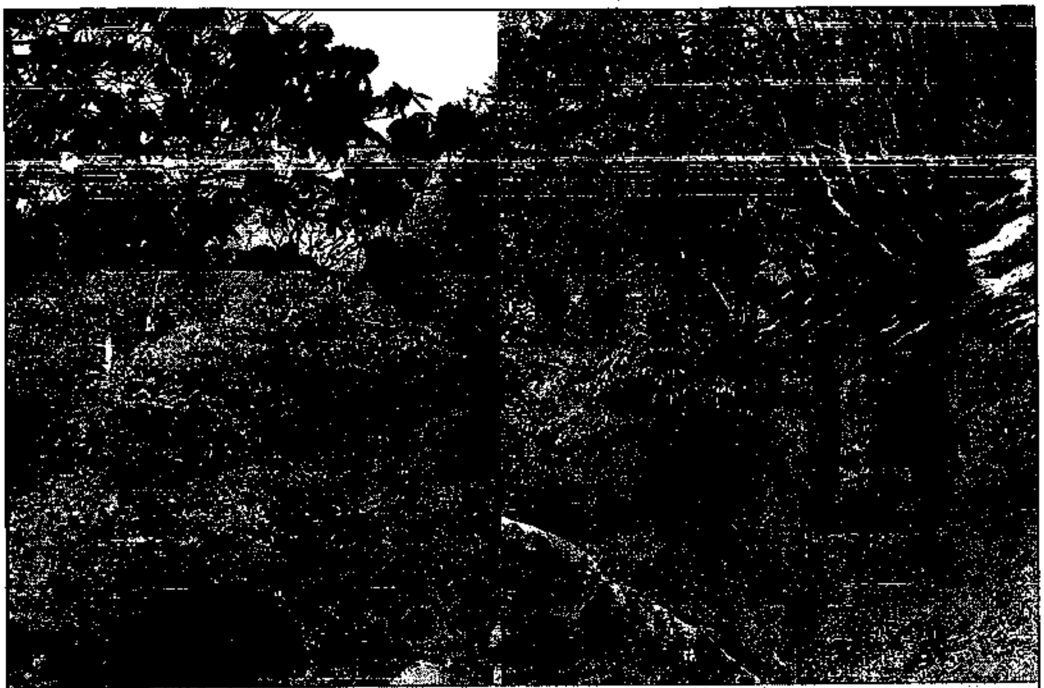
Species Name	Population Code	Location detail	Geo-coordinates
Te... w...biana	TB-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30°27'11.5" Long: E 79°14'29.9" Alt: 2577 m
	TB-03	Devban, Kanasar range, Chakrata	Lat: N 30°44'52.4" Long: E 77°51'58.3" Alt: 2816 m
	TB-05	Near Hans bugyal on rudranath trekking route, Gopeshwar	Lat: N 30°29'34" Long: E 79°16'40.1 Alt: 3135 m
	TB-07	Harshil, Cholmi, Uttarkashi, Uttarakhand	Lat: N 31001.319 Long: E 78044.700 Alt: 3139 m

Species Name	Population Code	Location detail	Geo-coordinates
M[illegible]a esculenta	ME-01	Trekking route of Mandal to Ansuya Devi temple, Gopeshwar	Lat: N 30⁰29'16.2" Long: E 79⁰17'30.0" Alt: [illegible]
	ME03	Nagnath, Kedarnath, Chamoli, Uttarakhand	Lat:N 30019'31.8" Long:E 79011'46.0" Alt:1801 m
	ME05	Chinapani, Champawat, Uttarakhand	Lat:N29°17'25.13" Long: E 80°6'28.04" Alt:1726 m
	ME07	Kamlake, Berinag, Pithauragarh, Uttarakhand	Lat:N29°50'53.04" Long:E 80°0'22.68" Alt:2001 m

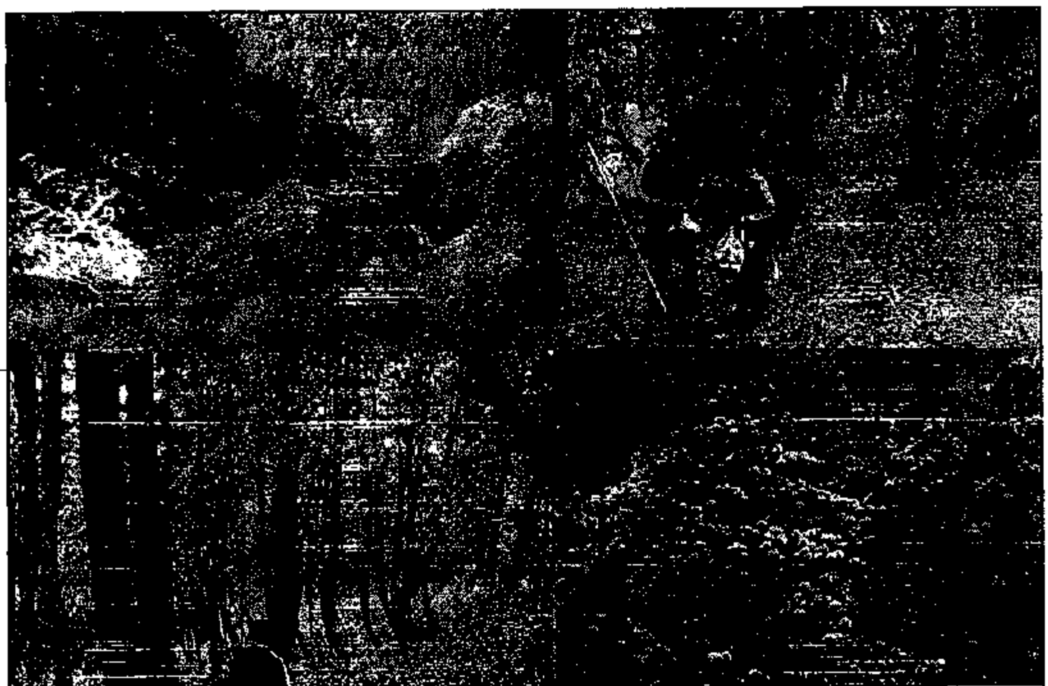
Species Name	Population Code	Location detail	Geo-coordinates
B[illegible]utilis	BU-01	Above the Hans bugyal on rudranath trekking route, Gopeshwar	Lat: N 30029'36.4" Long: E 79028'48.4" Alt: 3225 m
[illegible]ma butyracea	DB01	Lohaghat, Champawat, Singda, Uttarakhand	Lat: 29 30 11.60 N Long: 80 6 0.30 E Alt: 551 m

Species Name	Population Code	Location detail	Geo-coordinates
T[illegible]llichiana	TB-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	Lat: N 30^{0}27'11.5" Long: E 79^{0}14'29.9" Alt: 2577 m
	TB-03	Devban, Kanasar range, Chakrata	Lat: N 30^{0}44'52.4" Long: E 77^{0}51'58.3" Alt: 2818 m
	TB-05	Near Hans bugyal on rudranath trekking route, Gopeshwar	Lat: N 30^{0}29'34" Long: E 79^{0}18'40.1 Alt: 3135 m
[illegible]is			
Bet[illegible]a utilis	BU-01	Above the Hans bugyal on rudranath trekking route, Gopeshwar	Lat. N 30^{0}29'38.4" Long: E 79^{0}28'48.4" Alt: 3225 m

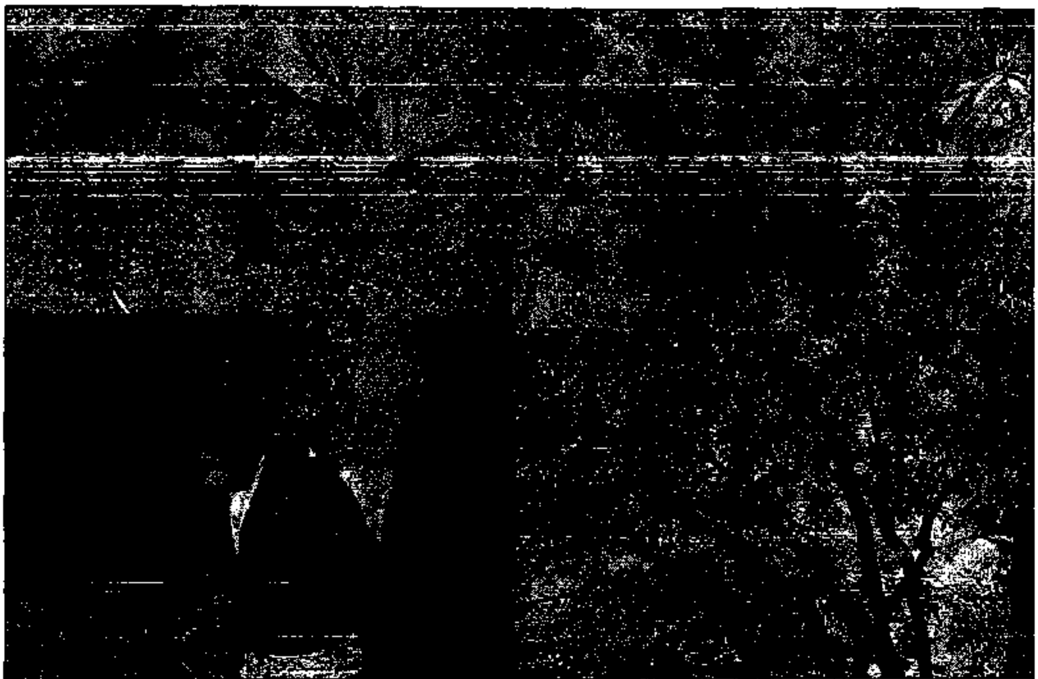
<u>Bhojpatra (*Betula utilis*) from Rudranath</u>



Burans (*Rhododendron arboreum* var. Red) from Chopta.

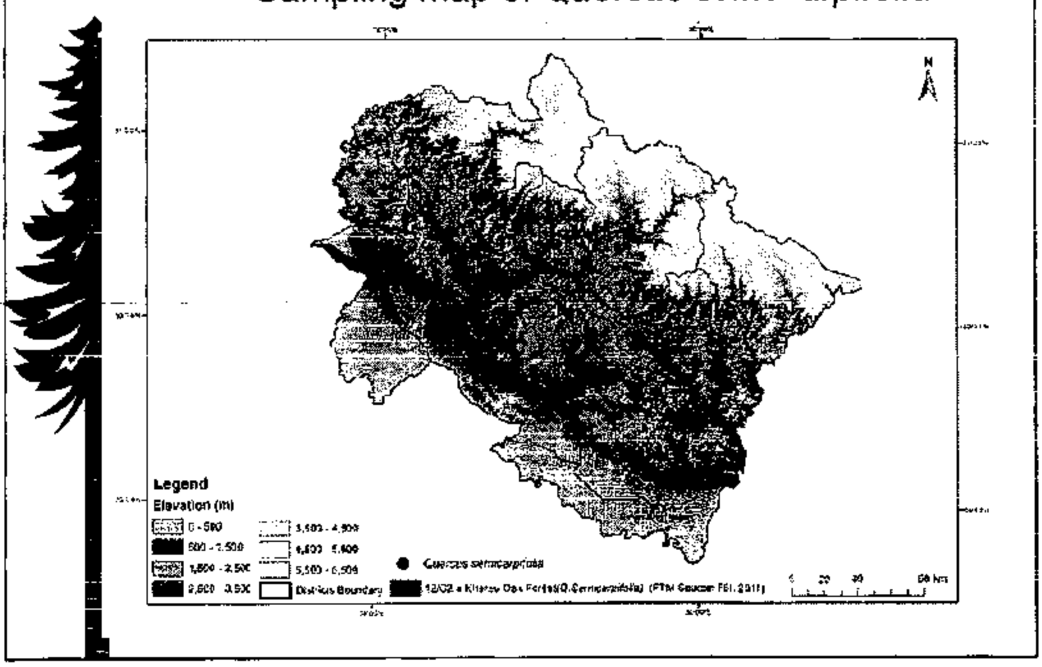


Burans (*Rhododendron arboreum* var. Pink) from Rudranath

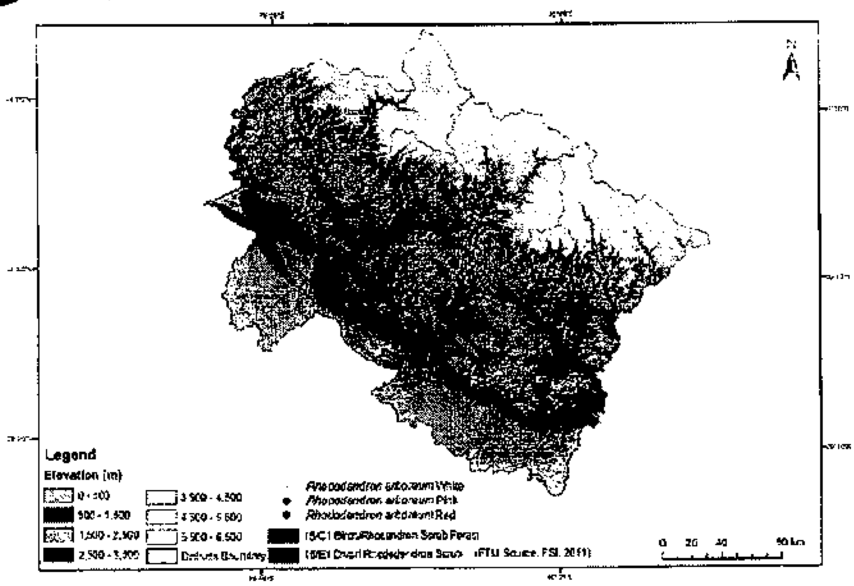


Kafal (*Myrica esculenta*) from trekking route of Anusuya Devi

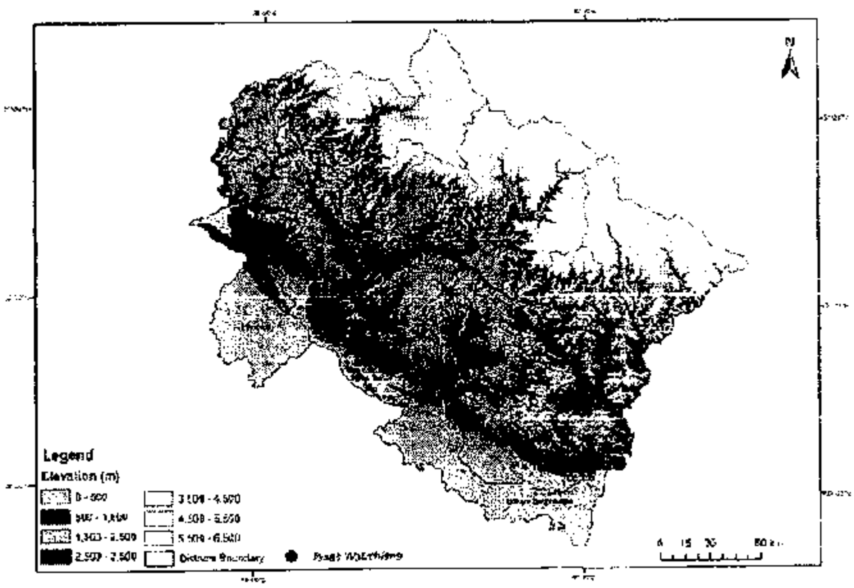
Sampling map of *Quercus semecarpifolia*



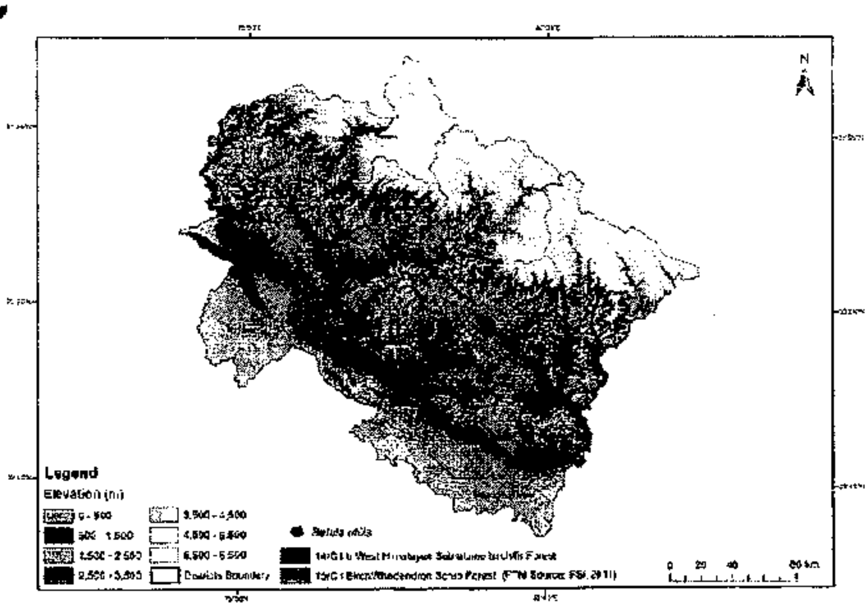
Sampling map of *Rhododendron arboreum*



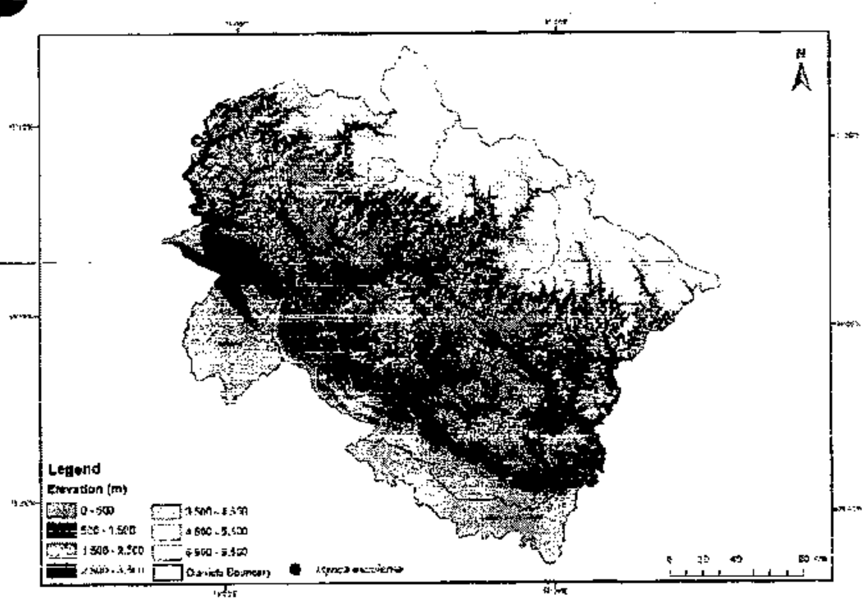
Sampling map of *Taxus wallichiana*



Sampling map of *Betula utilis*



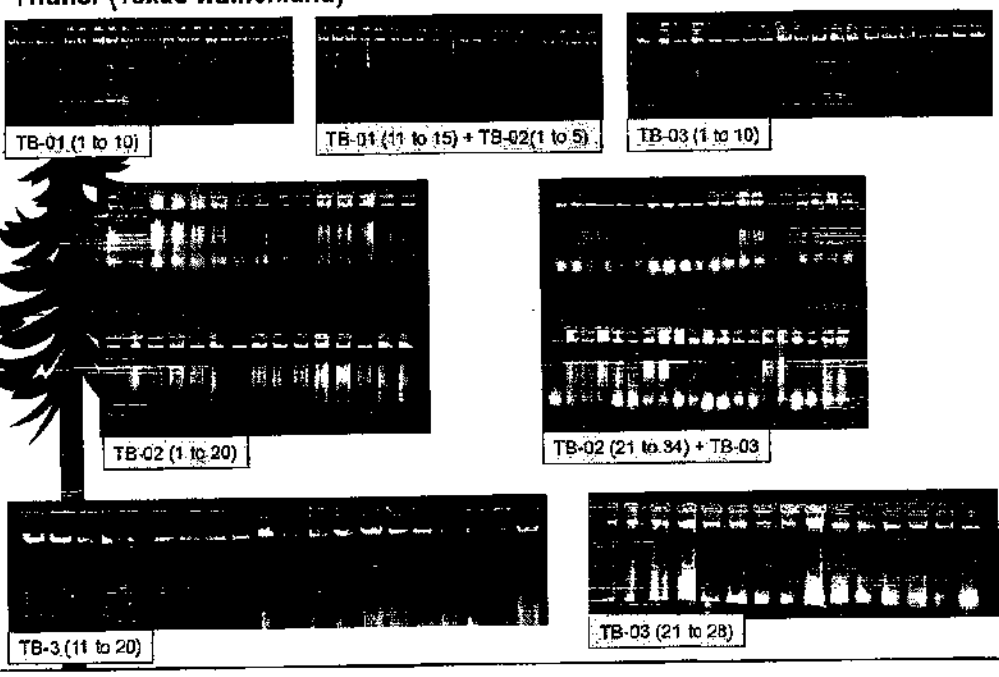
Sampling map of *Myrica esculenta*



Genomic DNA extraction and quantification

Species Name	No. of samples (Populations) collected	Protocol standardized	DNA extraction done	Quantitative and qualitative analysis done
Texas wallichiana	240 samples (8 pop)	Yes	240 samples (8 pop)	240 samples (8 pop)
Quercus semecarpifolia	270 samples (9 pop)	Yes	270 samples (9 Pop)	270 samples (9 Pop)
Rhododendron arboreum var Red	390 samples (13 pop)	Yes	390 samples (13 pop)	390 samples (13 pop)
Rhododendron arboreum var Pink	120 samples (4 pop)	Yes	120 samples (4 pop)	120 samples (4 pop)
Betula utilis	60 samples (2 pop)	Work going on	-	-
Myrica esculenta	240 samples (8 pop)	Yes	90 samples (3 pop)	ME01, ME02, ME03
Diploknemma butyracea	30 samples (1 pop))	Yes	30 samples (1 pop)	30 samples (1 pop)

Thuner (*Texas wallichiana*)



Chemical characterization of FGRs

- Total flavonoid content (TFC) and total anthocyanin content (TAC) in the flowers of the Rhododendron spp. identified as marker constituents for chemical screening of populations of Rhododendron spp. and identification of elite lines.
- Methodology for estimation of TFC and TAC in the Rhododendron flowers worked out.
- Three populations of *Rhododendron arboreum* (RA 3, RA 4 and RA 5) with respect to the total flavonoid contents (TFCs), characterized. TFCs (mg rutin equivalent /g extract) were found to be varying from 38.06 ±0.36 to 214.41± 4.04 (mean value 111.26 ±1.21), 42.06 ±0.22 to 141.44± 1.98 (mean value 97.97 ±1.47) and 70.96 ±1.33 to 224.44 ±0.88 (mean value 128.66 ±1.35), respectively.
- Further stem bark samples collected from population lines (ME 01, ME05, ME06, ME07 and ME08) of *Myrica esculenta*, and leaves samples collected from one population line (QS 06) of *Quercus semicarpifolia* were freeze dried and milled for their chemical analyses.

Chemical characterization of FGRs

- Extraction of the stem bark samples of ME 01 using 25% aqueous methanol for estimation of total tannin content completed. Extraction of these samples for determination of their total phenol contents (TPCs) was initiated and continued. Protocol for estimation of total phenol contents (TPCs) in these samples was standardized.
- Standardization of protocol for estimation of total triterpenoid content in the stem bark samples of *Betula utilis* population has been completed.

Working group 4 : FGR Conservation

me of Investigators	Specific responsibility and targets
Ashok Kumar, Sc. E person) Dinesh Kumar, Sc. F a Chand, Sc. D akant, Sc. C	Establishment of Field Gene Banks of priority FGR species. Includes collection of germplasm of selected species, multiplying and maintaining it in the nursery, site preparation, planting, site protection, and maintenance [*Target = 5 species*]
	Development and standardization of nursery techniques of FGR species of very high conservation concern. [*Target = 5 species*]
	Evaluation of selected PAs for their effectiveness in conserving priority FGRs. Floristic survey & transact studies in the selected PAs to cover different seasons.[*Target = 1 PA*]
	Establishment of FGR Conservation Areas (FGR-CAs) in natural forests for species of high conservation concern. [*Target = CAs for 5 species*]
D	*Circa situm* conservation of remnant individuals of important FGRs on lands outside forests. Survey for remnant populations of FGRs on private lands.
	Conservation assessment & management prioritization (CAMP) workshop for assessment of threat status of FGRs of Uttarakhand and preparation of Action Plans for conservation of species [*Targef = 1 Workshops*]

FGR Conservation

1. Five priority species have been sort listed for FGR Conservation. The species are *Cinnamomum tamala, Diploknema butyracea, Rhododendron arboreum, Myrica esculanta* and *Taxus wallichiana*.

2. Preliminary survey of all the species selected for conservation of their genetic resources was completed in both lower and middle Himalayas

3. A detailed survey of *Taxas wallichiana* and *Rhododendron arboreum* was conducted in forest ranges at Devban, Kanasar range; Bhujkoti, Riknar range; Lokhandi village, Kanasar range of Chakrata Forest Division, **Kedarnath Wildlife Sanctuary, Sukhi top of Harshil range, Gangotri, and upper Yamunotri** forest ranges, and Raditop of Badkot range.

FGR Conservation

4. The GPS locations of the <u>intact promising populations</u> were recorded. Six populations of *Diploknema butyracea* in District Pithoragarh at altitudinal range of 780 to 1290 m and four populations of *Myrica esculenta* have been located in District Pithoragarh and Champawat at altitudinal range of 1995 to 2001 m. Germplasm will be collected at time of seed maturation.

   Two nursery sites have been identified in District Pauri Garhwal and Chakrata for multiplication of germplasm.

6. Scientists have also visited Dev Van Forest Nursery Chakrata, Forest Nursery Harshil, Forest Nursery Sonegad to explore the possibility to establish field gene banks and propagation of *Texas wallichiana*.

7. Propagation techniques of *Cinnamomum tamala, Rhododendron arboreum, Myrica esculanta* and *Taxus wallichiana* is being standardized at FRI

Thank You

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Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority

Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in IA No.1337 with IA Nos.827, 1122, 1216, 1473 in WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 22nd March 2017.**

The Manager Incharge,
Corporation Bank, Lodhi Complex Branch,
Ground Floor, Block No.11, CGO Complex,
Lodi Road, **New Delhi 110 003.**

Sub.: **CAMPA / NCAC – assistance to Centre of Excellence on Forest Genetic Resources at FRI Dehradun.**

Sir,

This is to request that :

(1) an amount of Rs.1,46,25,000.00 (Rs One crore forty six lakhs and twenty five thousand only) may kindly be transferred immediately from SB/ Flexi A/c No.037100301120068 in your Bank in the name of Compensatory Afforestation Fund Main Account, to SB A/c No037100101024054 in the name of National CAMPA Advisory Council, in your Bank ;

(2) an amount of Rs.1,46,25,000.00 (Rs One crore forty six lakhs and twenty five thousand only) may kindly be transferred from SB A/c No.037100101024054 in the name of National CAMPA Advisory Council in your Bank, to Account No.496902010088596 in the name of Director, FRI in Union Bank of India, FRI Dehradun [IFSC Code UBIN0549690, MICR Code 248026003).

Yours faithfully,

(D K Sinha)
Inspector General of Forests,
Chief Executive Officer, Ad-hoc CAMPA
Member Secretary National CAMPA Advisory Council

Copy to The Director, Forest Research Institute, Dehradun, with reference to her letter No.9-108/DGTP CoFGR/FRI2016 dated the 9th December, 2016.

2. The progress in the Project requires to be speeded up, and the Quarterly Progress Reports should also be sent in time in future. Further a copy of note No.17-15/2015-RTI dated the 2nd March 2017 from the Dy Inspector General of Forests (RT), Ministry of Environment Forest & Climate Change is enclosed, with the request that an appropriate decision may be taken in the matter and conveyed to this Office.

(D K Sinha)
Inspector General of Forests,
Chief Executive Officer, Ad-hoc CAMPA
Member Secretary National CAMPA Advisory Council

Copy to Deputy Inspector General of Forests (RAT), Ministry of Environment Forests & Climate Change, IPB, New Delhi 110003.

Received

(D K Sinha)
Inspector General of Forests,
Chief Executive Officer, Ad-hoc CAMPA
Member Secretary National CAMPA Advisory Council

8V

Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority
Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in
IA No.1337 with IA Nos.827, 1122, 1216, 1473 in
WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 24th March 2017.**

The Country Representative,
IUCN India Country Office,
C-4/25 Safdarjung Dev Area,
New Delhi – 110 016.

Sub.: **CAMPA/ NCAC – IUCN Toolkit for Restoration of Mining Sites.**

Sir,

Please refer to your letter dated the 1st February 2017 on the subject mentioned above.

2. Further to the presentation on the subject Project, made on 3rd March 2017 in the Office of Shri D K Sinha, Inspector General of Forests (Forest Conservation), Ministry of Environment Forest & Climate Change and Chief Executive Officer, Ad-hoc CAMPA, and pursuant to the deliberations therein, it is requested that IUCN may make actionable recommendations specifically mentioning the requisite steps to be taken to reclaim the mined areas, and also propose Standard Operation Procedures for reclamation of various types of mines. The requisite recommendations, preferably forming part of a revised Toolkit, may kindly be furnished within one month, keeping in view that the originally proposed schedules for the Project have been far exceeded.

3. The refund of the unspent balance of the amounts sanctioned to the IUCN could, appropriately, be considered on completion of the Project.

Yours faithfully,

(Rajagopal Prashant)
Asstt Inspector General of Forests
Tel No.: (011) 24695401

दूरभाष/Phones :
कार्यालय/Offi. : 0135-2755277
0135-2224444
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0135-2224513
फैक्स/FAX : 91-0135-2756865
E-mail : dir_fri@icfre.org

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डॉ० सविता, भा.व.से.
निदेशक व.अ.सं.
एवं
कुलपति व.अ.सं. सम विश्वविद्यालय

Dr. SAVITA, IFS
Director FRI
and
Vice-Chancellor FRI Deemed University

वन अनुसंधान संस्थान
(भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद्)
(पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार की एक स्वायत्त परिषद्)
डाकघर न्यू फॉरेस्ट, देहरादून—248006

FOREST RESEARCH INSTITUTE
(Indian Council of Forestry Research and Education)
(An autonomous body of Ministry of Environment, Forests & Climate Change Govt. of India)
P.O. New Forest, Dehra Dun—248006

अ०शा०सं० D.O.No 9-108/DGTP-CoFGR/FRI 2016 / 430

दिनांक Dated, the Date 27-04-2017

To,

The Inspector General of Forests /
Chief Executive Officer (CEO), Ad-hoc CAMPA
Ministry of Environment, Forest and Climate Change
Indira Paryavaran Bhavan
Jorbagh Road
New Delhi - 110 003

Kind attention: Shri Rajagopal Prashant, AIG (FC)

Dy. No. 92309/12
Date 11/5/17

Sub : Adhoc CAMPA project - National Program for Conservation and Development of Forest Genetic Resources: Pilot Project "Centre of Excellence on Forest Genetic Resources" at FRI, Dehradun –Progress Report reg.

Sir,

Kindly find enclosed herewith two copies of the Progress Report on the subject cited project, for the period of October 2016 – March 2017. This is to further inform that Progress Reports of earlier quarters have already been submitted to your office.

Kind regards,

Encl. As above

Yours faithfully

27/04/2017
(Dr. Savita)
Director

AIGF(RP) 9/5

OSD CAMPA

National Program for
Conservation and Development of Forest Genetic Resources

Pilot Project
(Implemented at FRI, Dehradun)

On

Creation of Centre of Excellence on Forest Genetic Resources (FGR) of India (CoFGR)

Funded under
Adhoc CAMPA Fund
Ministry of Environment, Forest & Climate Change
(2016-2020)

Progress Report
(October 2016-March 2017)

Submitted by

Forest Research Institute (FRI),
New Forest P.O., Dehradun 248 006

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PROJECT SUMMARY

Title of the Project:	National Program for Conservation and Development of Forest Genetic Resources: Pilot on 'Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)'at FRI Dehradun
Funding Agency:	Adhoc CAMPA Fund Ministry of Environment, Forest & Climate Change, Govt. of India
Project Outlay:	Rs. 861.20 lakhs (January 2016 – 31 December 2020)
Project Period:	5 years
Grants released:	1st installment - 146.25 lakhs
	2nd installment - 146.25 lakhs
Date of release:	1st installment on 21st January 2016
	2nd installment on 22th March 2017
Project Executing Authority:	Director Forest Research Institute, Dehradun
Period of present progress report:	Quarterly report (October 2016- March 2017)
	Cumulative progress up to 31st March 2017

Progress report (October 2016 - March 2017)

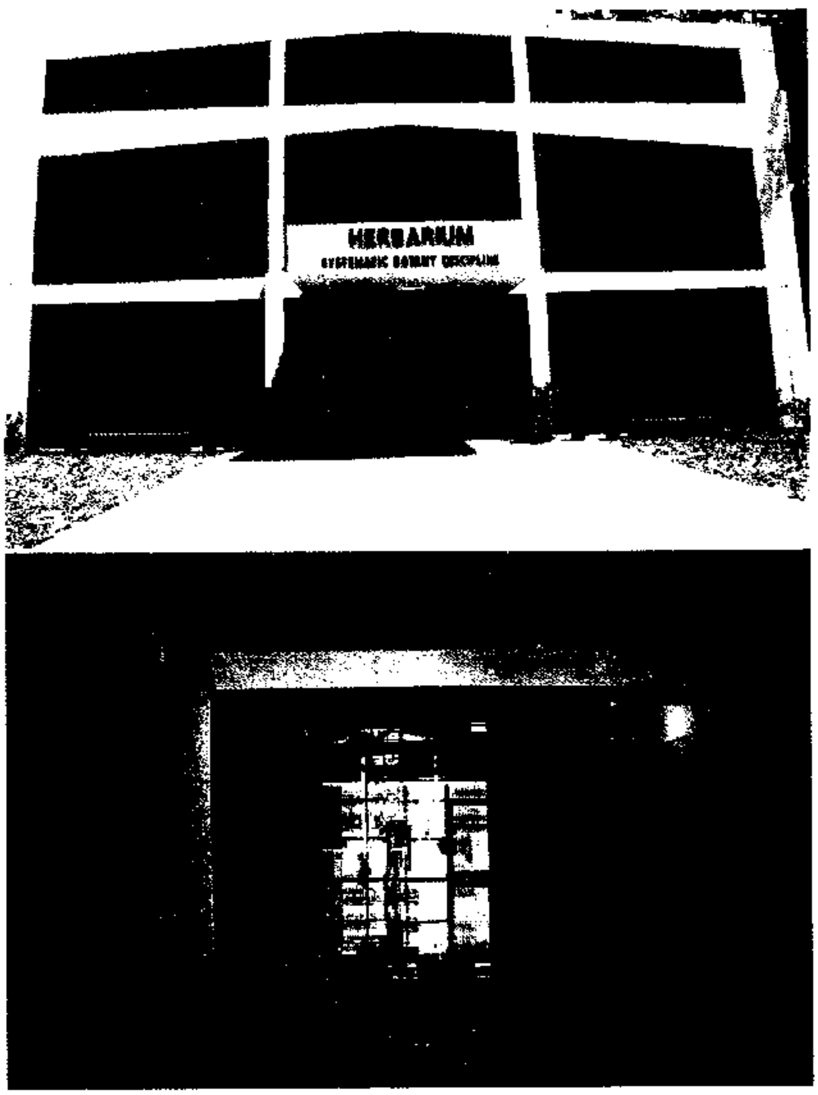
A brief progress of activities for the period of **October 2016 –March 2017** as per the action plan of the project has been summarized in the following points:

A. FGR Documentation

1. Up gradation of DD Herbarium

a) Renovation of Herbarium Building

During this quarter all civil works and super structural activities including flooring, false roofing, plastering and tile work, window panel fixation, and electrical work etc. were completed. The building has been completely renovated. Development of Scanning and Digitization Chambers are under process.



Renovated herbarium building

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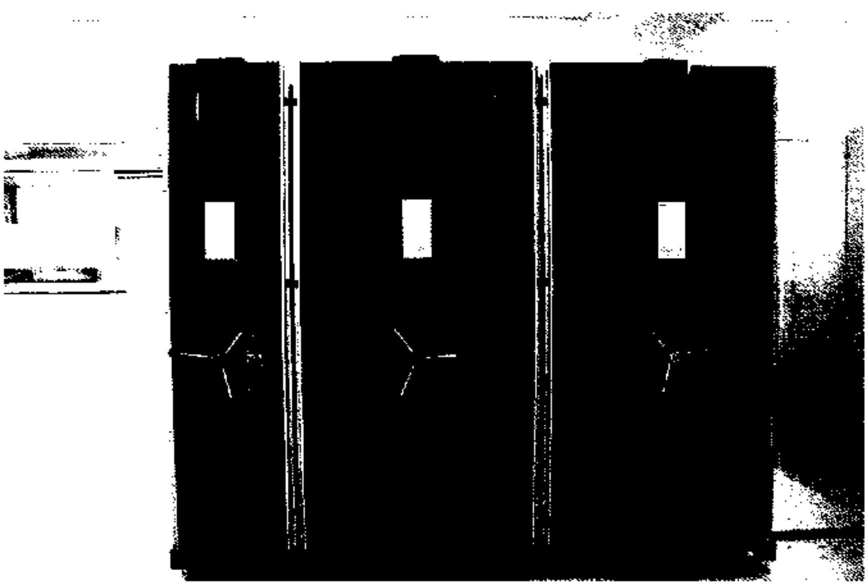
b) Purchase of mobile herbarium compactors:

Mobile herbarium compactors have been procured and installed in the renovated herbarium building. With the completion of renovation work of new herbarium hall, voluminous task of transferring Dicotyledonous floral specimens was initiated since February, 2017 following the Bentham & Hooker classification. So far 20% specimens have been transferred & remaining shall be done in the subsequent quarters.



Installed mobile herbarium compactors

c) **Documentation of FGR species**

a) **FGR distribution records**

The works related to extraction of information related to the distribution of FGR species from the working plans and the herbaria have been extracted from literature. The documents consulted for this purpose were FRI herbarium, BSI herbarium and working plans.

b) **Field Survey for distribution and regeneration**

After extraction of the distribution records of the FGR species, now the teams have initiate works on field surveys for ground verification of species and their populations, with GPS referencing. The field surveys in the following areas was completed during this period :

Pithoragarh and Champawat area:

Survey conducted for different ranges of Pithoragarh (Dharchula, Didihat, askot, Gangolihat and Pithoragarh) and Champawat (Lohaghat and Champawat) forest divisions and collected field data of several FGR species in month of October, 2016. These includes: *Abies spectabilis, Acer oblongum, Aesculus indica, Albizia chinensis, Albizia procera, Albizia lebbeck, Alnus nepalensis, Boehmeria rugulosa, Carpinus viminea, Cassia fistula, Cedrus deodara, Celtis tetrandra, Cinnamomum tamala, Cornus capitata, Diospyros montana, Diploknema butyracea, Engelhardtia colebrookiana, Erythrina suberosa, Ficus racemosa, Ficus rumphii, Ficus semicordata, Grewia optiva, Juglans regia, Litsaea monaptela, Litsaea glutinosa, Machilus odoratissima, Mangifera indica, Mitragyna parvifolia, Myrica esculenta, Oroxylum indicum, Ougeinia oojeinensis, Pinus roxburghii, Pinus wallichiana, Prunus cerasoides, Quercus floribunda, Quercus glauca, Quercus leucotrichophora, Quercus semecarpifolia, Rhododendron arbareum, Sapium insigni, Sterculia villosa, Syzygium cuminii, Terminalia arjuna, Terminalia bellirica, Toona ciliate, Taana serrata, Ziziphus mauritiana.*

In shrub and climber layer: *Adhatoda vasica, Asparagus adscendens, Callicarpa macrophylla, Debregeasia hypoleuca, Elaeagnus latifolia, Helicteres isora, Indigofera cassioides, Catunaregam spinosa, Prinsepia utilis, Zanthoxylum armatum, Chonemorpha macrophylla, Clematis gouriana,* and. *Stephania glabra*

Rare Endangered and Threatened taxa: *Brassiopsis aculeata Cinnamomum glanduliferum* (Champawat Range),, *Datisca cannabina* (Near Tapowan, Dharchula),, *Indopapdenia oudhensis* (Champawat), *Macranga pustulata* (Pithoragarh range), *Sterculia colorata* (Near Dharchula), *Neolitsea pallens* (Manch), *Uncaria pilosa* (Near Jalujibi), *Cyathea spinulosa* and *Ilex pseudo-odorata* (Shandev), *Trachycarpus takil* (Near Thal).

Khirsu and Vyasi area

Survey conducted in Khirsu (Pauri District, Uttarakhand) and Vyasi (Haridwar District, Uttarkhand) and collected field data of several FGR species in month of January, 2017. Data simulation of previously collected field data was also done in this quarter

Nainital [Ram Nagar Forest Division (Kaladungi, Dehchauri, Kotta and Kosi) and West Tarai Forest Division]:

Acacia nilotica ssp. *indica* (*Acacia arabica*), *Acacia catechu, Adina cordifolia, Aegle marmelos, Albizia lebbeck, Albizia procera, Alstonia schalaris, Anogeissus latifolia, Bauhinia racemosa, Bauhinia semla, Bischofia javanica, Bombax ceiba, Bridelia retusa, Buchanania lanzan, Butea monosperma, Careya arborea, Cassia fistula, Celtis tetrandra, Citrus medica, Cordia dichotoma, Crateva adansonii* ssp. *Odoraa, Dalbergia sissoo, Diospyros Montana, Emblica officinalis, Erythrina suberosa, Ficus auriculata, Ficus bengalensis, Ficus racemosa, Ficus rumphii, Ficus semicordata, Grewia optiva, Hymenodictyon orixense, Kydia calycina, Lagerstroemia parviflora, Lannea coromandelica, Litsaea glutinosa, Machilus duthiei, Madhuca longifolia, Mangifera indica, Melia azedarcach, Mitragyna parvifolia, Ougeinia oojeinensis, Pinus roxburghii, Pterospermum acerifolium, Putranjiva roxburghii, Schleichera oleosa, Semecarpus anacardium, Shorea robusta, Syzygium cuminii, Terminalia arjuna, Terminalia bellirica, Terminalia tamentosa, Toona ciliate, Ziziphus mauritiana*

In shrub and climber layers: *Adhatoda vasica, Asparagus adscendens, Callicarpa macrophylla, Catunaregam spinosa, Vitex negundo, Bauhinia vahlii, Celastrus* *paniculatus, Chanemorpha macrophylla, Clematis gouriana, Smilex ovalifolia, Cryptolepis buchanani.*

Rare Endangered and Threatened taxa: *Gardenia turgid, Heteropanax fragrans*

Trachycarpus takil ***Datisca cannabina*** ***Rivea ornata*** ***Taxus baccata***

Subalpine forest (*Abies spectabilis, Cupressus torulosa* and *Pinus wallichiana*)

Tarai Sal and Mix Forest

Figure showing some RET species

B. **FGR Seed and Germplasm storage**

1. **Population survey of FGR species**

Field tours were undertaken in different forest areas for survey of population of various FGR species and collection of seed. Seeds of 10 FGR species were collected from their natural zone of distribution (Table 1) during this period.

2. **Collection of seeds**

Seeds of the following species were collected from their range of distribution :

Table- 1 Seed collection sites of FGR species and their geographical locations

S. No.	Species	Site of Seed Collection	GPS Co-ordinates
1.	*Alnus nepalensis*	Kiskot Village, Champawat Range	$29^0$18'06.7"N, $80^0$04'51.1"E
1.	*Aristalachia elegans*	Jauljivi, Pithoragarh FD	$29^0$45'31.4"N, $80^0$22'19.2"E
3	*Bischafia javanica*	Jauljivi, Pithoragarh FD	$29^0$46'13.9"N, $80^0$23'36.5"E
4	*Pyrus pashia*	Narayanswami, Pithoragarh Range	$29^0$58'15.3"N, $80^0$39'16.3"E
		Champawat Range	$29^0$32'50.2"N, $80^0$11'07.1"E
5	*Pinus wallichiana*	Tanta Village, Dharchula Range	$29^0$59'18.6"N, $80^0$37'10.2"E
6	*Cedrus deadara*	Patal-Bhuwneswar, Gangolihaat	$29^0$41'17.0"N, $80^0$05'24.6"E
7	*Carpinus viminea*	Chopta-Mandal Forest	$29^0$41'17.0"N, $80^0$05'24.6"E
8	*Albizia julibrissin*	Arakot, Chamba	$30^0$22'0.25"N, $78^0$22'34.8"E
9	*Acacia catechu*	Thano range	$30^0$13'40.4"N, $78^0$13'29.4"E
10	*Dalbergia sissoo*	Thano range	$30^0$17'49.3"N, $78^0$07'18.5"E

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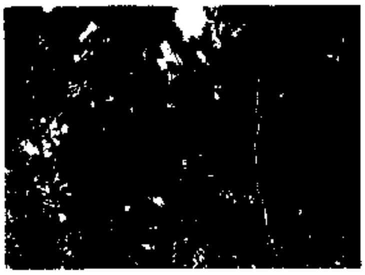
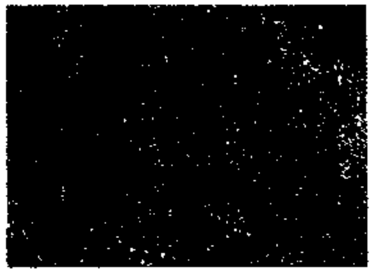

Aristolochia elegans


Bischofia javanica


Carpinus vimnea


Pinus wallichiana


Pyrus pashia


Dalbergia sissoo


Acacia catechu


Albizia julibrissin


Alnus nepalensis

3. Seed extraction and processing

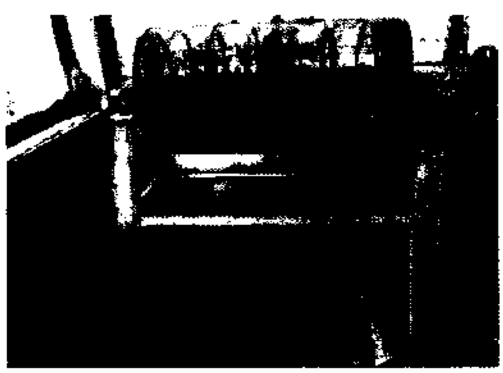
The seed extraction and processing works were completed in the following species :

Species	*Methodology*
Pinus wallichiana **and** ***Alnus nepalensis***	• Cones were sun dried for 10-12 days till they started to split. • Dry cones were placed in a drum rotator machine to separate the seeds from cones and de-winging was done. • Seeds were separated from the dusty impurities by sieving
Aristolochia elegans	• Fruits dried under indirect sunlight for 3 to 5 days • Seeds separated from the fruits once the fruits got split

	• Seeds separated from the dusty impurities by sieving
Bischofia javanica* and *Pyrus pashia	• Pulpy fruits were heaped for 7-10 days after ripening process. • Ripened fruits macerated, de-pulped and washed with tap water, seeds separated with the help of sieve. • Extracted seeds dried in cool air dryer at 15^0C and 15 % relative humidity.
Cedrus deodara	• Cones sundried for 12-14 days. • Seeds separated from the cones using cone extractor. • Empty seeds and chaff removed by winnowing.
Carpinus viminea	• Leaflets separated from the fruits. • Seeds separated from the debris, empty seeds and chaff by gentle winnowing.
Acacia catechu and Albizzia julibrissin	• Indehiscent pods sun dried and beaten gently. • Seeds separated after sieving and winnowing.
Dalbergia sissoo	• The seed of *Dalbergia sissoo* is being extracted manually from the pods and is under process.

Aristolochia elegans

Bischofia javanica



Carpinus vimnea *Cedrus deodara*

Cedrus deodara ***Pyrus pashia***

Dalbergia sissoo ***Acacia catechu***

After extraction of seeds, initial parameters on seed weight, seed moisture content, seed germination, etc. were recorded.

4. Seed moisture content

Moisture content of the seeds was determined by Oven-Dry method. In this method, Pre-weighed, grinded fresh seed materials were placed in an oven and maintained the temperature of oven at 103°C. Seeds were dried at this temperature for 17 hrs. After the prescribed period of seed drying, oven dried seeds were kept in desiccator filled with blue silica gel for avoiding the sudden cooling of seeds by acquiring moisture from the surroundings.

Cooled, oven dried seeds were weighed to calculate the moisture content.

$$\textbf{Seed Moisture Content (\%)} = \frac{\text{Fresh weight} - \text{Oven dry weight}}{\text{Fresh weight}} \times 100$$

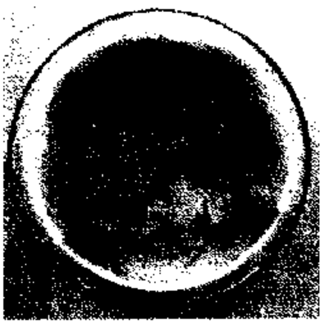
5. Seed germination test

Random sample of pure seeds were taken for seed germination test. Germination test was carried out in the germinator with controlled temperature 25^0C for temperate species and 30^0C for tropical species.

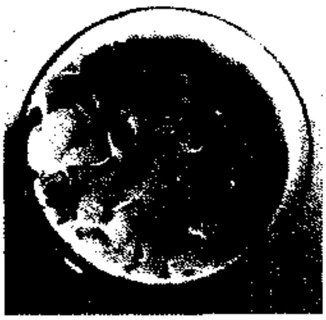
$$\textbf{\textit{Germinatian \% af seed}} = \frac{\text{Total number of seed germinated}}{\text{Total number of seed planted}} \times 100$$

Seed germination of all the species is in progress.

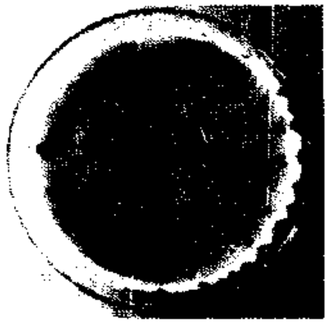
Seed Germination Test



Aristalachia elegans



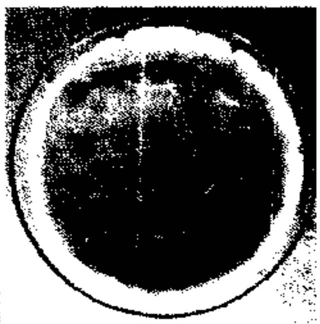
Bischafla javanica



Pinus wallichiana

Pyrus paschia

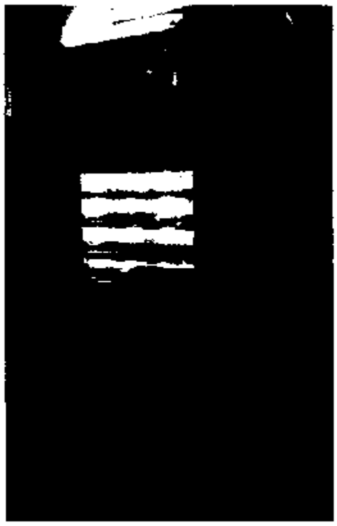
Dalbergia sissaa

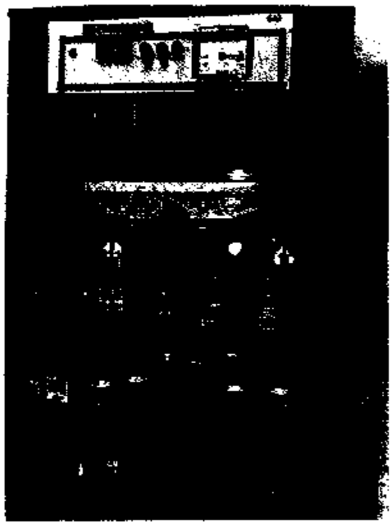


Acacia catechu

6. Seed drying and storage

Seeds were dried in cool air dryer at low temperature 15^0C and 15 percent relative humidity for slow desiccation to safe moisture levels for storage. Dried seeds of *Aristalochia elegans, Bischofia javanica, Carpinus viminea, Cedrus deadara,* Pinus *wallichiana, Pyrus pashia,* Dalbergia *sissoa, Acacia catechu, Albizia julibrissin* and *Alnus nepalensis* were stored in under controlled environmental condition.



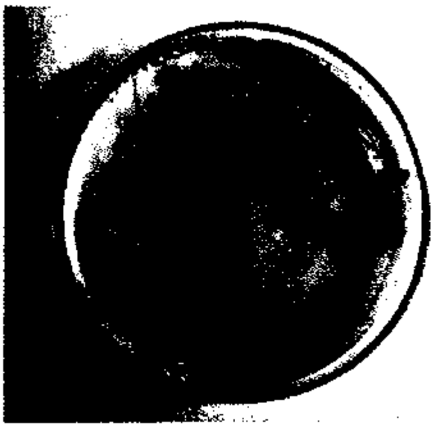


Seed drying in cool air seed drier   Seed storage in storage chamber

7. **Viability testing of stored seeds**

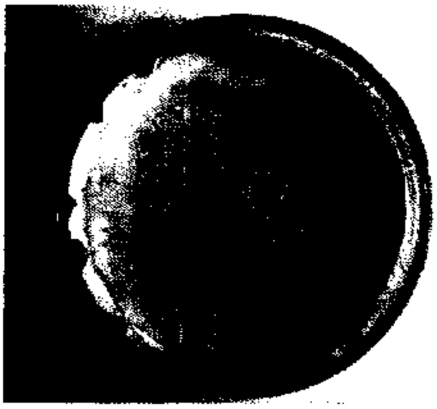
Viability testing of seeds has been done for following 6 species:

S. No.	Species for which viability testing has been done
1	*Desmodium oojeinensis*
2	*Toono ciliata*
3	*Aegle mormelos*
4	*Hippophae salicifolia*
5	*Rhododendron arboreum*
6	*Holoptelia integrifolia*



Toona ciliate   ***Aegle marmelos***

Hippophae salicifolia



Rhododendron arboreum

Seed viability testing in different species

8. In-vitro storage of FGR species

As the prerequisite for the development of any *in vitro* conservation methods for storage of FGR (in this case either FGR of very high conservation concern or those having recalcitrant seeds or both) is the availability of a standardized *in vitro* regeneration protocol. Thus experiments have been initiated to devise *in vitro* regeneration or micropropagation protocols for selected species as given below:

a) *Desmodium oojeinensis*
b) *Hippophae salicifolia*
c) *Acacia catechu*
d) *Taxus contorta*
e) *Rhododendron arboreum*

The brief progress of works has been summarized in the following table :

S.No.	**Species**	**Methodology**
1	***Desmodium oojeinensis***	
i)	**Culture Initiation from nodal explants**	
	Plant sample collection:	Near Bambusetum, Forest Research Institute, Dehradun
	Surface Sterilisation:	• Two different sets of treatment given: one set of explants were treated with 30% NaOCl for 30 minutes while the other set was treated with 0.1% $HgCl_2$ for 10 minutes to test the effective surface sterilants. Both sets were rinsed with autoclaved distilled water thrice to remove their traces. • Both sets were cultured in MS+2 mg/l BAP+ 0.25 mg/l Kinetin.

	In vitro response:	• After a week all NaOCl treated cultures were contaminated with bacterial and fungal growth. • The $HgCl_2$ set had less contamination but no bud break was observed in any culture.
ii)	***In vitro* seed germination and culture**	
	Seed collection	Procured from seed laboratory of Forest Research Institute, Dehradun
	Surface Sterilisation:	• Fungicide treatment was given with a solution containing 0.2% Bavistin & 0.1% Dithane M-45 for 15 minutes and washed thrice with distilled water. • Final surface sterilization was done with 0.1% $HgCl_2$ solution for 7 minutes and rinsed thrice with autoclaved distilled water to remove the traces of $HgCl_2$. • Finally seeds were placed on filter paper bridges immersed in liquid MS medium.
	In vitro response: 	After 15 days, *in vitro* seed germination was observed in some of the cultures.
iii	**Callus Culture:**	
	Source of callus	calli generated from cotyledons, epicotyls and hypocotyls of *in vitro* germinated seedlings
		• The calli were cultured in MS medium with 1 mg/l BAP to prevent drying. • The revived and green calli were cultured in MS medium supplemented with 1mg/l BAP and 10 mg/l $AgNO_3$
2	***Hippophae salicifolia***	
i)	***In vitro* Seed germination**	
	Seed collection	procured from seed laboratory of Forest Research Institute, Dehradun
	Surface Sterilisation:	• Owing to the problem of dormancy in seeds of *Hippophae,* few seeds after being treated with few drops of cetrimide for 15 minutes and thereafter with fungicide 0.2% bavistin+0.1%

		dithane M45 for 1.5 hours were kept immersed in 0.1%KNO_3 under dark conditions for 48 hours, 25°C. • Few seeds were kept untreated with 0.1% KNO_3 and used as control. • Finally both the sets (control as well as treated) were treated with 0.1% $HgCl_2$for 10 minutes under the laminar air flow and placed on filter paper bridges immersed in liquid MS medium while some of the seeds were inoculated on solid MS. *In vitro* seed germination was observed in some of the cultures after 15 days.
	In vitro **response:** 	40 % seed germination was observed in the seeds treated with 0.1%KNO_3 whereas 89 % seed germination was observed in untreated seeds.
3	***Acacia catechu***	
i)	***In vitro*** **seed germination and culture**	
	Seed collection	Procured from seed laboratory of Forest Research Institute, Dehradun.
	Surface Sterilisation:	• treated with few drops of cetrimide for 15 minutes, washed under running tap water. • treated with fungicide 0.2% bavistin+0.1% dithane-M45 for 45 minutes, rinsed with distilled water thrice to remove the traces of fungicide • finally treated with 0.1% $HgCl_2$for 7 minutes under the laminar air flow. • Sterilised seeds were then placed on filter paper bridges immersed in liquid MS medium. After 15 days *in vitro* seed germination was observed in some of the cultures.
	In vitro response:	70 % seed germination was observed.

		
4	***Taxus contorta***	
	Plant material collection	Collected from Deoban forest, Chakrata, Dehra Dun.
	Surface Sterilisation:	• The explants collected were cut into small segments and given a 10 min cetrimide wash followed by 15 min fungicide (Bavistin) wash. Final sterilization wash was given with 0.1 % Mercuric chloride for 10 min.
	Culture initiation	• explants were cultured on different medium combinations
	Medium 1	MS + 3% sucrose + 6.8gm/L Agar + 2.5 mg/L BAP + 1gm/L Activated Charcoal (AC)
	Medium 2	MS + 3% sucrose + 6.8gm/L Agar + 2 mg/L BAP
	Medium 3	½ MS + 3% sucrose + 6.8gm/L Agar + 1 mg/L IBA
	Medium 4	MS + 3% sucrose + 6.8gm/L Agar + 2 mg/L 2,4-D +5mg/L AC
	Medium 5	½ MS + 3% sucrose + 6.8gm/L Agar + 2.5 mg/L BAP + 1gm/L AC
	Medium 6	½ MS + 3% sucrose + 6.8gm/L Agar + 2.5 mg/L BAP + 0.1 mg/L NAA + 1 gm/L AC
	Medium 7	½ MS + 3% sucrose + 6.8gm/L Agar + 2.5 mg/L BAP + 100 mg/L $AgNO_3$ + 1 gm/L AC
	Medium 8	MS + 3% sucrose + 6.8gm/L Agar + 3 mg/L 2, 4-D + 5 mg/L AC
	***In vitro* response:** 	Explants cultured on Medium 7 showed best *in vitro* response with new buds opening up to generate new shoots. Explants cultured on Medium 3 and Medium 6 also showed some response. Further experiments will be carried out to ascertain the best medium for *in vitro* shoot propagation of *T. contorta*.
	Chemical induction of adventitious root formation in stem cuttings	• Stem cuttings of dipped in 0.25mM NAA, 0.25mM IBA and 0.05% Bavistin solutions for 24 hours. • planted in root trainers in vermiculite and 1:1:1 soil, sand and manure mixture and kept in a green

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		house and watered regularly to maintain humid conditions.
	Response:	• The results of the experiment will be recorded after 11 weeks.
5.	***Rhododendron arboreum***	
	Plant material collection	Maldevta and Chakrata area of Uttarakhand
i)	**Culture Initiation from nodal explants**	
	Surface Sterilisation	• The young buds and nodal segments were separated from the stem cuttings. and treated with few drops of cetrimide for 15 minutes and further treatments were given
	In vitro response:	• severe fungal and bacterial contamination in all the cultures.
6.	***Diploknema butyracea***	
	Plant material collection	Stem cuttings were collected from the nursery of Silviculture Division, Forest Research Institute, Dehradun.
	Nodal Segments:	
	Surface Sterilisation:	• Nodal segments were washed under running tap water, cut into 3-4 cm long sections and wiped with 70% alcohol and washed in solution containing 2-3 drops of cetrimide for 15 minutes and rinsed well. • Fungicide treatment was given with 0.2% Boon for 30 minutes and then washed thrice with distilled water. • Treated with 0.1% $HgCl_2$ for 7 minutes under the laminar air flow, rinsed with autoclaved distilled water thrice and finally cultured in following medium: MS+2 mg/l BAP and MS+ 2 mg/l Kinetin.
	In vitro response:	• Due to severe fungal and bacterial growth many cultures were contaminated and no observations could be made.

C. FGR Characterization

Molecular characterization

1. Collection of samples

Samples of following five species have been collected from their natural zone of occurrence and stored at -80^0 C.

- *Rhododendron arboreum var* red,
- *Texas wallichiana,*
- *Quercus semecarpifolia,*
- *Myrica esculenta and*
- *Betula utilis*

A total of 30-35 samples/trees were collected from each population in all the species. A total of 13 populations (4 populations of *Rhodadendron arbareum* var red, 2 populations of *Taxus wallichiana*, 2 populations of *Quercus semicarpifolia*, 4 populations of *Myrica esculenta* and 1 population of *Betula utilis*) were sampled from Champawat, Pithauragarh and Uttarkashi along with their geographical coordinates. The samples of these populations were segregated for chemical examination and DNA fingerprinting. The detail of the sampled populations is given in the following table:

Details of different populations collected

Population	Location	Latitude	Longitude	Altitude
***Rhododendron arbareum* var red**				
RA10	Siutal, Champawat, Uttarakhand	$9^0$17'40.75"	$80^0$11'2.10"	1769 m
RA11	Kamlake, Berinag, Pithauragarh, Uttarakhand	$9^0$50'55.70"	$80^0$0'41.55"	1993 m
RA12	Devdhula, Didihaat, Pithauragarh, Uttarakhand	$29^0$48'59.09"	80^0 13'6.64"	1691 m
RA13	Raditop, Ranwai, Uttarkashi, Uttarakhand	$30^0$46'15.7"	$78^0$15'23.3"	2233 m
Texas wallichiana				
TB07	Harshil, Cholmi, Uttarkashi, Uttarakhand	$31^0$01.319	$78^0$44.700	3139 m
TB08	Sukhitop, Uttarkashi, Uttarakhand	$31^0$00'9.7"	$78^0$41'42.5"	2795 m
Quercus semecarpifolia				
QS08	Yamunotri, Uttarkashi, Uttarakhand	$30^0$59'42.6"	$78^0$27'36.4"	2942 m

QS09	Raditop, Uttarkashi, Uttarakhand	30^{0}45’20.2”	78^{0}12’32.4”	2589 m
Myrica esculenta				
ME05	Chinapani, Champawat, Uttarakhand	29°17'25.13"	80°6'28.04"	1726 m
ME06	Siutal, Champawat, Uttarakhand	29°17'40.70"	80°11'2.24"	1766 m
ME07	Kamlake, Berinag, Pithauragarh, Uttarakhand	29°50'53.04"	80° 0'22.68"	2001 m
ME08	Devdhula, Didihaat, Pithauragarh, Uttarakhand	29°48'58.73"	80°13'5.37"	1695 m
Betula utilis				
BU02	Harshil, Cholmi, Uttarkashi, Uttarakhand	31^{0}01.353	78^{0}44.642	3126 m

2. Genomic DNA extraction

Genomic DNA has been extracted from the following 10 populations. Protocol for DNA extraction from *Betula utilis* has been standardized but some modifications are still required to improve the quality and yield of DNA. Protocol for *Diploknemma butyraceae* has been standardized.

Species	DNA extraction done
Rhododendron arboreum var red	RA09, RA10, RA11, RA12, RA13
Quercus semicarpifolia	QS08, QS09
Texas wallichiana	TB07, TB08
Diploknemma butyracea	DB01

3. Quantitative and Qualitative analysis of Genomic DNA

The concentration and absorbance ratio (A_{260}/A_{280} nm) of the DNA samples representing to the following populations were quantified using Bio photometer (Eppendorf-6131, Germany) and quality of genomic DNA was analyzed on 0.8% agarose gel.

Species	DNA quantification done
Rhododendron arboreum var red	RA08, RA09, RA10, RA11, RA12, RA13
Quercus semicarpifolia	QS08, QS09
Texas wallichiana	TB07, TB08
Diploknemma butyracea	DB01

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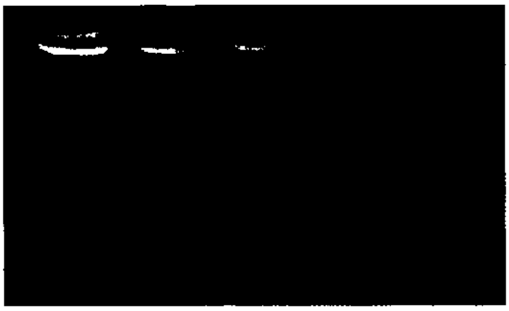
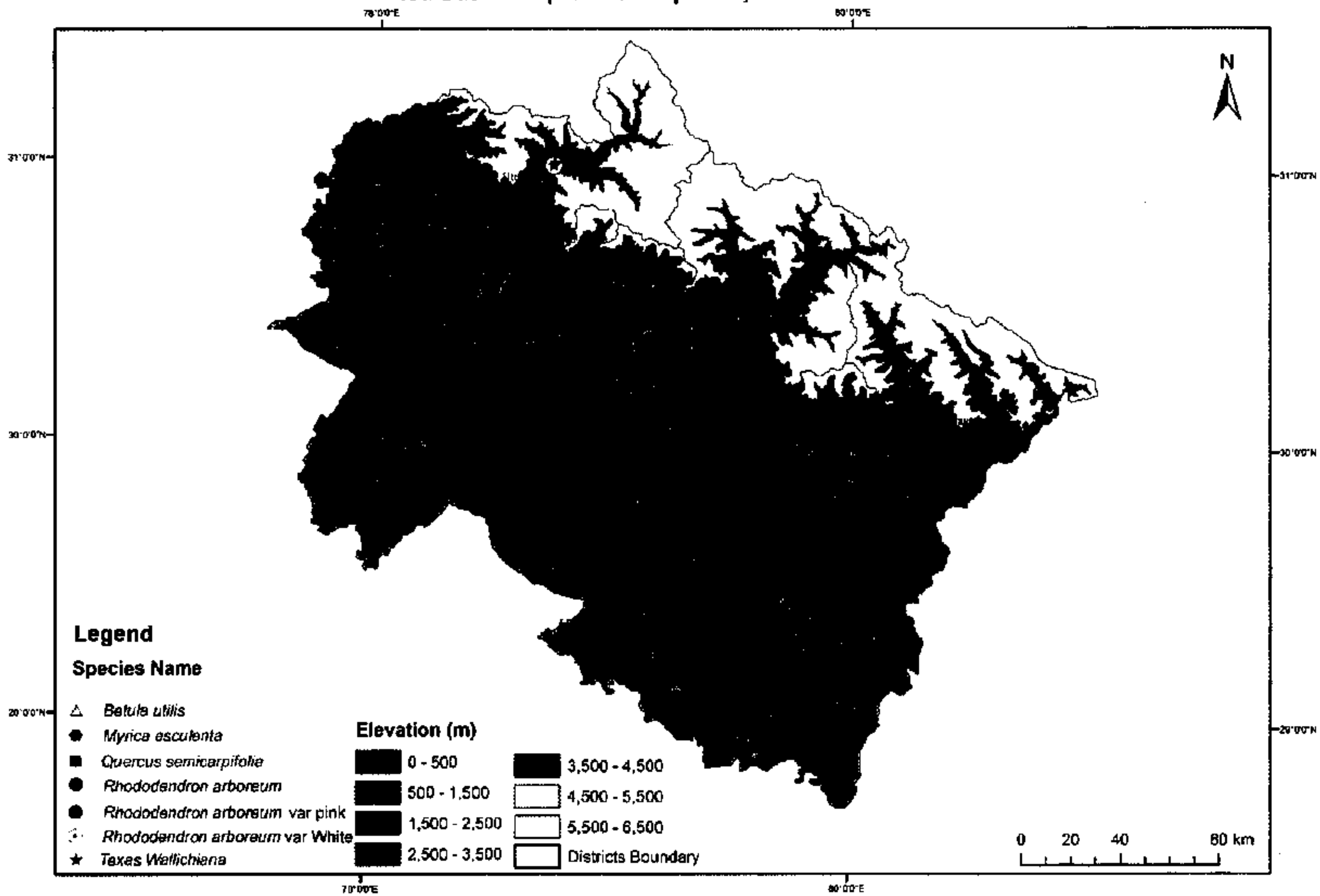


Genomic DNA extracted from
Betula utilis

Genomic DNA extracted from
Diploknemma butyracea

Gel Photographs showing Genomic DNA extracted from genotypes of different species

Distribution Map of Plant Species, November - 2016



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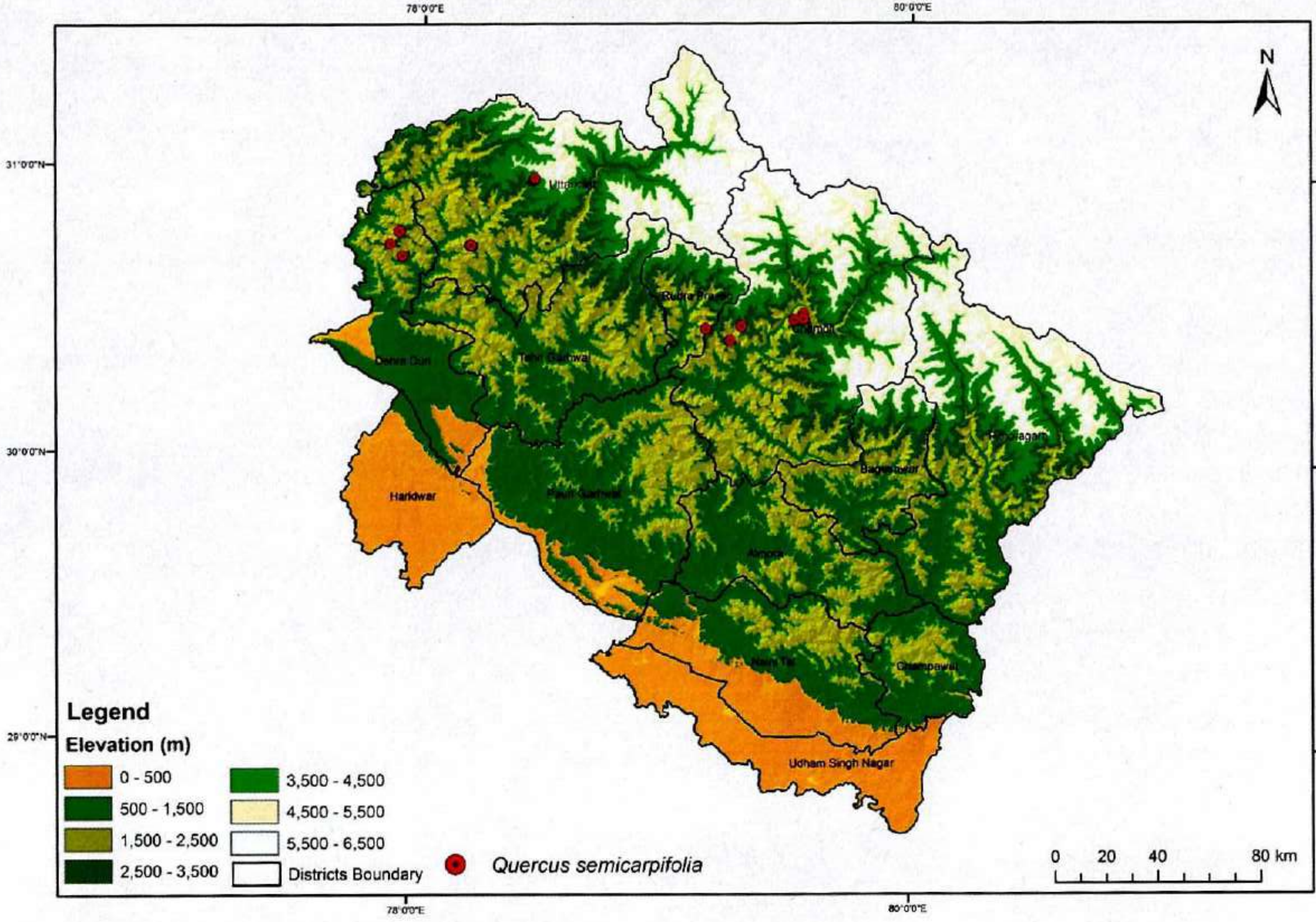
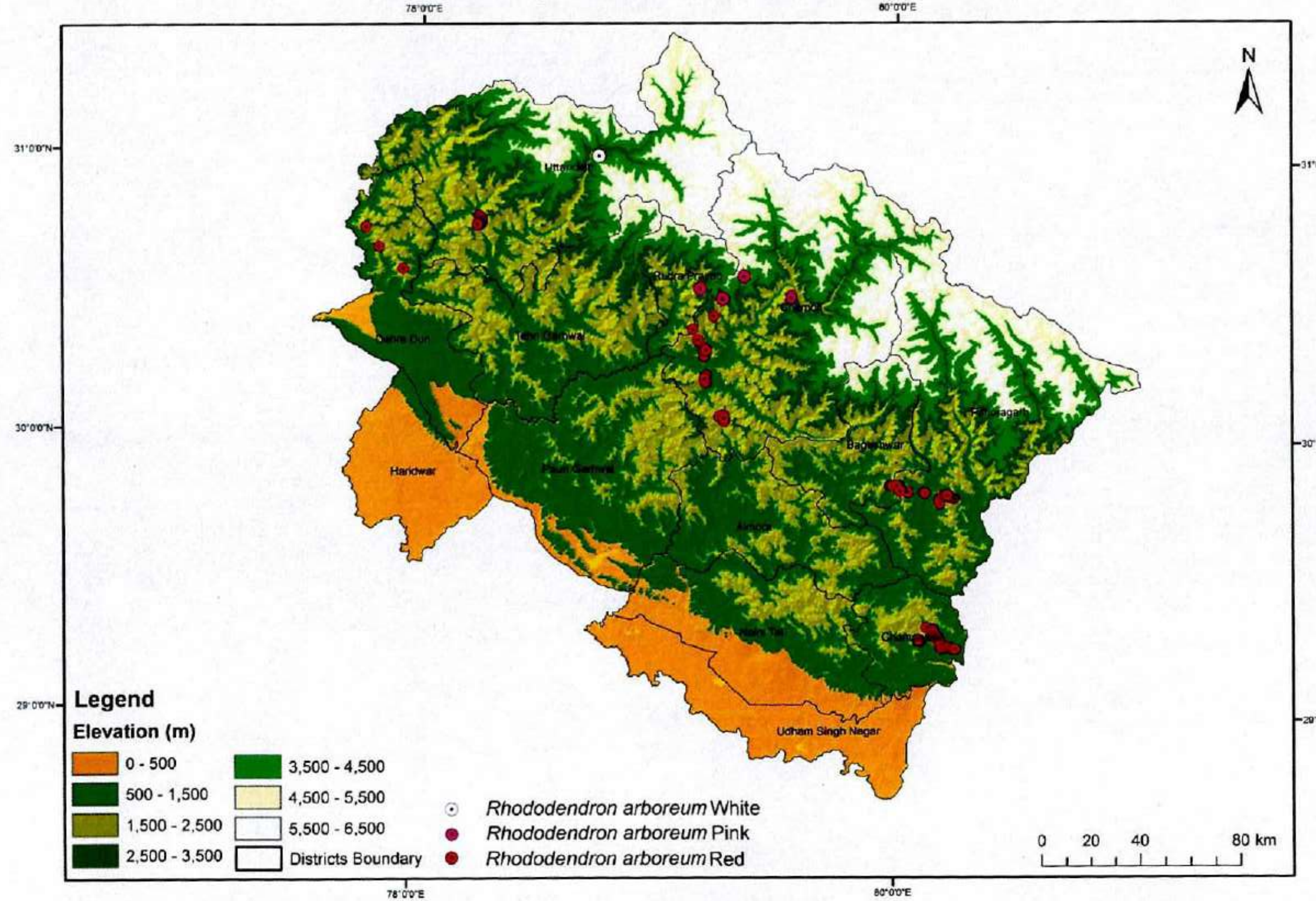
Distribution Map of *Quercus semicarpifolia*



Distribution Map of Rhododendron Spp.Pink, Red and White



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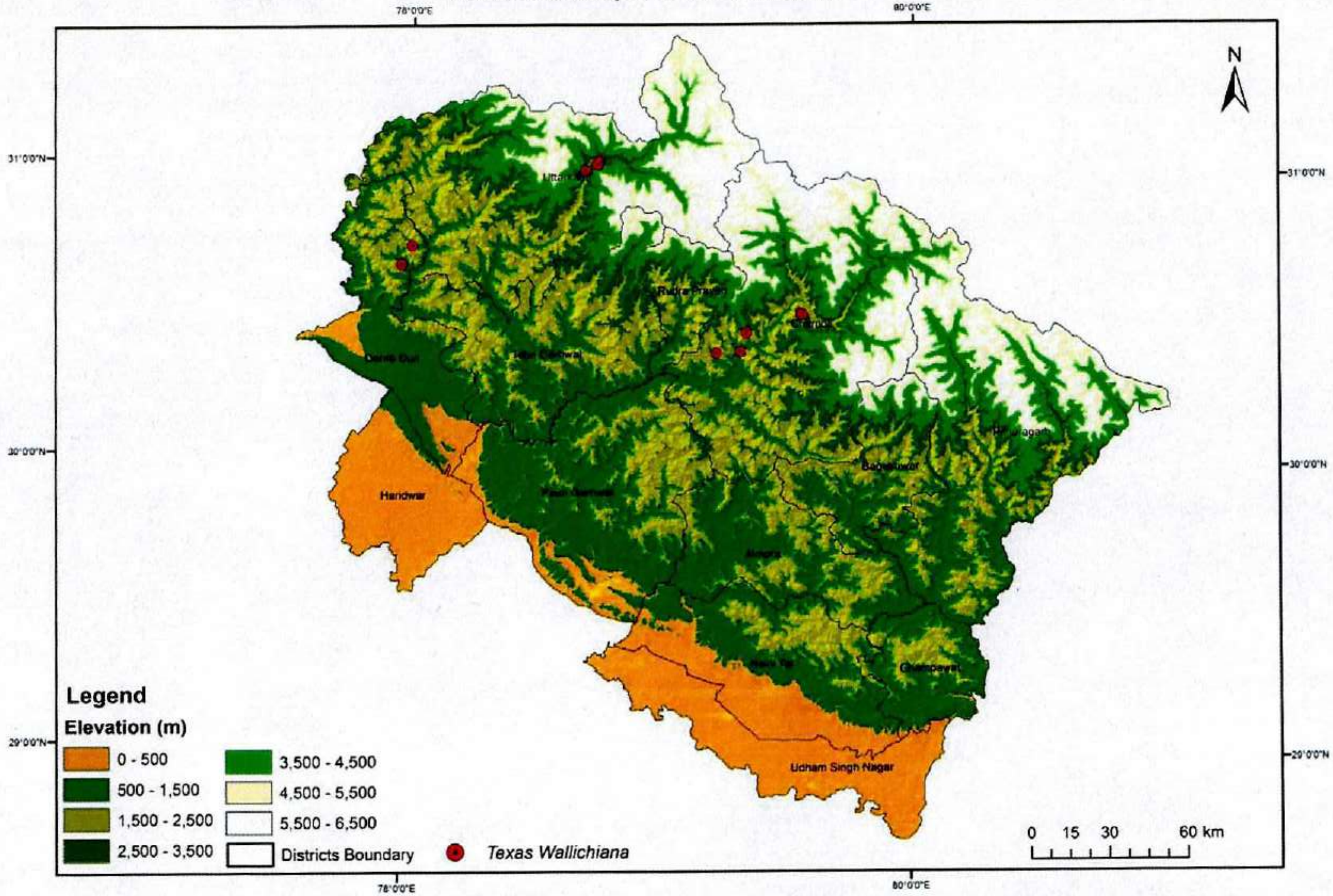
Distribution Map of *Texas wallichiana*



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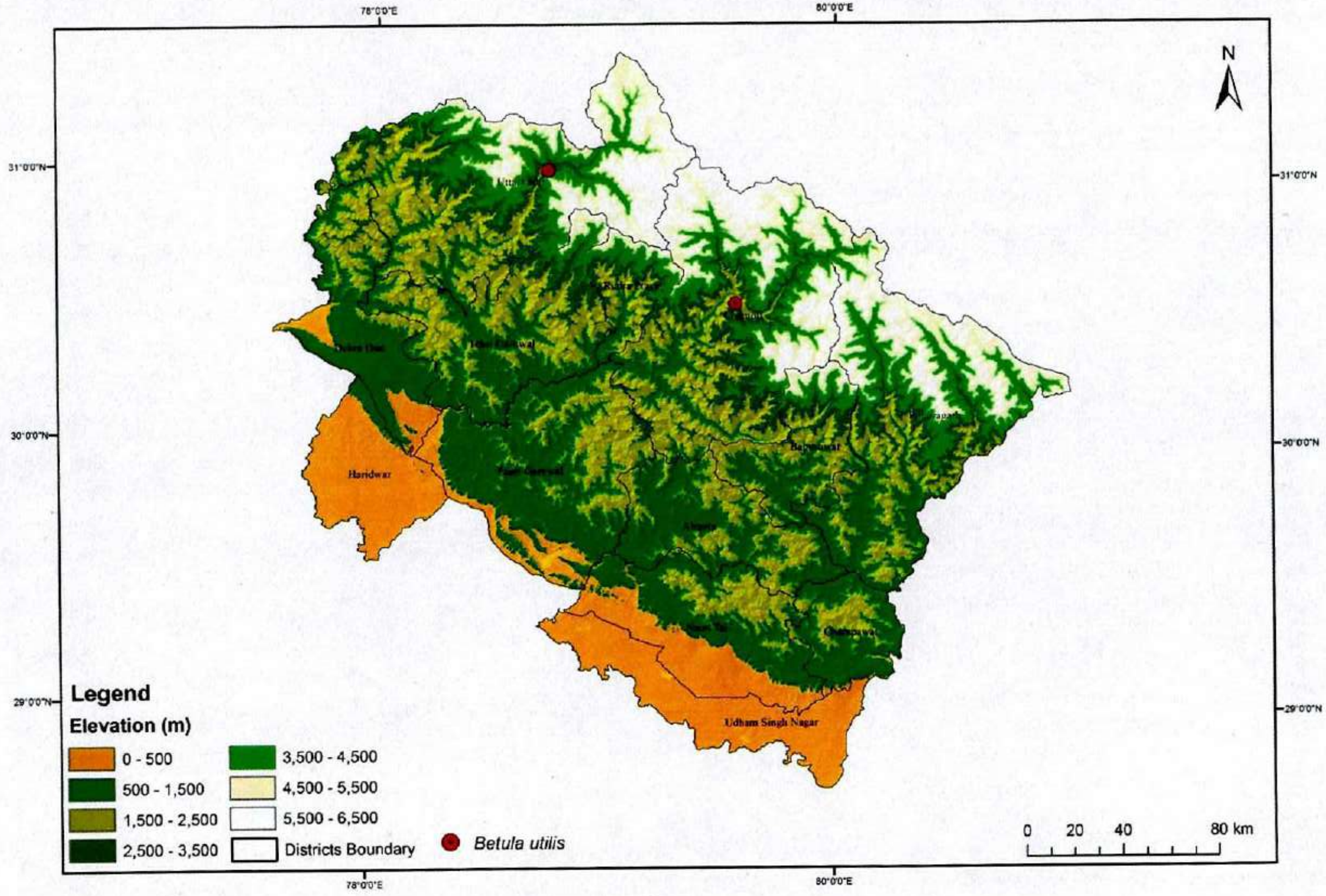
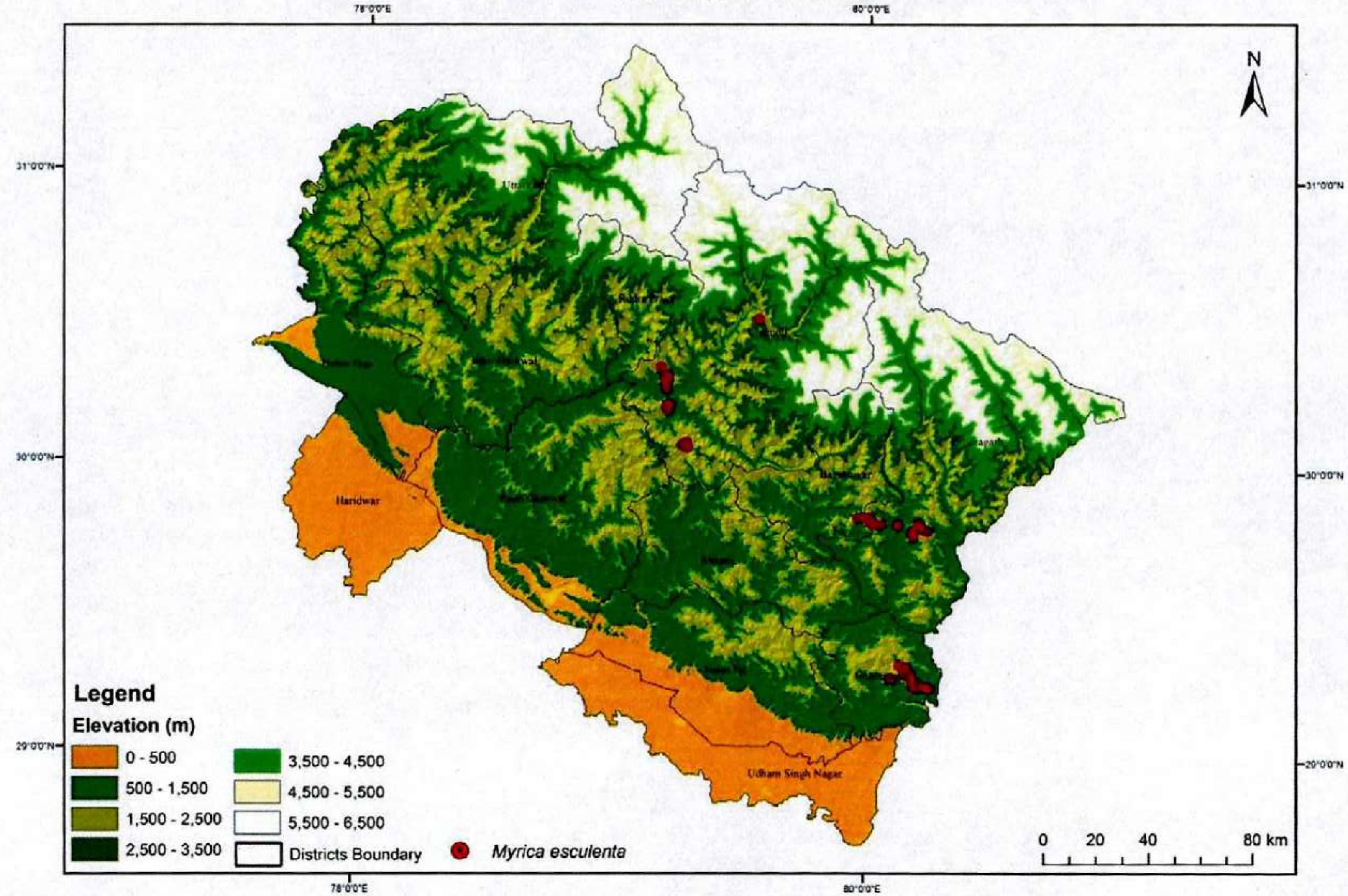
Distribution Map of *Betula utilis*



Distribution Map of *Myrica esculenta*



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CHEMICAL CHARACTERIZATION

Targets	Activity	Achievements
Evaluation and molecular characterization of FGRs, specifically, for biochemical traits and screening for disease and pests towards enhancing productivity.	Chemical marker(s) assisted screening of the target tree species and characterization of the elite accessions / genotypes	• Biochemical characterization of *Rhododendron arboreum* population RA04 with respect to the total flavonoid contents (TFCs), determined in their flowersusing spectrophotometric method was completed. TFCs (mg rutin equivalent /g extract) were found to be varied from 42.06 ±0.22 to 141.44± 1.98 (mean value 97.97 ±1.47). • Estimation of Total Phenolic Contents (TPCs) using standardized protocol in the extracts of the stem bark samples of *Myrica esculenta* population line (ME 01) obtained using 25% aqueous methanol was completed. • Stem bark samples collected from four population lines (ME05, ME06, ME07 and ME08) of *Myrica esculenta* were freeze dried and milled. Extraction of these samples for determination of their TPCs was initiated and continued. • Standardization of protocol for estimation of total tri- terpenoid content in the stem bark samples of *Betulo utilis* population was completed. • Rest of the work is in progress.

D. FGR Conservation

Survey of the natural populations of *Taxus wallichiano* and *Rhododendron arboreum* var red was done in different places *viz.* Sukhi top of Harshil range, Gangotri, and upper Yamunotri forest ranges, and Raditop of Badkot range. Populations of *Myrica esculento* was surveyed and marked from Pithauragarh and Champawat districts.

Visited the nursery of Harshil and Sonegad to explore the possibilities of association with forest department for multiplication *Taxus wallichiana* as well as to establish a nursery and field gene bank.

The location and other details of populations studied have been given in the following table :

Species Name	Population	Location detail	Latitude	Longitude	Altitude
Texas wallichiana	TBUK01	Harshil, Cholmi, Uttarkashi, Uttarakhand	31°01.319	78°44.700	3139 m
	TBUK02	Sukhitop, Uttarkashi, Uttarakhand	31°00'9.7"	78°41'42.5"	2795 m
***Rhododendron arboreum* var Red**	RACW01	Siutal, Champawat, Uttarakhand	29°17'40.75"	80°11'2.10"	1769 m
	RAPG02	Kamlake, Berinag, Pithauragarh, Uttarakhand	29°50'55.70"	80°0'41.55"	1993 m
	RAPG03	Devdhula, Didihaat, Pithauragarh, Uttarakhand	29°48'59.09"	80° 3'6.64"	1691 m
	RAUK04	Raditop, Ranwai, Uttarkashi, Uttarakhand	30°46'15.7"	78°15'23.3"	2233 m
Myrico esculenta	MECW01	Chinapani, Champawat, Uttarakhand	29°17'25.13"	80° 6'28.04"	1726 m
	MECW02	Siutal, Champawat, Uttarakhand	29°17'40.70"	80°11'2.24"	1766 m
	MEPG03	Kamlake, Berinag, Pithauragarh, Uttarakhand	29°50'53.04"	80° 0'22.68"	2001 m
	MEPG04	Devdhula, Didihaat, Pithauragarh, Uttarakhand	29°48'58.73"	80°13'5.37"	1695 m

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Cumulative Progress Report till 31st March, 2017

Background Information

Forest Genetic Resources (FGRs) constitute a very important sub-set of biodiversity Conserving FGR is vital, as they are unique and irreplaceable resources for the future. In India alone, more than 340 million people are estimated to be dependent upon the FGRs for their livelihoods. There is a definite need to address the FGR related issues through a comprehensive FGR conservation and development strategy and implementation plan.
As per present state of knowledge, 18,236 higher plant species (18,159 Angiosperms and 77 Gymnosperms) documented from India so far (*BSI, 2015: Plant Discoveries 2014*). More than 80% of this higher plant diversity is contained in the forest habitats (≈14,500 species). About half of this forest plant diversity constitutes FGRs (≈7,250 species), the remaining being herbaceous flora including soft climbers, twiners, herbs, and grasses. FGRs contain a huge potential in ensuring food and health security of the country's burgeoning human population and its livestock.

To generate understanding and knowledge on FGR, and to develop and strengthen in situ and ex situ FGR conservation programmes, the National CAMPA Advisory Council (NCAC) of Ministry of Environment and Forests & Climate Change, Govt. of India has sanctioned a project entitled "National Program for Conservation and Development of Forest Genetic Resources: Pilot Project Proposal to be implemented at FRI on Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)". The secondt instalment of the project 146.25 lakh was received in third week of March 2017. A brief progress of activities for the period till March 2017 as per the action plan of the project has been summarized in the following points :

Progress of Works

As per the action plan of the project, activities were initiated and following four working groups have been created in FRI to achieve the targets of the project :

i. FGR Documentation
ii. FGR Seed and Germplasm Storage
iii. FGR Characterization Cell
iv. FGR Conservation Cell

The targets under the projects have been assigned to each of the working groups on individual scientist basis which is being closely monitored by the Coordinator of the project. The contractual staff required under the project has been appointed an now is in position. All the working groups have started their activities as per the assigned action plan. The brief description of the activities so far taken up has been detailed below:

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A. FGR documentation

1. Upgradation of DD Herbarium

a) Purchase of mobile herbarium compactors:

Detailed specifications for purchase of herbarium compactors were made. The whole process of tendering was repeated three times and finally the supply order was placed. Mobile herbarium compactors have been procured and installed in the recently renovated herbarium building. With the completion of renovation work of new herbarium hall, voluminous task of transferring Dicotyledonous floral specimens was initiated since February, 2017 following the Bentham & Hooker classification. So far 20% specimens have been transferred & remaining shall be done in the subsequent quarters.

b) Renovation of herbarium building

Detailed measurement and estimation of civil and electrical work with the help of Engineering Cell was prepared. As per the expert opinion, keeping in view the load of compactors per square meter, these compactors could be installed in the herbarium section at the ground floor only with certain modifications in the present internal structure which was considered by the engineering cell. All civil work and super structural activities including flooring, false roofing, plastering and tile work, window panel fixation, and electrical work etc. has been completed. Construction of Scanning and Digitization Chambers are under process.

2. Documentation of FGR species

a) Listing and Prioritization of the FGR Species

A list of 250 priority species (141- tree species, 29 shrubs, 15 lianas/woody climbers and 65 RET species) has been prepared. Out of which 50 species have been selected for the preparation of eco-distribution maps. Distribution of 200 species has been traced from DD herbarium, BSI herbarium and working plans. List of remaining 50 species is under progress with the consultation from expert members/working plans of the respective divisions/literary work from respective areas etc.

b) FGR distribution records

DD Herbarium and BSI Herbarium (Northern Circle) was consulted. Detailed information about projects species was collected. For distribution of selected FGR species, distribution record from literature has been consulted.

c) **Field Survey for distribution and regeneration**

Field survey of five districts (6 Forest Divisions) viz. Dehradun (Narendra Nagar, Chakrata) Haridwar, Champawat, Almora, Pithoragarh, Chamoli (Kedarnath W.L.S., Valley of flowers W.L.S.), East Terai (Kishenpur, Dolly range, Surai range) and Tehri Forest Division were carried out. Enumeration of species in strategic locations was carried out and regeneration of priority species was recorded. Field data was collected from Dehradun, Haridwar, Champawat, Almora and Pithoragarh forest divisions. Field survey for distribution of prioritized species was carried out in three forest divisions: Chamoli (Kedarnath W.L.S., Valley of flowers W.L.S.); East Terai (Kishenpur, Dolly range, Surai range) and Tehri Forest Division.

Pithoragarh (Dharchula, Didihat askot Gangolihat and Pithoragarh) and Champawat (Lohaghat and Champawat):

Abies spectabilis, Acer oblangum, Aesculus indica, Albizia chinensis, Albizia procera, Albizia lebbeck, Alnus nepalensis, Boehmeria rugulosa, Carpinus viminea, Cassia fistula, Cedrus deodara, Celtis tetrandra, Cinnamomum tamala, Cornus capitata, Diospyros mantana, Diploknema butyracea, Engelhardtia calebrookiana, Erythrina suberosa, Ficus racemosa, Ficus rumphii, Ficus semicordata, Grewia optiva, Juglans regia, Litsaea monoptela, Litsaea glutinosa, Machilus odoratissima, Mangifera indica, Mitragyna parvifolia, Myrica esculenta, Oroxylum indicum, Ougeinia aojeinensis, Pinus roxburghii, Pinus wallichiana, Prunus cerasoides, Quercus flaribunda, Quercus glauca, Quercus leucotrichophora, Quercus semecarpifolia, Rhododendron arboreum, Sapium insigni, Sterculia villosa, Syzygium cuminii, Terminalia arjuna, Terminalia bellirica, Taona ciliate, Toona serrata, Ziziphus mauritiana.

In shrub and climber layer:

Adhatoda vasica, Asparagus adscendens, Callicarpa macrophylla, Debregeasia hypoleuca, Elaeagnus latifolia, Helicteres isora, Indigofera cassioides, Catunaregam spinosa, Prinsepia utilis, Zanthoxylum armatum, Chanemorpha macrophylla, Clematis gouriana, and. *Stephania glabra*

Rare Endangered and Threatened taxa:

Brassiopsis aculeata Cinnamomum glanduliferum (Champawat Range),, *Datisca cannabina* (Near Tapowan, Dharchula),, *Indopapdenia oudhensis* (Champawat), *Macranga pustulata* (Pithoragarh range), *Sterculia colorata* (Near Dharchula), *Neolitsea pallens* (Manch), *Uncaria pilosa* (Near Jalujibi), *Cyathea spinulosa* and *Ilex pseuda- odorata* (Shandev), *Trachycarpus takil* (Near Thal)

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Nainital [Ram Nagar Forest Division (Kaladungi, Dehchauri, Kotta and Kosi) and West Tarai Forest Division]:

Acacia nilatica ssp. *indica* (*Acacia arabica*), *Acacia catechu, Adina cardifolia, Aegle marmelas, Albizia lebbeck, Albizia pracera, Alstonia schalaris, Anogeissus latifalia, Bauhinia racemasa, Bauhinia semla, Bischafia javanica, Bombax ceiba, Bridelia retusa, Buchanania lanzan, Butea manasperma, Careya arbarea, Cassia fistula, Celtis tetrandra, Citrus medica, Cardia dichatama, Crateva adansonii* ssp. *Odoraa, Dalbergia sissaa, Diaspyros Mantana, Emblica afficinalis, Erythrina suberosa, Ficus auriculata, Ficus bengalensis, Ficus racemasa, Ficus rumphii, Ficus semicardata, Grewia optiva, Hymenodictyon arixense, Kydia calycina, Lagerstraemia parviflora, Lannea coromandelica, Litsaea glutinasa, Machilus duthiei, Madhuca longifolia, Mangifera indica, Melia azedarcach, Mitragyna parvifalia, Ougeinia aojeinensis, Pinus raxburghii, Pterospermum acerifolium, Putranjiva roxburghii, Schleichera oleasa, Semecarpus anacardium, Shorea robusta, Syzygium cuminii, Terminalia arjuna, Terminalia bellirica, Terminalia tamentosa, Toana ciliate, Ziziphus mauritiana*

In shrub and climber layer:

Adhatoda vasica, Asparagus adscendens, Callicarpa macrophylla, Catunaregam spinosa, Vitex negundo, Bauhinia vahlii, Celastrus paniculatus, Chonemorpha macrophylla, Clematis gouriana, Smilex ovalifolia, Cryptolepis buchanani

Rare Endangered and Threatened taxa:

Gardenia turgid, Heteropanax fragrans

3. **Development of Eco-distribution maps of important FGRs**

Mapping methodology was developed by discussions with the experts of this field. Sampling methodology was developed for collection of GPS points. The methodology was tested by carrying out field visits in the Mohand and Sukhblock of Chilllawalii Range, Rajaji National Park, Dehradun (Uttrakhand). Mapping was done and the estimation was quite similar to the FSI Forest Type Report (Satellite Image LISS III used) and working plan (methodology not known to us) for Rajaji National Park indicating the reliability and accurateness of the adopted methodology.

B. FGR seed and germplasm storage

1. **Collaboration with NBPGR, New Delhi**
    - Explored the possibility of utilizing long term storage facility of NBPGR for storage of forestry species

- Obtained information about drying process of seeds, various storage chambers, cryopreservation cell etc.

- As per the request of FRI, National Bureau of Plant Genetic Resources (NBPGR) New Delhi organised a training course on "Techniques for of Conservation of Plant Genetic Resources" from 27th June to 2nd July, 2016. Ten Scientists and research personnel working in various components of CoFGR-CAMPA project, participated in the training.

- A draft MOU has been developed between FRI Dehradun and NBPGR New Delhi for utilizing the genebank space of NBPGR for the long term storage of the FGR species.

2. Survey of populations for seed collection

It is intended to collect seeds of 90 important FGR species in this project for their storage and conservation. Surveys were conducted for demarcation of populations of important FGR species and availability of their seeds.

Forest Range	Species surveyed
Timli Forest Range	*Syzygium cuminii, Terminalia bellerica, Holaptelia integrifolia, Dalbergia sisoo, Albizzia procera (kalasirus)*
Ramgarh park Range/Forest Range	*Terminalia chebula, Ougenia aajensis, Aegle marmelos, Syzygium cuminii, Toona ciliata*
Lachhiwala Range	*Acacia catechu, Dalbergia sisaa*
Rajaji Tiger Reserve, Motichur	*Ougenia oojeinensis, Toona ciliate, Bombex ceiba, Terminalia chebula, Terminalia bellerica*
Kansro Forest Range, Dehradun Forest Division	*Adina cordifolia, Aegle marmelos, Albizzia procera, Haloptelia integrifalia, Lannea grandis, Schleichera oleosa, Terminalia bellerica*
Rishikesh Forest Range, Dehradun Forest Division	*Aegle marmelos, Albizzia procera, Bombex ceiba, Holaptelia integrifolia,*
Gaula Forest Range, Haldwani Forest Division	*Albizzia odoratissima Acacia catechu*
Kishanpur Forest Range, Haldwani Forest Division	*Bombex ceiba, Lagerstroemia parviflora*
Haldwani Forest Range, Central Tarai Forest Division, Haldwani	*Adina cordifolia, Albizzia procera*
Chhakata Range, East Tarai Forest Division, Haldwani	*Acacia catechu, Adina cordifolia, Holoptelia integrifolia,*
Tanda Forest Range, Central Tarai Forest Division, Haldwani	*Acacia catechu, Garuga pinnata, Mallotus philippensis, Toona ciliata*
Pipalpadav Forest Range, Central Tarai Forest Division, Haldwani	*Acacia catechu, Bombex ceiba*
Fatehpur Forest Range, Ramnagar Forest Division	*Adina cardifolia, Aegle marmelos, Anogeissus latifolia, Bombex ceiba, Dalbergia sisoo, Holoptelia integrifolia, Desmodium oojeinensis, Schleichera oleosa, Terminalia bellerica, Toona ciliata*

Bhakhra Forest Range, Central Tarai Forest Division, Haldwani	*Aegle marmelos, Emblica afficinalis*
Barhani Forest Range, Central Tarai Forest Division, Haldwani	*Acacia catechu, Aegle marmelas, Bombex ceiba, Holaptelia integrifolia, Mallotus philippensis,*
Nandhaur Forest Range, East Tarai Forest Division, Haldwani	*Acacia catechu, Adina cardifalia, Dalbergia sisaa, Dioscarea bulbifera, Desmodium aajeinensis, Schleichera aleasa,*
Barakoli Forest Range, Sitarganj, East Tarai Forest Division, Haldwani	*Acacia catechu, Dalbergia sisao, Halaptelia integrifalia, Schleichera aleasa,*
Kaladhoongi Forest Range, Ramnagar Forest Division	*Adina cardifalia, Anageissus latifolia, Lannea grandis, Schleichera oleasa,*
Almora Forest Range, Almora Forest Division	*Myrica esculenta, Quercus leucotrichophora, Taana ciliata*
Ranikhet Forest Range, Almora Forest Division	*Myrica esculenta, Quercus leucotrichophora,*

3. Collection of seeds of FGRs

The team visited Radi Top area, Barkot for survey and seed collection of *Rhododendron arboreum* and Asnolgad near Foolchatti for collection of *Hippophae salicifolia* seeds.

Species	Site of seed collection
Dugenia oojensis	Rajaji Tiger Reserve, Dehradun Forest Division
Taana ciliata	Rajaji Tiger Reserve, Dehradun Forest Division, Almora Forest Range, Almora Forest Division
Aegle marmelas	Kansro Forest Range, Dehradun Forest Division, Fatehpur Forest Range, Ramnagar Forest Division,
Terminalia bellerica	Kansro Forest Range, Dehradun Forest Division,
Holoptelia integrifalia	Kansro Forest Range, Dehradun Forest Division, Timli Forest Range, Dehradun Forest Division
Desmodium oojeinensis	Rajaji Tiger Reserve, Dehradun Forest Division
Schleichera oleosa	Chilla Range, Gohri Range, Kalsi, Narendra Nagar
Fraxinus xanthaxylaides	Kailashpur, Malari Beat, Joshimath Range
Alnus nepalensis	Kiskot Village, Champawat Range
Aristolochia elegans	Jauljivi, Pithoragarh FD
Bischofia javanica	Jauljivi, Pithoragarh FD
Pyrus pashia	Narayanswami, Pithoragarh Range
	Champawat Range
Pinus wallichiana	Tanta Village, Dharchula Range
Cedrus deadara	Patal-Bhuwneswar, Gangolihaat
Carpinus viminea	Chopta-Mandal Forest

Albizia julibrissin	Arakot, Chamba
Acacia catechu	Thano range
Dalbergia sissoo	Thano range

4. **Procurement and repair of lab equipments**
   E tender was floated for procurement of seed drier and incubator. Repairing of few laboratory equipments is under progress.

5. **Seed extraction and processing**
   Seeds were extracted from the ripened fruits of all the species, cleaned and processed for further tests. Initial parameters on seed weight, seed dimensions, seed moisture content, seed germination, etc. were recorded.

6. **Seed Handling**
   Collected seeds were pre-cleaned and the impurities, foreign materials, soil particles, twigs and leaves which are detrimental to seed viability, were removed. Purity of the seed lot was calculated.

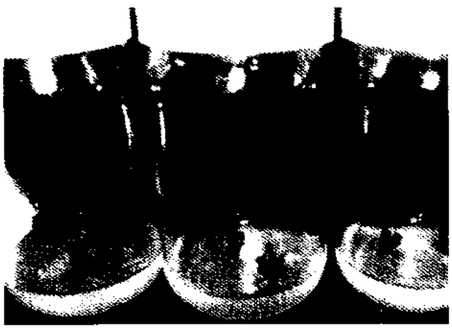
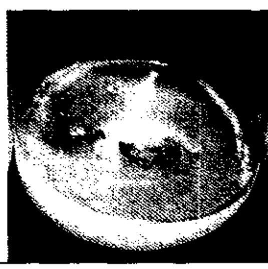
7. **Seed Drying and Storage**
   Seeds of *S. oleosa* were kept in storage at ambient room temperature for after-ripening. Seeds were desiccated to lower moisture levels with silica gel and stored under low temperature (5°C) in Low Temperature Storage Cabinet. Seeds were dried in cool air dryer at low temperature 15^0C and 15 percent relative humidity for slow desiccation to safe moisture levels for storage. Dried seeds of *Aristolochia elegans, Bischofia javanica, Carpinus viminea, Cedrus deodara,* Pinus *wallichiana, Pyrus pashia, Dalbergia sissoo, Acacia catechu, Albizia julibrissin* and *Alnus nepalensis* were stored in under controlled environmental condition.

8. **Quarterly Viability testing of seeds**
   Germination test were conducted on the stored seeds of different species viz. *Desmadium oojeinensis, Toona ciliata, Aegle marmelos, Hippophae salicifolia, Rhododendron arboreum* and *Holoptelia integrifolia.*

9. ***In-vitro* storage of FGR species**

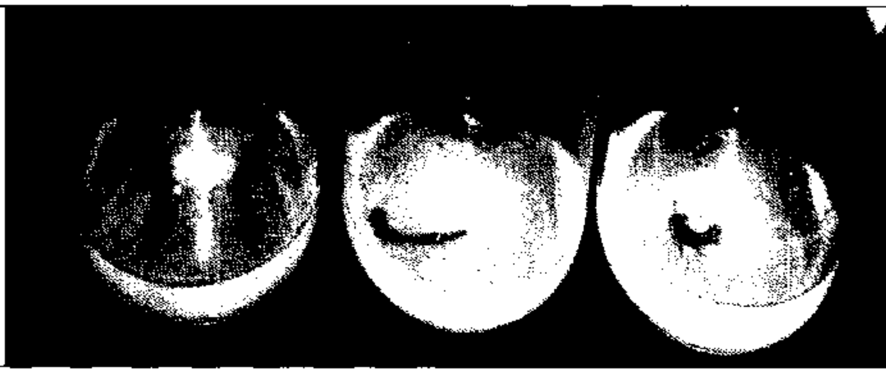
   Activities planned:
   - Developing protocols for in vitro storage of germplasm of FGR species of very high conservation concern and ones having recalcitrant seeds
   - Developing protocols for storage of germplasm of red listed species of FGR in the form of 'pollens'
   - Maintaining minimal growth cultures and embryo cultures

Explants of *Taxus contorta* and *Rhododendron arboreum* were collected from forest near deovan (Chakrata) and area near Kaddukhal (Tehri/Musoorie) respectively and micro-propagation trial initiated.

S. No.	Species	Methodology
1.	***Rhododendron arboreum***	
	Sample collection	Mussourie and Chakrata area of Dehradun and Mazgaon (Tehri Garhwal), Uttarakhand.
i) **Culture Initiation from nodal explants:**		
	Culture Initiation:	nodal explants were cultured in MS, DKW and AM supplemented with different concentrations of 6-Benzylaminopurine (BAP) and 2, 4 dichlorophenoxyacetic acid (2, 4 D). 18 medium combinations were used.
	***In vitro* response:** 	Nodal segments did not show any axillary or adventitious bud break or callus formation in cultures. Bacterial and fungal contamination in cultures was a challenge in the establishment of *in vitro* cultures. Standardization of effective concentration of sterilants, duration of treatments and concentrations of plant growth regulator etc. is further ongoing in order to overcome the problem of microbial contaminations.
ii) **Culture Initiation from leaf explants:**		
	Culture Initiation:	Small sections of leaves were cultured on MS medium supplemented with different concentrations of BAP and 2, 4-D to initiate callus cultures. 8 different combinations were used.
	***In vitro* response** 	Callus formation was initiated in some of the cultures and these are now under multiplication and will be used to induce somatic embryogenesis or organogenesis.
	Culture initiation and callus formation and multiplication of shoot segments:	

		
iii) **Modifications in culture Initiation from nodal explants:**		
	Surface Sterilisation:	• The young buds and nodal segments were separated from the stem cuttings. and treated with few drops of cetrimide for 15 minutes and further treatments were given
	In vitro **response:**	• Due to severe fungal and bacterial contamination all the cultures were damaged and no observations could be made.
2.	***Taxus contorta***	
	Sample collection	Deoban, Chakrata area of Dehradun, Uttarakhand
i)	**Culture initiation from nodal explants:**	
	Culture Initiation:	Current year growth was taken for culture initiation. Nodal explants were cultured in Murashige & Skoog's medium (MS) supplemented with different concentrations of 6-Benzylaminopurine (BAP) and 2, 4 dichlorophenoxyacetic acid (2, 4 D). 3 medium combinations were used.
	In vitro **response:** 	Callus formation initiated in some of the cultures. New shoot bud initiation unsuccessful due to contamination and necrosis of cultures.
	Culture initiation and callus formation and multiplication of shoot segments:	

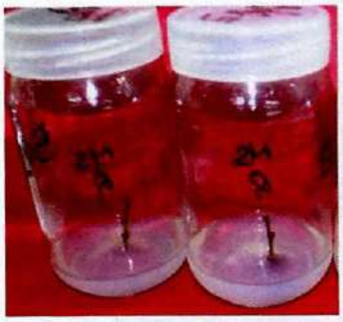
Ary



	Modifications in culture initiation from nodal explants:	
	Surface Sterilisation:	• The explants collected were cut into small segments and given a 10 min cetrimide wash followed by 15 min fungicide (Bavistin) wash. Final sterilization wash was given with 0.1 % Mercuric chloride for 10 min.
	Culture initiation	• explants were cultured on different medium combinations
	Medium 1	MS + 3% sucrose + 6.8gm/L Agar + 2.5 mg/L BAP + 1gm/L Activated Charcoal (AC)
	Medium 2	MS + 3% sucrose + 6.8gm/L Agar + 2 mg/L BAP
	Medium 3	½ MS + 3% sucrose + 6.8gm/L Agar + 1 mg/L IBA
	Medium 4	MS + 3% sucrose + 6.8gm/L Agar + 2 mg/L 2,4-D +5mg/L AC
	Medium 5	½ MS + 3% sucrose + 6.8gm/L Agar + 2.5 mg/L BAP + 1gm/L AC
	Medium 6	½ MS + 3% sucrose + 6.8gm/L Agar + 2.5 mg/L BAP + 0.1 mg/L NAA + 1 gm/L AC
	Medium 7	½ MS + 3% sucrose + 6.8gm/L Agar + 2.5 mg/L BAP + 100 mg/L $AgNO_3$ + 1 gm/L AC
	Medium 8	MS + 3% sucrose + 6.8gm/L Agar + 3 mg/L 2, 4-D + 5 mg/L AC

	***In vitro* response:** 	Explants cultured on Medium 7 showed best *in vitro* response with new buds opening up to generate new shoots. Explants cultured on Medium 3 and Medium 6 also showed some response. Further experiments will be carried out to ascertain the best medium for *in vitro* shoot propagation of *T. contorta*.
	Chemical induction of adventitious root formation in stem cuttings 	• Stem cuttings of dipped in 0.25mM NAA, 0.25mM IBA and 0.05% Bavistin solutions for 24 hours. • planted in root trainers in vermiculite and 1:1:1 soil, sand and manure mixture and kept in a green house and watered regularly to maintain humid conditions.
	Response:	• The results of the experiment will be recorded after 11 weeks.
3	***Myrica esculenta***	
	Sample collection	VMG in Botany Division of FRI
i)	**Culture initiation from nodal explants**	
	Culture Initiation:	Current season shoot and leaves were cultured in MS and WPM supplemented with different concentrations of Kinetin, 6-Benzylaminopurine (BAP) and Napthalene acetic acid (NAA). 7 medium combinations were used.
	***In vitro* response:** 	Excessive release of phenolics observed in cultures within 24 hours of culture initiation. Incorporation of 0.5% PVP into the medium controlled the release of phenolics to some extent. However no *in vitro* axillary bud induction or callus initiation was observed in any of the treatments.
ii)	**Culture initiation from leaf explants**	

	In vitro response: 	
4.	***Quercus semecarpifolia***	
	Sample collection	Kanatal (Tehri Garhwal).
i)	**Culture initiation from nodal explants**	
	Culture Initiation:	Nodal segments were cultured in MS and WPM supplemented with different concentrations of 6-Benzylaminopurine (BAP) and Indole acetic acid (IAA). 5 medium combinations were used.
	In vitro response: 	The cultures are being observed for any *in vitro* bud induction
5.	***Quercus floribunda***	
	Sample collection	Kanatal (Tehri Garhwal).
i)	**Culture initiation from nodal explants**	
	Culture Initiation:	similar as in *Q. semecorpifolia*

	***In vitro* response:** 	The cultures are being observed for any *in vitro* bud induction.
6.	***Desmodium oojeinensis***	
	Sample collection	Seeds were procured from Forest tree seed laboratory, Silviculture Division, FRI.
i)	**In vitro seed germination**	
	Culture Initiation:	surface sterilized seeds were put for germination in petriplates under four different conditions
	***In vitro* response:** 	In all the cases predominant seed browning was observed along with slight emergence of radical which ultimately died after few days.
	Further modifications:	Time duration of $HgCl_2$ treatment was reduced to 5 & 7 minutes and seeds were aseptically placed on filter paper bridges in culture tubes containing liquid MS basal medium.

<table>
<tr><td></td><td>In vitro response:
</td><td>The seeds germinated well in both the conditions and cotyledons emerged after 5 days.</td></tr>
<tr><td></td><td colspan="2">D. oojeinensis hypocotyls, epicotyl and cotyledonary segments cultured onto different culture media
</td></tr>
<tr><td></td><td colspan="2">Somatic organogenesis from calli originated from hypocotyls of D. Oojeinensis
</td></tr>
<tr><td>ii)</td><td colspan="2">Culture initiation from nodal explants</td></tr>
<tr><td></td><td>Plant sample collection:</td><td>Near Bambusetum, Forest Research Institute, Dehradun</td></tr>
<tr><td></td><td>Surface Sterilisation:</td><td>• Nodal segments washed under running tap water, cut into 3-4 cm long sections and wiped with 70% alcohol.
• Washed in solution containing 2-3 drops of cetrimide for 15 minutes and rinsed well.
• Fungicide treatment with 0.2% Boon for 30 minutes
• Washed thrice with distilled water.
• Two different sets of treatment given: one</td></tr>
</table>

		set of explants were treated with 30% NaOCl for 30 minutes while the other set was treated with 0.1% $HgCl_2$ for 10 minutes to test the effective surface sterilants. Both sets were rinsed with autoclaved distilled water thrice to remove their traces. • Both sets were cultured in MS+2 mg/l BAP+ 0.25 mg/l Kinetin.
	In vitro response:	• After a week all NaOCl treated cultures were contaminated with bacterial and fungal growth. • The $HgCl_2$ set had less contamination but no bud break was observed in any culture.
iii)	***In vitro* seed germination and culture**	
	Seed collection	procured from seed laboratory of Forest Research Institute, Dehradun
	Surface Sterilisation:	• Seeds were washed in solution containing 2-3 drops of cetrimide for 10 minutes and rinsed well. • Fungicide treatment was given with a solution containing 0.2% Bavistin & 0.1% Dithane M-45 for 15 minutes and washed thrice with distilled water. • Final surface sterilization was done with 0.1% $HgCl_2$ solution for 7 minutes and rinsed thrice with autoclaved distilled water to remove the traces of $HgCl_2$. • Finally seeds were placed on filter paper bridges immersed in liquid MS medium.
	***In vitro* response:** 	After 15 days, *in vitro* seed germination was observed in some of the cultures.
iii	**Callus Culture:**	
	Source of callus	calli generated from cotyledons, epicotyls and hypocotyls of *in vitro* germinated seedlings

		• The calli were cultured in M5 medium with 1 mg/l BAP to prevent drying. • The revived and green calli were cultured in M5 medium supplemented with 1mg/l BAP and 10 mg/l $AgNO_3$
7	***Hippophae salicifalia***	
i)	***In vitro* Seed germination**	
	Seed collection	procured from seed laboratory of Forest Research Institute, Dehradun
	Surface Sterilisation:	• Owing to the problem of dormancy in seeds of *Hippophae,* few seeds after being treated with few drops of cetrimide for 15 minutes and thereafter with fungicide 0.2% bavistin+0.1% dithane M45 for 1.5 hours were kept immersed in 0.1%KNO_3 under dark conditions for 48 hours, 25°C. • Few seeds were kept untreated with 0.1% KNO_3 and used as control. • Finally both the sets (control as well as treated) were treated with 0.1% $HgCl_2$for 10 minutes under the laminar air flow and placed on filter paper bridges immersed in liquid MS medium while some of the seeds were inoculated on solid MS. *In vitro* seed germination was observed in some of the cultures after 15 days.
	***In vitro* response:** 	40 % seed germination was observed in the seeds treated with 0.1%KNO_3 whereas 89 % seed germination was observed in untreated seeds.
8	***Acacia catechu***	
i)	***In vitra* seed germination and culture**	
	Seed collection	Procured from seed laboratory of Forest Research Institute, Dehradun.
	Surface Sterilisation:	• treated with few drops of cetrimide for 15 minutes, washed under running tap water.

C.

F G R		• treated with fungicide 0.2% bavistin+0.1% dithane-M45 for 45 minutes, rinsed with distilled water thrice to remove the traces of fungicide • finally treated with 0.1% $HgCl_2$for 7 minutes under the laminar air flow. • Sterilised seeds were then placed on filter paper bridges immersed in liquid MS medium. After 15 days *in vitro* seed germination was observed in some of the cultures.
c h a r a c t e r	***In vitro*** **response:** 	70 % seed germination was observed.
i 9.	***Diploknema butyracea***	
z a t	**Plant material collection**	Stem cuttings were collected from the nursery of Silviculture Division, Forest Research Institute, Dehradun.
i	**i) Culture Initiation from nodal segments**	
o n M O L E C U L A R	**Surface Sterilisation:**	• Nodal segments were washed under running tap water, cut into 3-4 cm long sections and wiped with 70% alcohol and washed in solution containing 2-3 drops of cetrimide for 15 minutes and rinsed well. • Fungicide treatment was given with 0.2% Boon for 30 minutes and then washed thrice with distilled water. • Treated with 0.1% $HgCl_2$ for 7 minutes under the laminar air flow, rinsed with autoclaved distilled water thrice and finally cultured in following medium: MS+2 mg/l BAP and MS+ 2 mg/l Kinetin.
C H A	***In vitro*** **response:**	• Due to severe fungal and bacterial growth many cultures were contaminated and no observations could be made. Browning was also predominantly present in all the cultures.

FGR CHARACTERIZATION

1. Collection of samples

Extensive survey and sampling work has been initiated in Uttrakhand hills for the selected species. Samples of seven species (*Rhododendron arboreum* var red, Rhododendron arboreum var pink, *Texas wallichiana, Quercus semecarpifolia, Myrica esculenta, Diploknemma butyracea* and *Betula utilis*) have been collected from their natural zone of occurrence and stored at -80°C. A total of 30-35 samples/trees were collected from each population in all the species. So far 45 populations have been sampled from Uttarakhand along with their geographical coordinates. The samples of these populations were segregated for chemical examination and DNA fingerprinting. The detail of the sampled populations is given in the following table:

Species	Population	Location
***Rhododendron arboreum* var red**	RA01	Kanchula Kharg, Chamoli, Uttarakhand
	RA02	Chopta, Chamoli, Uttarakhand
	RA03	Janglat Chowki, Chakrata, Dehradun, Uttarakhand
	RA04	Budher, Chakrata, Dehradun, Uttarakhand
	RA05	Near Nagthala, Churani, Chakrata, Dehradun, Uttarakhand
	RA06	Mohankhal, Nagnath, Kedarnath, Chamoli, Uttarakhand
	RA07	Kedarnath, Chamoli, Uttarakhand
	RA08	Dhanpur range, Kedarnath, Chamoli, Uttarakhand
	RA09	Chinapani, Champawat, Uttarakhand
	RA10	Siutal, Champawat, Uttarakhand
	RA11	Kamlake, Berinag, Pithauragarh, Uttarakhand
	RA12	Devdhula, Didihaat, Pithauragarh, Uttarakhand
	RA13	Raditop, Ranwai, Uttarkashi, Uttarakhand
***Rhododendron arboreum* var pink**	RP01	Kanchula Kharg, Chamoli, Uttarakhand
	RP02	Chopta, Chamoli, Uttarakhand
	RP03	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	RP04	Auli, Joshimath, Chamoli, Uttarakhand
Texas wallichiana	TB01	Kanchula Kharg, Chamoli, Uttarakhand
	TB02	Chopta, Chamoli, Uttarakhand
	TB03	Devban, Chakrata, Dehradun, Uttarakhand
	TB04	Bhujkoti, Chakrata, Dehradun, Uttarakhand
	TB05	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	TB06	Auli, Joshimath, Chamoli
	TB07	Harshil, Cholmi, Uttarkashi, Uttarakhand
	TB08	Sukhitop, Uttarkashi, Uttarakhand

Quercus semicarpifolia	QS01	Kanchula Kharg, Chamoli, Uttarakhand
	QS02	Chopta, Chamoli, Uttarakhand
	QS03	Devban, Chakrata, Dehradun, Uttarakhand
	QS04	Bhujkoti, Chakrata, Dehradun, Uttarakhand
	QS05	Lokhandi, Chakrata, Dehradun, Uttarakhand
	QS06	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	QS07	Auli, Joshimath, Chamoli, Uttarakhand
	QS08	Yamunotri, Uttarkashi, Uttarakhand
	QS09	Raditop, Uttarkashi, Uttarakhand
Betula utilis	BU01	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	BU02	Harshil, Cholmi, Uttarkashi, Uttarakhand
Myrica esculenta	ME01	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	ME02	Gairsain, Kedarnath, Uttarakhand
	ME03	Nagnath, Kedarnath, Chamoli, Uttarakhand
	ME04	Dhanpur range, Kedarnath, Chamoli, Uttarakhand
	ME05	Chinapani, Champawat, Uttarakhand
	ME06	Siutal, Champawat, Uttarakhand
	ME07	Kamlake, Berinag, Pithauragarh, Uttarakhand
	ME08	Devdhula, Didihaat, Pithauragarh, Uttarakhand
Diploknemma butyracea	DB01	Lohaghat, Champawat, Singda, Uttarakhand

2. **Genomic DNA extraction**

Different protocols were tried for DNA extraction from *Rhododendron arboreum* and finally on the basis of concentration (ng/µl) and purity ($A_{260/280}$), the CTAB method given by Doyle and Doyle, 1990 was used for DNA extraction. The same protocol resulted in good yield of genomic DNA from *R. arboreum* var pink, *Texas wallichiana* and *Quercus semicarpifolia*. Genomic DNA has been extracted from the following 38 populations. DNA extraction protocol has been standardized for *Diploknemma butyracea* as well as *Betula utilis* although the protocol for later species needs some improvement to enhance the yield and quality of extracted DNA.

Details of populations from which DNA has been extracted:

Species	DNA extraction done
Rhododendron arboreum var red	RA01, RA02, RA03, RA04, RA05, RA07, RA08, RA09, RA10, RA11, RA12, RA13
Rhododendron arboreum var pink	RP01, RP02, RP03, RP04
Texas wallichiana	TB01, TB02, TB03, TB04, TB05, TB06, TB07, TB08,

Quercus semicarpifolia	QS01, QS02, QS03, QS04, QS05, QS06, QS07, QS08, QS09
Myrica esculenta	ME01, ME02, ME03
Diploknemma butyracea	DB01

3. Qualitative and Quantitative analysis of Genomic DNA

The concentration and absorbance ratio (A_{260}/A_{280} nm) of the DNA samples were quantified using Biophotometer (Eppendorf-6131, Germany). So far DNA quantification has been done for 38 populations. The quality of genomic DNA extracted from genotypes of all the species was analyzed on 0.8% agarose gel. Detail of populations for which DNA quantification has been done is given in the following table:

Details of populations for which DNA Quantification has been completed

Species	DNA quantification done
Rhododendron arboreum var red	RA01, RA02, RA03, RA04, RA05, RA07, RA08, RA09, RA10, RA11, RA12, RA13
Rhododendron arboreum var pink	RP01, RP02, RP03, RP04
Texas wallichiana	TB01, TB02, TB03, TB04, TB05, TB06, TB07, TB08
Quercus semicarpifolia	QS01, QS02, QS03, QS04, QS05, QS06, QS07, QS08, QS09
Myrica esculenta	ME01, ME02, ME03
Diploknemma butyracea	DB01

CHEMICAL CHARACTERIZATION

For chemical marker(s) assisted screening of *Rhododendron orboreum* and characterization of the elite accessions / genotypes desired numbers of flower samples of two population lines grown in Janglat Chowki, Kanasar Village, Charata and Budher, Kanasar Village, Charata were collected and extracted with acidulated methanol. Some of the extracts were concentrated in vaccum and their yields were determined. Experiments for determining the total flavonoid contents in these extracts using spectrophotometric method were continued.

Further stem bark samples collected from one population line (ME 01, ME05, ME06, ME07 and ME08) of *Myrico esculenta*, and leaves samples collected from one population line (QS 06) of *Quercus semicarpifolia* were freeze dried and milled for their chemical analyses. Extraction of the stem bark samples of ME 01 using 25% aqueous methanol for estimation of total tannin content was initiated and continued.

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- Biochemical characterization RA03, RA04 and RA 05 with respect to the total flavonoid contents (TFCs) was determined in their flowers using spectrophotometric method. TFCs (mg rutin equivalent /g extract) were found to be varying from 38.06 ±0.36 to 214.41± 4.04 (mean value 111.26 ±1.21) and 70.96 ±1.33 to 224.44 ±0.88 (mean value 128.66 ±1.35), respectively.

- Estimation of TFCs in the flower samples of the population line of RA 4 was continued.

- Extraction of the stem bark samples from one population line (ME 01) of *Myrica esculenta* using 25% aqueous methanol was completed.

- Protocol for estimation of total phenol contents (TPCs) in these samples was standardized.

- Estimation of TPCs using standardized protocol in these samples was initiated and continued.

- Biochemical characterization of RA04 with respect to TFCs determined in their flowers was completed. TFCs (mg rutin equivalent /g extract) were found to be varied from 42.06 ±0.22 to 141.44± 1.98 (mean value 97.97 ±1.47).

- Estimation of TPCs using standardized protocol in the extracts of the stem bark samples of *Myrica esculenta* population line (ME 01) obtained using 25% aqueous methanol was completed.

- Stem bark samples collected from *Myrica esculenta* populations (ME 05, ME06, ME07 and ME08) were freeze dried and milled. Extraction of these samples for determination of their TPCs was initiated and continued.

- Standardization of protocol for estimation of total TTP in the stem bark samples of *Betula utilis* population was completed.

- Rest of the work is in progress.

D. FGR conservation

Five priority species have been sort listed for FGR Conservation as per the target of the project. The species are *Cinnamomum tamala, Diploknema butyracea, Rhododendron arboretum, Myrica esculanta* and *Taxus wallichiana.* The survey and review and literature through records were conducted to know distribution and status of prioritized species. Scientists have visited forest areas at Chakrata area for exploring the possibility of field gene banks. Preliminary survey of all the species selected for conservation was completed in both lower and middle Himalaya. A detailed survey of *Taxas wallichiana* and *Rhododendron arboretum* was made in different forest ranges at (Devban, Kanasar range; Bhujkoti, Riknar range; Lokhandi village, Kanasar range of Chakrata Forest Division and some locations of Kedarnath Wildlife Sanctuary). The GPS location of the intact promising populations was recorded. Six populations of *Diploknema butyracea* have been located in Distt Pithoragarh at altitudinal range of 780 to 1290 m. Two nursery sites have been tentatively identified in District Pauri Garhwal and Chakrata for multiplication of germplasm. Scientists have also visited Dev Van Forest Nursery to explore the possibility to establish field gene bank and propagation of *Texas wallichiana*.

Species Name	Population	Location	Latitude	Longitude	Altitude
Texas wallichiana	TWCH1	Devban, Kanasar range, Chakrata	30°44'52.4"	77°51'58.3"	2818 m
	TWCH2	Bhujkoti, Riknar range, Chakrata	30°47'14.2"	77°55'24.2"	2693 m
	TWCH3	Near Hans bugyal on rudranath trekking route, Gopeshwar	30°29'34"	79°18'40.1	3135 m
	TWKN1	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	30°27'11.5"	79°14'29.9"	2577 m
	TWKN2	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	30°28'51.9"	79°11'52.3"	2937 m
***Rhododendron arboreum* var Red**	CHRA-01	Janglat Chowki, Kanasar range, Chakrata	30°43'43.7"	77°51'52.5"	2363 m
	CHRA-02	Budher, Kanasar range, Chakrata	30°45'43.5"	77°47'08.8"	2442 m
	CHRA-03	Near Nagthala, River range, Chakrata,	30°35'25.1"	77°56'16.3"	2161 m
	KNRA-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	30°27'11.5"	79°14'29.9"	2577 m
	KNRA-02	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	30°28'51.9"	79°11'52.3"	2937 m
	KNRA(P)-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	30°27'11.5"	79°14'29.9"	2577 m
	KNRA(P)-02	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	30°28'51.9"	79°11'52.3"	2937 m
	GRA(P)-03	Near Hans bugyal on rudranath trekking route, Gopeshwar	30°29'34"	79°18'40.1"	3135 m
***Rhododendron arboreum* var Pink**	KNRA(P)-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	30°27'11.5"	79°14'29.9"	2577 m
	KNRA(P)-02	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	30°28'51.9"	79°11'52.3"	2937 m
	GRA(P)-03	Near Hans bugyal on rudranath trekking route, Gopeshwar	30°29'34"	79°18'40.1"	3135 m
Texas	TBUK01	Harshil, Chholmi,	31°01.319	78°44.700"	3139 m

wallichiana		*Uttarkashi, Uttarakhand*			
	TBUK02	Sukhitop, Uttarkashi, Uttarakhand	31°00'9.7"	78°41'42.5"	2795 m
***Rhododendron arboreum* var Red**	RACW01	Siutal, Champawat, Uttarakhand	29°17'40.75 "	80°11'2.10"	1769 m
	RAPG02	Kamlake, Berinag, Pithauragarh, Uttarakhand	29°50'55.70 "	80°0'41.55"	1993 m
	RAPG03	Devdhula, Didihaat, Pithauragarh, Uttarakhand	29°48'59.09 "	80°13'6.64"	1691 m
	RAUK04	Raditop, Ranwai, Uttarkashi, Uttarakhand	30°46'15.7"	78°15'23.3"	2233 m
Myrica esculenta	MECW01	Chinapani, Champawat, Uttarakhand	29°17'25.13 "	80°6'28.04"	1726 m
	MECW02	Siutal, Champawat, Uttarakhand	29°17'40.70 "	80°11'2.24"	1766 m
	MEPG03	Kamlake, Berinag, Pithauragarh, Uttarakhand	29°50'53.04 "	80°0'22.68"	2001 m
	MEPG04	Devdhula, Didihaat, Pithauragarh, Uttarakhand	29°48'58.73 "	80°13'5.37"	1695 m

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Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority
Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in
IA No.1337 with IA Nos.827, 1122, 1216, 1473 in
WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 23rd May 2017.**

Note.

Sub.: **CAMPA/ NCAC – Assistance for the Pilot Project "Centre of Excellence on Forest Genetic Resources" at FRI Dehradun.**

A copy of the Quarterly Progress Report as on 31 03 2017 received from the Forest Research Institute (Indian Council of Forestry Research and Education), Dehradun, on the subject Project, vide their letter No.9/108/DGTP-CoFGR/FRI.2016/430 dated the 27th April 2017 is enclosed, with the request that comments/ observations may kindly be furnished, early. RT Divn's file No.17-15/2015-RT is relevant.

(Rajagopal Prashant)
Asstt Inspector General of Forests
Tel No.: (011) 24695401

To

Dy IGF (RT)
(Dr Suneesh Buxy)
Ministry of Env Forest & CC.

Encl.: a.a.

कार्पोरेशन बैंक
Corporation Bank

LSI
Date : 26/04/2017
Time : 15:41 Hrs
Page : 1

RTGS Customer Payment Outward Report

CREATE DATE :26/04/2017
MESSAGE TYPE :298
MESSAGE PRIORITY: 11
UTR :CORPR92017042603710006
RECEIVER :UBIN0549690
DIRECTION :OUTGOING
STATUS :SSN Ack.Received

CREATOR BY :E24827
SUB MESSAGE TYPE :R41
POSSIBLE DUPL. MESG:
RETURN PAYME
SENDER :CORP0000371

Transaction Reference Number

Transaction Reference Number	CORPR92017042603710006
Value Date.Currency.Amount	
Value Date	26/04/2017
Currency	INR
Amount	2,28,28,000.00
Ordering Customer	
Ordering Customer	03710010 1024054
Ordering Institution	
Bank Identifier Code	
Name and Address	037100101024054 NATIONAL CAMPA ADVISORY COUNCIL MINISTRY OF FORESST GOVT OF INDIA R NO 115 1ST FLOOR
Account with Institution	
Bank Identifier Code	
Benificiary Customer	
Account Number	496902050000138
Name and Address	INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION DEHRADUN DEHRADUN

Details of Payment

Sender to Receiver Information /OTH/DR SB01024054
/OTH/CR 496902050000138

Corporation Bank, Block-11, CGO Complex, New Delhi

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Gulab Singh, IFS
Asst. Inspector General of Forests (RT)
E-mail – agmu235@ifs.nic.in
Tel :- 011-24695389

Government of India
Ministry of Environment, Forests & Climate Change
Vayu Wing, 5th Floor, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi – 110003

F. No. 17-15/2015-RT **Dated:29.05.2017**

OFFICE MEMORANDUM

Sub: CAMPA/NCAC- Assistance for the Pilot Project "Centre of Excellence of Forest Genetic Resources" at FRI Dehradun –reg.

Please refer to your note no. 13-17/2012-CAMPA dated 23.05.2017 on the subject mentioned above. In this context, this is to inform you that the achievements are field related, so comments of RT Division is infructuous as already communicated vide O.M dated 02.03.2017 (copy enclosed).

2. This is for your kind information and further necessary action please.

Encl:- As above

29/5/17

(Gulab Singh)
Asst. Inspector General of Forests (RT)

To:-

Shri R. Prashanth, AIGF (FC),
MoEF&CC, New Delhi

OSD

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Dr. Suneesh Buxy, IFS
Dy. Inspector General of Forests (RT)
E-mail – digfrt-mef@nic.in
Tel :- 011-24695233

Government of India
Ministry of Environment, Forests & Climate Change
Agni Wing, 3rd Floor, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi – 110003

F. No. 17-15/2015-RT **Dated: 02.03.2017**

OFFICE MEMORANDUM

Sub: CAMPA Project- National Program for Conservation and Development of Forest Genetic Resources: Pilot Project proposal to be implemented at FRI, Dehradun–reg.

Please refer to your note no. 13-17/2012-CAMPA dated 19.12.2016 on the subject mentioned above.. In this context, the Power Point Presentation received from FRI, Dehradun is enclosed herewith for further necessary action please. It is suggested that committee may be formed to see annual program and achievements in ICFRE & MoEF under project mentioned above. Achievements are field related so comments of RT Division is infructuous.

2. This is for your kind information and further necessary action please.

Encl:- As above

(Dr. Suneesh Buxy)
Dy. Inspector General of Forests (RT)

To:-

Shri R. Prashanth, AIGF (FC), MoEF&CC, New Delhi

Prondol
06-03-17

IUCN India Country Office
C-10 Gulmohar Park
New Delhi 110049
India

Tel +91 11 2652 7742
Fax +91 11 2652 7742
priya.sinha@iucn.org
www.iucn.org/india

16, May 2017

To,
Shri Rajgopal Prashant
Asstt Inspector General of Forest
Ministry of Environment, Forest & Climate Change

Subject: **CAMPA/NCAC – Assistance to IUCN- Developing a tool kit for Restoration of Mining Sites.**

Reference: **IUCN letter dated 01, February 2017**

Sir,

In continuation to our letter under reference 2 above, audit report with respect to the project initiated "*Developing a tool kit for Restoration of Mining Sites*" is attached herewith.

As may be seen, out of total sanctioned amount of INR 28,75,000 (Twenty Eight Lac Seventy Five Thousand), an amount of INR 24,67,966 (Twenty Four Lac Sixty Seven Thousand Nine Hundred Sixty Six) is the eligible expenditure as certified in the audit report.
Accordingly an amount of INR 4,07,034 (Four Lac Seven Thousand Thirty Four) has remained unutilized.

It is requested that account details for remained amount may please be communicated.

Thanking You
Yours Faithfully

PR Sinha
Country Representative
IUCN India

Encl: as above

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KHANNA & ANNADHANAM
CHARTERED ACCOUNTANTS

INDEPENDENT AUDITORS' REPORT

To

International Union for Conservation
of Nature and Natural Resources (IUCN)
India Country Office
C-4/25, Safdarjung Development Area
New Delhi-110016

We have audited the attached "Fund Utilization Statement" in respect of the project 'Compensatory Afforestation Fund Management and Planning Authority(CAMPA)' undertaken by International Union for Conservation of Nature and Natural Resources (IUCN) having its office at C-4/ 25 Safdarjung Development Area, New Delhi- 110016, pursuant to an agreement between Ministry of Environment Forests and Climate Change (MoEFCC) and International Union for Conservation of Nature and Natural Resources (IUCN), India Country Office during the project period 1st September, 2015 to 31st October, 2016.

Management's Responsibility for the Fund Utilization Statement

The grantee(IUCN) is responsible for the preparation of the 'Fund Utilization Statement'for the period1st September, 2015 to 31st October, 2016 based on generally accepted principles of accounting and for such internal controls as management determines is necessary to enable the preparation of Fund Utilization Statement'that is free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on the 'Fund Utilization Statement'for the period ending 31st October, 2016based on our audit. We conducted our audit in accordance with International Auditing Standards (ISA) issued by International Federation of Accountants (IFAC). Those standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the 'Fund Utilization Statement' is free from material misstatement.

KHANNA & ANNADHANAM * NEW DELHI * CHARTERED ACCOUNTANTS

3/7B, 2ND FLOOR, ASAF ALI ROAD, NEW DELHI-110002
TELE : 91 (11) 23244061, 23244062, 23244063 FAX : 91 (11) 23244475
E-mail:knatax@rediffmail.com

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the 'Fund Utilization Statement'. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the 'Fund Utilization Statement', whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the entity's preparation of the 'Fund Utilization Statement' in order to design audit procedures that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of the entity's internal control. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of accounting estimates made by management, as well as evaluating the overall presentation of the 'Fund Utilization Statement'.

We substantively examinedthat there is supporting documentation related to reported expenditure and we believe that the audit evidence we have obtained is sufficient to provide a basis for our audit opinion on the appropriateness of the expenditure reported in the 'Fund Utilization Statement'.

Opinion

The result of our tests disclosed `1,100 together with Supervision and Coordination charges `165 related thereto were noted to be ineligible, being unsupported.

In our opinion, except for the effect of the aforesaid unsupported costs, the 'Fund Utilization Statement' referred to above presents fairly in all material respects, project grant and costs incurred/reimbursed for the period 1st September, 2015 to 31st October, 2016 in accordance with the terms of agreement and MoEFCC'srequirements for Financial Reporting.

KHANNA & ANNADHANAM * CHARTERED ACCOUNTANTS * NEW DELHI

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Other Matters

In the case of staff time, though deviations were noted between the actual monthly time and the budgeted time, on overall basis the staff time was within the budgeted time with no excess time being charged to the project.

The report is intended for the information of Ministry of Environment Forests and Climate Change and IUCN India Country Office.However, upon acceptance by MoEFCC, this report is a matter of public record and its distribution is not limited.

For Khanna&Annadhanam
Chartered Accountants
(FRN: 001297N)

KHANNA & ANNADHANAM NEW DELHI CHARTERED ACCOUNTANTS

(K.A. Balasubramanian)
Partner
Membership No. 17415

Place: New Delhi

Date: 6/3/17

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KHANNA & ANNADHANAM
CHARTERED ACCOUNTANTS

To,

International Union for Conservation
of Nature and Natural Resources (IUCN)
India Country Office
C-4/25, Safdarjung Development Area
New Delhi-110016

Dear Sir,

Sub: Audit of International Union for Conservation of Nature and Natural Resources (IUCN) grant for "Mining and Biodiversity Conservation Issues" under the agreement dated September, 2015 between IUCN and MoEFCC.

We are pleased to submit our report on the result of the project audit of 'Mining and Biodiversity Conservation Issues' for the period 1st September 2015 to 31st October, 2016 .

A. BACKGROUND

In September, 2015, "International Union for Conservation of Nature and Natural Resources, India (IUCN), India Country Office" entered into an agreement with Ministry of Environment Forests and Climate Change (MoEFCC) for assessment on Mining and Biodiversity Conservation Issues.

The total project cost estimated for the above said project was Rs. 28,75,000/- which was sanctioned as grant by MoEFCC for various activities in terms of contract for a period from 1st September, 2015 to 31st October, 2016.

B. AUDIT OBJECTIVES AND SCOPE

The objectives of audit are:

- Express an opinion on whether the Fund Accountability Statement for the project presents fairly in all material respects, project receipts and cost incurred during the

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E-mail:knatax@rediffmail.com

period from 1st September, 2015 to 31st October, 2016 in accordance with the terms of the agreements and in conformity with generally accepted principles of accounting.

- Evaluate and obtain sufficient understanding of the Internal Control System related to the project and assess control risk, and identify reportable conditions including material internal control weakness.

- Perform tests to determine whether IUCN has complied in all material aspects agreement terms and applicable laws and regulations related to the project and express an opinion thereon. We have conducted the audit in accordance with the relevant auditing standards.

Our scope of work consisted of the following:

- Review of the contract dated 1st September, 2015 and other relevant documents laws / regulations applicable to the project and their compliance.

- Examination of the books of account and other statements maintained by IUCN for the said project and documents supporting receipts and expenditures are in accordance with the grant.

- Evaluation of adequacy of IUCN internal controls and procedures relevant to the project.

In determining compliance with the terms of contract, applicable laws and regulations, we designed audit steps to provide reasonable assurance in detecting errors, irregularities that could have direct and material effect on the Fund Accountability Statement.

C. RESULTS OF AUDIT

The following are the results of our audit :

1. <u>Opinion on Fund Accountability Statement</u>

In our opinion the Fund Accountability Statement subject to ineligible or unsupported costs and read with the notes detailed in the fund accountability statement presents, fairly in all material respects, costs incurred and reimbursed for the period September, 2015 to

KHANNA & ANNADHANAM NEW DELHI CHARTERED ACCOUNTANTS

October, 2016, in accordance with the terms of agreements and in conformity with generally accepted principles of accounting.

2. Review of Internal Control

Our study and evaluation of the internal controls structure of IUCN disclosed no material reportable conditions. Since the project has come to a close and the weaknesses noticed were not material, no separate letter has been addressed to the management of IUCN in this regard.

3. Compliance Review

As part of our audit objectives of obtaining reasonable assurance about whether the Fund Accountability Statement is free from any material misstatement, we performed tests of IUCN'S compliance with terms specified in the agreement.

The results of our tests indicate that IUCN has except for the instances mentioned in our report, complied in all material respects with the terms of the contract.

4. Other matters

We noted certain ineligible or unsupported costs in the Fund Accountability Statement which have been detailed by us in notes to the said fund accountability statement. The adjustments made in the Fund Accountability Statement were on account of recording various expenses

For **KHANNA & ANNADHANAM**
Chartered Accountants
(FRN: 01297N)

KHANNA & ANNADHANAM CHARTERED ACCOUNTANTS NEW DELHI

(K. A. Balasubramanian)
Partner
Membership No. 017415

Place: New Delhi
Date : 9/3/17.

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Project Title	:	CAMPA
NGO Name	:	IUCN India Country Office
Project Country	:	India
Project Duration (months)	:	September 15- October 16
Grant Amount (`)	:	28,75,000

FUND UTILISATION STATEMENT

(Amounts In `)

Budget Items	Budgeted Amount (A)	Total Expenditure (B)	Adjustment (C)	Actual After Adjustment (D) = (B) +(C)	Ineligible (E) =(D)-(A)	Unsupported (F)	Total ineligible (G) =(E) +(F)	Eligible Expenditure (H) =(D)-(G)	Remarks, if any
a) Staff Charges / Consultancy Charges	1,300,000	1,296,060	-	1,296,060	-	-	-	1,296,060	Refer Note 1
b) Research and Produce Publications	300,000	296,675	-	296,675	-	-	-	296,675	
c) Consultative Workshop with Stakeholders	600,000	303,217	-	303,217	-	-	-	303,217	
d) Printing and Dissemination	100,000	100,000	-	100,000	-	-	-	100,000	Refer Note 1
e) Travel	200,000	151,205	-	151,205	-	1,100	1,100	150,105	Refer Note 2
SUB-TOTAL A (a+b+c+d+e)	2,500,000	2,147,157	-	2,147,157	-	1,100	1,100	2,146,057	
f) Supervision and Coordination (15%) (B)	375,000	322,074	-	322,074	-	165	165	321,909	
GRAND TOTAL (A+B)	2,875,000	2,469,231	-	2,469,231	-	1,265	1,265	2,467,966	

Explanatory Notes to Fund Utilisation Statement attached

Notes :

1. Includes provision towards Consultancy and Printing and Dissemination charges amounting to Rs. 1,00,000/- each.

2. Out of the total travel expense, Rs. 1,100 taxi charges incurred by Shilpi Misra at Dehradun visit diallowable being unsupported with related Supervision charges of ` 165.

As per our report on even date attached
For Khanna and Anandhanam
(Chartered Accountants)
(FRN 001297N)

K. A. Balasubramanian
(Partner)
M. No. 017415
Place : New Delhi
Date : 06/03/2017

IUCN INDIA COUNTRY OFFICE C-4/26, S.D.A. New Delhi-16 Ph: 011-26527742

International Union for Conservation of Nature and Natural Resources

KHANNA & ANNADHANAM
CHARTERED ACCOUNTANTS

EXPLANATORY NOTES TO THE FUND ACCOUNTABILITY STATEMENT

1. GENERAL

Pursuant to the agreement between International Union for Conservation of Nature and Natural Resources (IUCN), India Country Office and Ministry of Environment Forests and Climate Change (MoEFCC), the MoEFCC had agreed to provide support to IUCN to implement a project entitled 'Compensatory Afforestation Fund Management and Planning Authority (CAMPA).

2. DURATION

The duration of the project of 6 months was extended to 12 months. The Fund Accountability Statement (FAS) has been prepared for the period beginning 1ST September, 2015 to 31st October, 2016.

3. EXTENSION OF PROJECT TIME

The contract was originally planned to be completed within 6 months but was extended for further 6 months on a no cost extension basis.

4. PROJECT GRANT RECEIVED

During the period under reference the project had received the following amounts:

Date	Installment (₹)	TDS Deducted (₹)	Amount (₹)
1st September, 2015	28,75,000	NIL	28,75,000
Total	**28,75,000**	**NIL**	**28,75,000**

3/7B, 2ND FLOOR, ASAF ALI ROAD, NEW DELHI-110002
TELE : 91 (11) 23244061, 23244062,
E-mail: knatax@rediffmail.com

Subject: **RE: Notice**
Date: 05/16/17 10:04 AM
From: SINHA Priya <Priya.SINHA@iucn.org>
[redacted] To: "adhoc-campa-mef@nic.in" <adhoc-campa-mef@nic.in>
Cc: ISHWAR N M <NM.ISHWAR@iucn.org>

image001.gif (3kB)

Dear Shri Prashant,
I acknowledge receipt of the meeting notice.
Accordingly, I along with my colleague Dr N.M.ISHWAR will be at the meeting tomorrow at 3 P.M.
Best Wishes
PRSinha

Priya Ranjan Sinha (Mr)
Country Representative
India Country Office
IUCN (International Union for Conservation of Nature)
C-10, Gulmohar Park, New Delhi 110049. India
Tel. +91 11 2652 5554, Fax +91 11 2652 7742,
www.iucn.org

From: adhoc-campa-mef@nic.in [mailto:adhoc-campa-mef@nic.in]
Sent: 11 May 2017 16:07
To: SINHA Priya
Subject: Notice

--

Ad-hoc CAMPA, Ministry of Environment, Forest & Climate Change,
Block-3, 4th Floor, Hall No.1,
CGO Complex, Lodhi Road, New Delhi - 110 003.
Phone : 011-24368006
Telefax : 011-24368007
E-mail : adhoc-campa-mef@nic.in

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0135-2224513
फैक्स/FAX : 91-0135-2756865
E-mail : dir_fri@icfre.org

डॉ० सविता, भा.व.से.
निदेशक व.अ.सं.
एवं
कुलपति व.अ.सं. सम विश्वविद्यालय
Dr. SAVITA, IFS
Director FRI
and
Vice-Chancellor FRI Deemed University

वन अनुसंधान संस्थान
(भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद्)
(पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार की एक स्वायत्त परिषद्)
डाकघर न्यू फॉरेस्ट, देहरादून—248006
FOREST RESEARCH INSTITUTE
(Indian Council of Forestry Research and Education)
(An autonomous body of Ministry of Environment, Forests & Climate Change Govt. of India)
P.O. New Forest, Dehra Dun—248006

अ०शा०सं० D.O.No 9-108/DGTP-CoFGR/FRI 2016

दिनांक Dated, the Date 4-08-2017

To,

The Inspector General of Forests /
Chief Executive Officer (CEO), Ad-hoc CAMPA
Ministry of Environment, Forest and Climate Change
Indira Paryavaran Bhavan
Jorbagh Road
New Delhi - 110 003

Kind attention: Shri Rajagopal Prashant, AIG (FC)

Sub : **Adhoc CAMPA project - National Program for Conservation and Development of Forest Genetic Resources: Pilot Project "Centre of Excellence on Forest Genetic Resources" at FRI, Dehradun –Progress Report reg.**

Sir,

R-121253/AIG(FC) 16/8/17

Kindly find enclosed herewith two copies of the Progress Report on the subject cited project, for the quarter ending June 2017. You are further requested to kindly release the second year's budget as per the project outlay at the earliest as many of the activities and procurements are under process.

Kind regards,

Encl. As above

Yours faithfully

4/08
(Dr. Savita)
Director

DIG(WK)
Sir my pl see
11/8/17

4/16/8

OSD

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National Program for Conservation and Development of Forest Genetic Resources

Pilot Project
(Implemented at FRI, Dehradun)

On

Creation of Centre of Excellence on Forest Genetic Resources (FGR) of India (CoFGR)

Funded under
Adhoc CAMPA Fund
Ministry of Environment, Forest & Climate Change
(2016-2020)

Progress Report
(April -June 2017)

Submitted by

Forest Research Institute (FRI),
New Forest P.O., Dehradun 248 006

PROJECT SUMMARY

Title of the Project:	National Program for Conservation and Development of Forest Genetic Resources: Pilot on 'Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)'at FRI Dehradun
Funding Agency:	Adhoc CAMPA Fund Ministry of Environment, Forest & Climate Change, Govt. of India
Project Outlay:	Rs. 861.20 lakhs (January 2016 – 31 December 2020)
Project Period:	5 years
Grants released:	1st installment - 146.25 lakhs
	2nd installment - 146.25 lakhs
Date of release:	1st installment on 21st January 2016
	2nd installment on 22nd March 2017
Project Executing Authority:	Director Forest Research Institute, Dehradun
Period of present progress report:	Quarterly report (April - June 2017)
	Cumulative progress up to 30th June 2017

Progress report (April 2017-June 2017)

A brief progress of activities for the period of **April 2017 –June 2017** as per the action plan of the project has been summarized in the following points:

A. FGR Documentation

1. Upgradation and Digitization of DD Herbarium:-

a) Shifting of Herbarium specimens

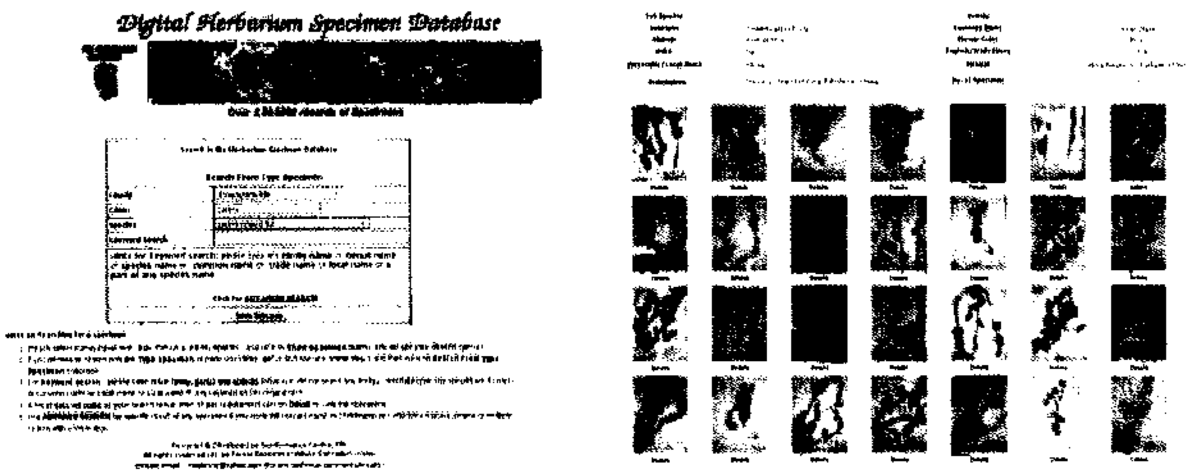
Renovation of new Herbarium hall has been completed. Mobile compactors have been installed. Voluminous task of transferring and arranging Dicotyledonous floral specimens following the Bentham & Hooker classification has been initiated since February, 2017. So far 30% of the total specimens have been transferred to the compactors and remaining shall be done in the next quarters.

A view of New Herbarium hall with state of art Compactors after furnish

Shifting of Herbarium specimens

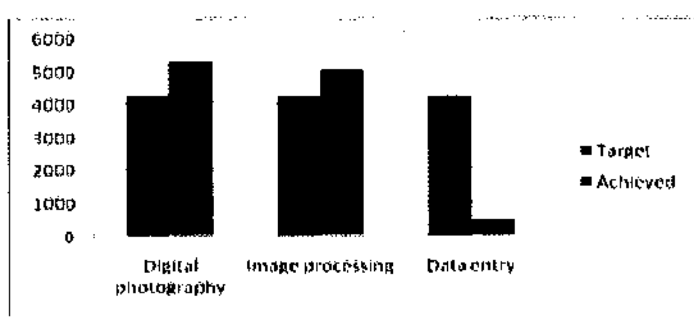
b) Digitization of DD Herbarium:

The Herbarium database specifically designed to manage DD Herbarium information was developed under a plan project and was named as *Digital Herbarium Specimen Database* http://10.1.250.237/hadmin/harbarium.php (currently available at FRI intranet), primarily to serve as a digital Herbarium catalogue of the DD collections. The complete digitization of *ca.* 3,30,000 specimens was mammoth task and major portion of the digitization has been completed under plan project. Remaining 68,000 specimens are still to be digitized, which has been taken up under the present project.



Screenshot of a. homepage of Digital herbarium specimen database system
b. species database page with digital images

The targeted specimens to be digitized under the current quarter were 4250 specimens, which is 12.5% of the total number of angiospermic species available in DD Herbarium. A total of 5250 high quality digital photographs captured; 5000 digital images processed using Photoshop elements or other image processing applications in two sizes viz. thumbnail image (8 KB) and large view image (~800 KB). A total of 457 fully data based material with high quality images have been added in to *Digital Herbarium Specimen Database*.



Growth of the DD dataset under current quarter (April to June, 2017)

Documentation of FGR species

a) **Field Survey for distribution:**
During the period, surveys have been conducted in different districts of Uttarakhand viz. Nainital, Uttarkashi, Tehri, Rudraprayag, Chamoli and collected field data of several FGR species as detailed below :

1. **Nainital (Nandhaur wildlife sanctuary, Nainital Forest Division, Haldwani Forest Division and Ramnagar Forest Division):**

Data on distribution of species have been collected from different forest divisions. Species reported from the area are:
Acer oblongum, Aesculus indica, Albizia lebbeck, Albizia procera Acacia catechu, Adina cordifolia, Bauhinia semla, Bombax ceiba, Bauhinia racemosa Bischofia javanica Ficus racemosa, Holoptelia integrifolia, Anogeissus latifolia, Trema orientalis, Toona ciliata, Litsaea monoptela ,Mangifera indica, Putranjiva roxburghii, Ougeinia oojeinensis, Wendlandia heynei, Garuga pinnata, Shorea robusta, Terminalia tomentosa, Terminalia bellirica, Hymenodictyon orixense, Ficus rumphii, Ficus auriculata , Ficus semicordato, Olea paniculata, Lagerstroemia parviflora, Salix tetrasperma, Albizia odoratissima, Melia azedarcach, Pinus roxburghii, Bridelia retusa, Buchanania lanzan, Schleichera oleosa, Sapium insigni, Pistacia integerrima, Boehmeria rugulosa, Lannea coromandelica, Cinnamomum tamala, Machilus gamblei, Engelhardtia colebrookiana, Machilus odoratissima, Populus ciliate, Fraxinus micrantha, Quercus floribunda, Myrico esculenta, Cornus capitata, Rhododendron arboreum, Prunus cerasoides, Betula alnoides, Quercus semicarpifolia, Quercus lanata, Carpinus viminea, Abies pindrow in tree layer.

In shrub layer*:* *Vitex negundo, Debregeasia hypoleuca* and *Catunaregam spinosa.*
In climbers: *Bauhinia vahlii, Pueraria tuberosa, Ventilago denticulata, Cryptolepis buchanani*
Rare: *Marsdenia lucida* and *Butea pellita*

2. **Uttarkashi (Tons Forest Division, Gobind Wildlife sanctuary):**

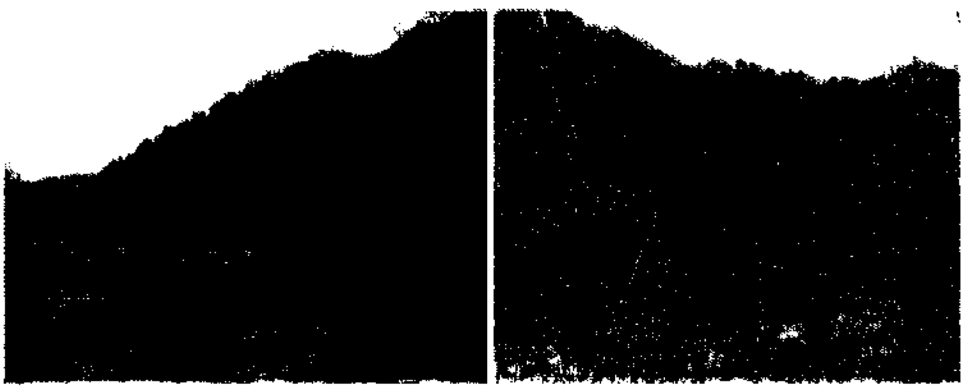
Data on distribution of species have been collected from different forest divisions of the district. Species reported from the area are:
Abies pindrow, Acer oblongum, Aesculus indica, Albizia chinensis, Alnus nepalensis, Bauhinia semla, Betula alnoides, Carpinus viminea, Celtis australis, Celtis tetrandra, Cedrus deodara, Cornus capitata, Corylus jacquemontii, Dalbergia sissoo, Ficus auriculata, Ficus neriifolia var. *nemaralis, Ficus semicardata, Fraxinus micrantha, Grewia optiva, Hovenia dulcis, Hymenodictyon orixense, Juglans regia, Machilus duthiei, Myrica esculenta, Picea smithiana, Pinus wallichiana, Pinus roxburghii, Pistacia integerrima, Populus ciliata, Prunus cerasoides, Punica granatum, Pyrus pashia, Quercus floribunda, Quercus glauca, Quercus leucotrichophora, Rhododendron arboreum, Salix tetrasperma, Sapium insigne, Sterculia villosa, Toona ciliate, Toona serrota, Ulmus wallichiana* in tree layer;

In shrub layer: *Berberis lyceum, Elaeagnus latifolia, Picrasma quassioides, Rhus parviflora.*
In climbers: *Pueraria tuberosa.*

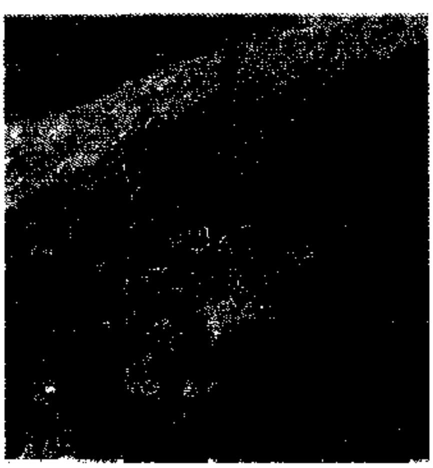
3. **Chamoli (Badrinath and Niti and Mandal):**

Data on distribution of species have been collected from different forest divisions of the district. Species reported from the area are:
Abies pindrow, Acer ceasium, Aesculus indica, Acer sterculiaceum , Alnus nepalensis, Prunus cornuto, Betula alnoides, Betula utilis, Buxus wallichiana, Cedrus deodara, Cupressus torulosa, Dodecadenia grandiflora, Juniperus macropoda m Juglans regia, Machilus adoratissima, Picea smithiana, Pinus wallichiana, Pinus roxburghii, Populus ciliata, Quercus leucatrichophora, Hippophae cerasifolia, Quercus floribunda, Quercus semicarpifolia, Rhododendron arboreum, Taxus baccata, Toona serrata in tree layer.

In shrub layer: *Ephedra gerardiana.*
Rare: *Michelia kisopa, Fraxinus xonthoxyloides*



View of Dry Deciduous Forest at Nandhaur Wildlife Sanctuary, Haldwani



Butea peltata

Marsdenia lucida

Carpinus viminea

Litsea lanuginose

Albizia julibrissin

Cornus capitata

Olea cuspidata

Buxus wallichiana

887

Corylus jacquemontii

Hovenia dulcis

B. FGR Seed and Germplasm storage

1. Population survey of FGR species

Field tours were undertaken in different forest areas for survey of population of various FGR species (of high conservation concern or economically important) and collection of seeds. The following species were identified and locations were marked for future references (Table-1).

Table-1: Details of the species identified

S. No.	Species	Geographical location	GPS co-ordinates
1	***Cinnamomum tamala***	Mandapur, Raipur Range	30°21'55.1"N 78°16'20.9"E
2	***Buxus wallichiana***	Buranshkhanda, Mussoorie FD	30°26'47.1"N 78°11'32.3"E
3	***Celtis tetrandra***	Motichur F. Rest House	30°00'48.8"N 78°11'20.8"E
4	***Diospyros exculeata***	Pashimi beat, jamun Khata, Motichur TR	30°03'34.4"N 78°11'40.8"E
5	***Schleichera oleosa***	Kansro range, Motichur	30°04'14.7"N 78°09'24.3"E
6	***Careya arborea***	Koyalpura, Kansro, Rajaji TR	30°4'07.1"E 78°06'51.8"E
7	***Buchanania lanzan***	Kansro, Rajaji TR	30°03'46.7"N 78°08'56.8"E
8	***Albizia odoratissima***	Kansro, Rajaji TR	30°05'20.3"N 78°078'54.9"E

9	***Gmelina arborea***	Jamunchata,Kansro Rajaji TR	$30^{0}05'20.5''$N $78^{0}07'54.9''$E
10	***Dalbergia lanceolaria***	Mansa devi temple, Haridwar	-
11	***Fraxinus micrantha***	Buranskhanda, Dhaunalti	-
12	***Alangium salvifolium***	Shyampur Forest Range, Haridwar	-

2. Collection of seeds

Seeds of the targeted FGR species were collected from their natural distribution areas. Basic information about collected species are described as follows:

Table 2: Seed collection sites of FGR species and their geographical locations

Species	Site of Seed Collection	GPS Co-ordinates
Leucomeris spectabilis	Kaddukhal, Mussoorie FD	$30^{0}19'44.5''$N, $78^{0}08'49.3''$E $30^{0}19'36.5''$N, $78^{0}09'51.1''$E
Engelhardtia spicata	Dugadda, Raipur	$30^{0}19'37.4''$N, $78^{0}09'57.0''$E
Careya arborea	Motichur range, Rajaji TR	-
Gmelina arborea	Sushila Tiwari Herbal Garden, Rishikesh	$30^{0}60'35''$N $78^{0}17'50''$E

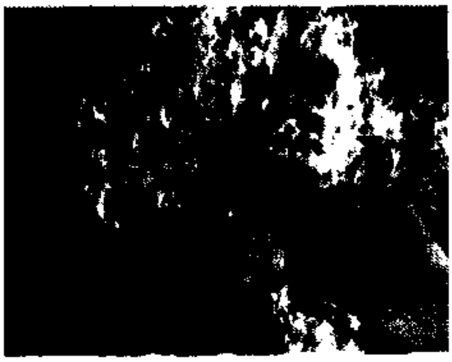
3. Seed extraction and processing

The seed extraction and processing works were completed in the following species:

Table-3: Methodology of extraction of seeds

Species	***Methodalagy***
Engelhardtia spicata	• Wing-seeds dried under shade for 2-3 days • Hairy seeds were de-winged by rubbing • Seeds were separated from hairs by winnowing
Leucomeris spectabilis	• Hairy seeds were separated manually
Careya arbarea	• Pulpy fruits were heaped for 5 to 7 days for decomposing the pulp. • Fruits were de-pulped and washed with tap water. • Extracted seeds dried in cool air dryer at 15^{0}C and 15% relative humidity.
Gmelina arborea	• Pulpy fruits were kept for 5 days for after-ripening process • Fruits were soaked in water and de-pulped • De-pulped seeds were washed thoroughly in water and separated

Careya arborea fruit with seeds



Seed extraction of Leucomeris spectabilis

Initial parameters like seed weight, seed moisture content, seed germination, etc. were conducted after seed extraction.

4. Seed moisture content

Moisture content in the seeds was determined by Oven-Dry method. In this method, Pre-weighed, grinded fresh seed materials were placed in an oven maintained at 103°C. Seeds were dried at this temperature for 17+-1hr.

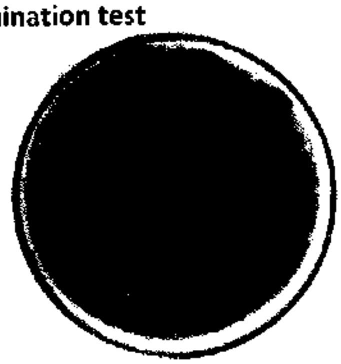
Species	Moisture Content (%)
Engelhardtia spicata	10.99
Leucomeris spectabilis	6.00
Gmelina arborea	20.21
Careya arborea	22.24

5. Seed germination test

Random sample of pure seeds were taken for seed germination test. Germination test was carried out in the germinator with controlled temperature 25^0C for temperate species and 30^0C for tropical species. Seed germination of all the species is in progress.

$$\text{Germination \% of seed} = \frac{\text{Total number of seed germinated}}{\text{Total number of seed planted}} \times 100$$

Germination test



Careya arborea

Gmelina arborea

6. Seed drying and storage

Seeds were dried in cool air dryer at low temperature 15^{0}C and 15 percent relative humidity for slow desiccation to safe moisture levels for storage. Dried seeds of *Engelhardtia spicata, Leucomeris spectabilis, Gmelina arborea* and *Careya arbarea* were stored under controlled conditions in low-temperature seed storage cabinet.

7. Viability testing of stored seeds

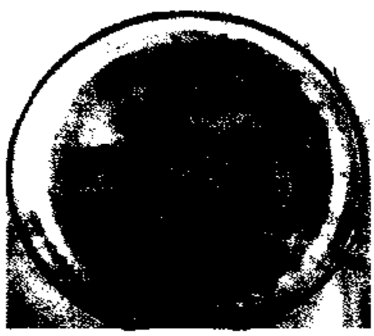
Viability of stored seeds of species was evaluated through germination test *viz., Desmodium oojeinensis, Aegle marmelos, Acacia catechu, Albizia julibrissin, Toona ciliata, Hippophae salicifolia, Bischofia javanica, Holoptelia integrifolia, Pyrus pashia, Pinus wallichiana* and *Aristolochia elegans.*

S. No.	Species	Germination %
1.	*Desmodium oojeinensis*	46
2.	*Aegle marmelos* (Source: Kansro Forest Range)	84
3.	*Aegle marmelos* (Source: Fatehpur Forest Range, Haldwani)	58
4.	*Acacia catechu*	48
5.	*Albizia jullibrissin*	58
6.	*Toona ciliata*	10
7.	*Hippophae salicifolia*	89
8.	*Bischofia javanica*	71
9.	*Holoptelia integrifolia*	89
10.	*Pyrus pashia*	13
11.	*Pinus wallichiana*	37
12.	*Aristolochia elegans*	46

Desmodium oojeinensis

Holoptelia integrifolia

Aegle marmelos



Hippophae salicifolia

In vitro storage of FGR species

As the prerequisite for the development of any *in vitro* conservation methods for storage of FGR (in this case either FGR of very high conservation concern or those having recalcitrant seeds or both) is the availability of a standardized *in vitro* regeneration protocol. Thus experiments have been initiated to devise *in vitro* regeneration or micropropagation protocols for selected species as given below:

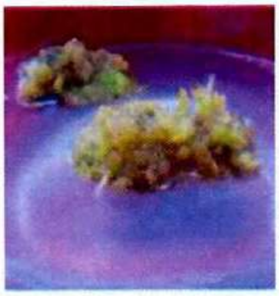
1. *Desmodium oojeinensis*
2. *Dodecadenia grandiflora*
3. *Diploknema butyraceae*
4. *Taxus contorta*
5. *Hippophae salicifolia*
6. *Albizzia julibrisin*
7. *Betula utilis*
8. *Aristilochia punjabensis*
9. *Butea pellita*

The brief progress of works has been summarized in the following table:

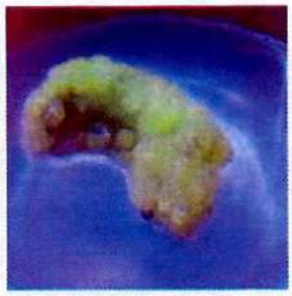
<table>
<tr><td>1.</td><td colspan="3">Desmodium oojeinensis</td></tr>
<tr><td>i)</td><td colspan="3">Subculture of in vitro grown micro shoots</td></tr>
<tr><td></td><td colspan="3">The in vitro grown micro shoots were subcultured in M5 media with BAP ranging from 0.5-2.0 mg/l for further proliferation and following results were obtained.</td></tr>
<tr><td></td><td>S. No.</td><td>Media Combinations</td><td>Average Multiplication Rate</td></tr>
<tr><td></td><td>1</td><td>MS + 0.5 (mg/l) BAP</td><td>1.0</td></tr>
<tr><td></td><td>2</td><td>MS + 1.0 (mg/l) BAP</td><td>3.0</td></tr>
<tr><td></td><td>3</td><td>MS + 1.5 (mg/l) BAP</td><td>2.0</td></tr>
<tr><td></td><td>4</td><td>MS + 2.0 (mg/l) BAP</td><td>2.5</td></tr>
<tr><td></td><td colspan="3">In vitro response:</td></tr>
<tr><td></td><td colspan="3">
Organogenesis in callus cultures: Microshoots multiplication</td></tr>
<tr><td>ii)</td><td colspan="3">Subculture of Calli:</td></tr>
<tr><td></td><td colspan="3">The calli obtained from epicotyls, hypocotyls and cotyledons were transferred to different media combinations to obtain a suitable callus proliferation medium</td></tr>
</table>

	S. No	Media Combination	Texture of Calli	Intensity of Calli formation
	1	MS + 0.5 (mg/l) NAA+ 0.5 (mg\l) BAP	Greenish	++++
	2	MS + 0.5 (mg/l) NAA+ 1.0 (mg\l) BAP	Light green	+++
	3	MS + 0.5 (mg/l) NAA+ 1.5 (mg\l) BAP	Greenish brown	+++
	4	MS + 0.5 (mg/l) NAA+ 2.0 (mg\l) BAP	Light brown	++++
	5	MS + 0.5 (mg/l) NAA+ 2.5 (mg\l) BAP	Brown	++
	6	MS + 0.5 (mg/l) TDZ+ 0.5 (mg\l) BAP	Brownish	+++
	7	MS + 0.5 (mg/l) TDZ+ 1.0 (mg\l) BAP	Greenish	+++
	8	MS + 1.0 (mg/l) TDZ+ 1.0 (mg\l) BAP	Brownish	++

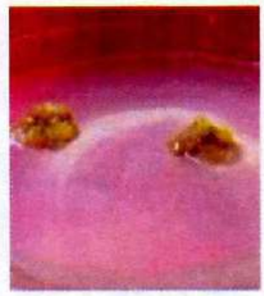
***In vitro* response:**



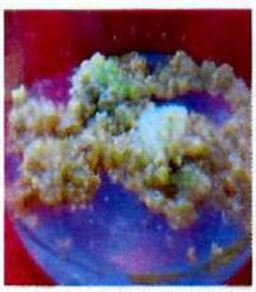
Medium-5



Medium-6



Medium-8



Multiplication of callus in different MS medium combinations

2. *Dodecadenia grandiflora*

i) Induction of nodal segments:

The stem cuttings of *Dodecadenia grandiflora* were brought from Dhanaulti area, Mussoorie forest division.

D. grandiflora : Nodal explants

Surface sterilization:

The nodal segments were separated from the stem cuttings after wiping with 70% alcohol and washed with few drops of cetrimide under running tap water for 10 min. Then they were treated with 1.0% Bavistin+0.2% M-45 fungicide for 15-20 min. in 100ml of distilled water and rinsed thrice with distilled water. Finally they were treated with 0.1% $HgCl_2$ for 5 min. and washed thrice with autoclaved distilled water.

***In vitro* induction:**

The nodes were then inoculated under the laminar air flow in MS media containing 1.0(mg\l) and 2.0 (mg\l) BAP.

***In vitro* response:**

Due to severe fungal contamination, no observations could be made. Experiments will be repeated again.

3. ***Diploknema butyraceae***

i) **Induction of *calli* from leaves:**

The leaves of *Diploknema butyraceae* were collected from the nursery of the Silviculture division of Forest Research Institute, Dehradun.

Surface sterilization:

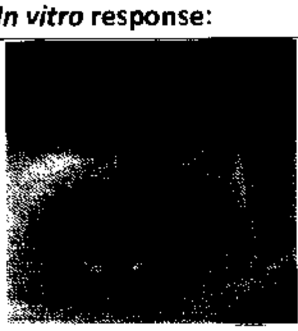
The leaves were wiped with alcohol and cut in small sections which were treated with few drops of cetrimide under running tap water for 10 min. Then they were treated with 1.0% Bavistin+0.2% M-45 fungicide for 10 minutes in 100ml of distilled water and rinsed thrice with distilled water. Finally they were treated with 5% NaOCl for 5 min. and washed thrice with autoclaved distilled water.

***In vitro* induction:**

The cut leaves were inoculated in following media combinations

S. No	Media Combinations	Intensity of calli formation
1	MS	No callus formation
2	MS + 4.44 (µM) BAP+1.13 (µM) 2,4-D	+++
3	MS + 4.44 (µM) BAP+2.62 (µM) 2,4-D	+++
4	MS + 4.44 (µM) BAP+3.92 (µM) 2,4-D	++
5	MS + 4.44 (µM) BAP+4.53 (µM) 2,4-D	++++

***In vitro* response:**



Medium-2

Medium -1

Medium -3

Medium-4

Medium-5

4. ***Taxus contorta***

i) ***In vitro* multiplication**

After the shoots had grown to length of 5 – 6 cms, the shoots were cut and transferred to new media for further shoot elongation. Two new media combinations were tried for shoot growth and multiplication of in vitro grown shoots.

S. No	Media Combinations	Intensity of calli formation
1	½MS + 1 mg/L BAP + 1 gm/L AC + 100 mg/L $AgNO_3$	No callus formation
2	½MS + 1 gm/L AC + 100 mg/L $AgNO_3$	No callus formation

***In vitro* response:**

Yellowing of leaves was observed after 4 weeks hence the shoots were again transferred to fresh media with different combinations. Results are awaited for this.

In vitro multiplication of *T. contorta* shoots

ii) ***In vitro* growth and multiplication of calli**

In vitro calli was initiated from *T. contorta* stem cuttings and the calli has been subcultured on two different types of media to check the response of growth of calli.

S. No	Media Combinations	Intensity of calli formation
1.	MS + 2mg/ L 2,4-D + 5 mg/L AC	Result awaited
2.	½ WPMSH + 2mg/ L 2,4-D + 0.5 mg/L BAP	Result awaited

***In vitro* response:**

Excessive release of phenolics observed in cultures within 24 hours of culture initiation. Incorporation of 0.5% PVP into the medium controlled the release of phenolics to some extent. However no in vitro axillary bud induction or callus initiation was observed in any of the treatments.

	 *In vitro* grown callus
iii)	***In vitro* embryo isolation and calli culturing**
	Seeds of *T. contorta* were collected from Deoban forest area in Chakrata forest division.
	Surface sterilization:
	The seeds were soaked in distilled water for one week with regular change of water every day. After one week the seeds were surface sterilized with a few drops of cetrimide solution followed with 0.2% Nativo (fungicide) treatment for half an hour. The seeds were finally sterilized with 0.1% $HgCl_2$ for 15 minutes.
	***In vitro* embryo isolation:**
	The seeds were excised open from the centre with the help of a scalpel and embryo was isolated and cultured on media (½ WPMSH + 2mg/ L 2,4-D + 0.5 mg/L BAP).
	***In vitro* response:**
	Very few seeds had a viable embryo in them. Rest were already dead. Due to severe contamination, no observations could be made. The experiment will be repeated if more seeds of the same could be collected in future.
iv)	***In vitro* bud induction and shooting:**
	Stem cuttings of *T. contorta* were collected from Deoban forest area in Chakrata forest division.
	Surface sterilization:
	The stem cuttings were surface sterilized first with a few drops of cetrimide solution followed with 0.2% Nativo (fungicide) treatment for 15 mins. The cuttings were finally sterilized with 0.1% $HgCl_2$ for 10 minutes.
	***In vitro* induction:**
	Six different media combinations were tried to ascertain the best media combination of bud induction.

S. No	**Media Combinations**	**Intensity of calli formation**
1.	Basal ½ MS + 1 gm/L AC	++++
2.	½ MS + 0.5 mg/L BAP + 1 gm/L AC	++
3.	½ MS + 1 mg/L BAP + 1 gm/L AC	++
4.	½ MS + 1.5 mg/L BAP + 1 gm/L AC	++
5.	½ MS + 2 mg/L BAP + 1 gm/L AC	++
6.	½ MS + 2.5 mg/L BAP + 1 gm/L AC	++++
7.	½ MS + 3 mg/L BAP + 1 gm/L AC	++

***In vitro* response:**

In vitro bud induction and shoot growth in *T. contorta.*

5. ***Hippophae salicifolia***

i) ***In vitro* multiplication of shoots**

In vitro grown shoots were further sub cultured on media for shoot multiplication

***In vitro* response:**

In vitro subcultured shoots are health and further experiments are planned.

In vitro multiplication of *H. salicifolia* shoots

ii) ***In vitro* somatic embryogenesis**

In vitro grown shoots and leaves of *H. salicifolia* were subcultured on three different media combinations to induce somatic embryos.

S. No	Media Combinations	Intensity of calli formation
1.	¼ MS + 1 mg/L BAP + 0.1 mg/L Kin	Result awaited
2.	NN + 0.3 mg/L BAP + 0.2 mg/L IAA	Result awaited
3.	SH + 1 mg/L Kin + 0.5 mg/L IAA	Result awaited

6. ***Albizzia julibrisin***

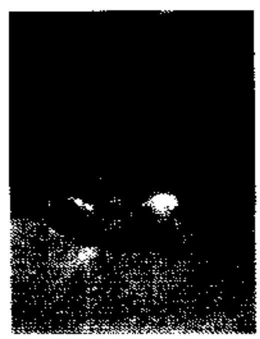
i) ***In vitro* seed germination:**

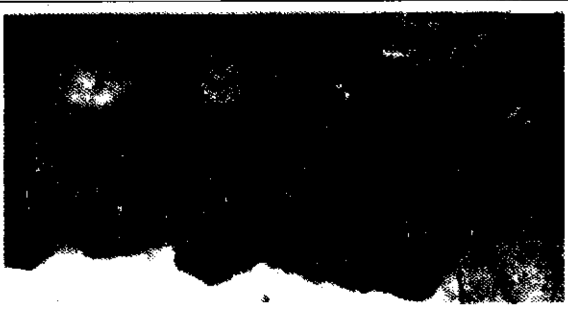
Seeds procured from Seed lab in FRI were used for the experiments. The seeds were soaked in hot water 80 – 90 °C and left in the same for twenty four hours.

Surface sterilization:

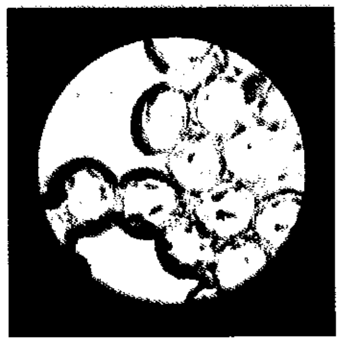
The seeds were surface sterilized first with a few drops of cetrimide solution followed with 0.2% Nativo (fungicide) treatment for 30 mins. The cuttings were finally sterilized with 0.1% $HgCl_2$ for 15 minutes.

<table>
<tr><td></td><td colspan="3">In vitro seed germination:</td></tr>
<tr><td></td><td colspan="3">The seeds were inoculated on MS basal media for germination and kept in culture room.</td></tr>
<tr><td></td><td colspan="2">In vitro response:

Very high germination rate (80%) was observed in the seeds of A. Julibrisin.</td><td></td></tr>
<tr><td>ii)</td><td colspan="3">In vitro subculture of seedlings</td></tr>
<tr><td></td><td colspan="3">The seedlings thus obtained were subcultured on three different types of media with specific plant part being sub cultured to specific media.</td></tr>
<tr><td></td><td>Plant part</td><td>Media Combinations</td><td>Intensity of calli formation</td></tr>
<tr><td></td><td>Roots</td><td>B5 + 0.05 µM TDZ</td><td>Callus formed and differentiated into shoots</td></tr>
<tr><td></td><td>Hypocotyle</td><td>MS + 10.8 µM NAA + 4.4 µM BAP + 0.2 g/L Myo-inositol</td><td>Callus formed and differentiated into shoots</td></tr>
<tr><td></td><td>Shoot apex</td><td>B5 basal media</td><td>Increase in biomass and root formation in some shoots</td></tr>
<tr><td></td><td colspan="3">In vitro response:</td></tr>
<tr><td></td><td>
Callus formation and shoot regeneration from roots</td><td>
Callus formation and shoot regeneration from hypocotyle</td><td>
Callus formation and initial shoot formation</td></tr>
<tr><td>7.</td><td colspan="3">Betula utilis</td></tr>
<tr><td>i)</td><td colspan="3">In vitro germination of seeds</td></tr>
<tr><td></td><td colspan="3">The seeds were collected from Kedarnath forest division.</td></tr>
<tr><td></td><td colspan="3">Surface sterilization:</td></tr>
<tr><td></td><td colspan="3">The seeds were surface sterilized first with a few drops of cetrimide solution followed with 0.2% Nativo (fungicide) treatment for 10 mins. The cuttings were finally sterilized with 0.1% $HgCl_2$ for 5 minutes.</td></tr>
</table>

	***In vitro* induction:**
	The seeds after sterilization were inoculated on MS basal media
	***In vitro* response:** The germination rate of the seeds in very low with only one to two seeds showing germination in around 50 seeds inoculated. The seeds germinated are being maintained for seedling growth. Further experiments will be planned once the biomass of the seedling has increased. 
8.	***Aristilochia punjabensis***
i)	***In vitro* and normal seed germination**
	Seeds of *A. punjabensis* were procured from Seed lab, FRI.
	Surface sterilization:
	The seeds were surface sterilized first with a few drops of cetrimide solution followed with 0.2% Nativo (fungicide) treatment for 10 mins. The cuttings were finally sterilized with 0.1% $HgCl_2$ for 5 minutes.
	***In vitro* induction:**
	The seeds after sterilization were inoculated on MS basal media.
	***In vitro* response:**
	No seed germination could be seen after 4-6 weeks of seed inoculation. To check the germination of seeds, some seeds were also potted in pots in the green house. The seeds in the green house germinated but the percentage was very low (40 %). Further experiments will be planned once the seedlings are big enough to extract expalnts.
	  Seed germination in green house
9.	***Butea pellita***
i)	***In vitro* callus induction:**
	Stem cuttings and leaves of *Butea pellita* Syn *Meizotropis pellita* were collected from Patwadangar, Manora forest range, Waldiyakhan, Nainital
	Surface sterilization:
	The leaves were surface sterilized first with a few drops of cetrimide solution followed with 0.2% Nativo (fungicide) treatment for 10 mins. The cuttings were finally sterilized with 0.1% $HgCl_2$ for 5 minutes.
	***In vitro* induction:**
	The seeds after sterilization were inoculated on MS + 2 mg/L 2,4-D

	***In vitro* response:** After 4 weeks callus formation could be observed in the leaves. Further experiments have been planned once the calli has grown to a substantial amount.	

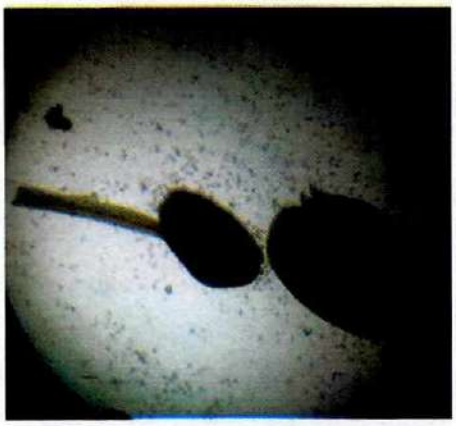
Pollen Storage Experiments:	
Preliminary studies have been initiated for pollen storage experiments.	
1.	***Diploknema butyraceae***
	Pollens from flower buds of *Diploknema butyraceae* growing in FRI campus were collected.
	Microscopic studies:
	The samples collected were used to observe the stage of nucleus; microscopic slides were prepared by staining the pollens in dilute acetocarmine solution and observed under light microscope under different magnifications.
	Observations and Results: More optimization of staining protocols is however required and other stains would also be tried for the same. 
2.	***Butea pellita* Syn *Meizotropis pellita***
	Stem cuttings of *Butea pellita* Syn *Meizotropis pellita* bearing flower buds were collected from Patwadangar, Manora forest range, Waldiyakhan, Nainital
	Microscopic and pollen studies:
	To ascertain the viability of the pollen grains, in vitro pollen germination was also attempted by keeping fresh pollens in a drop of water over a microscopic slide and observing under light microscope under different magnifications. More methods of in vitro viability assessment will also be tried. Stem cuttings bearing unopened buds were also kept in growth room with their ends dipped in water, to initiate opening of buds and anther dehiscence.

Observations and Results:

Pollen tubes of different lengths were observed clearly thus showing viability of the pollens. However the cuttings could not survive under these conditions and dried off with time.

Floral buds of different sizes

Stems bearing floral buds



Pollen tube growth in *B. pellita* pollens observed under light microscope
(arrow heads indicate elongated pollen tube)

Training at National Bureau of Plant Genetic Resources (NBPGR)

In order to get hands-on experience about the pollen storage experiments, the techniques involved etc., scientists in NBPGR have been approached and a visit is planned for the same in the month of July 2017 itself. This will help in proper establishment of experiments in tissue culture lab at FRI.

C. FGR Characterization

1. Collection of samples

Samples of five species were collected from their natural zone of occurrence and stored at -80^0 C.

- *Rhododendron arboreum var* red,
- *Texas wallichiana,*
- *Quercus semicarpifolia,*
- *Myrica esculenta and*
- *Betula utilis*

A total of 30-35 samples/trees were collected from each population in all the species. A total of 32 populations (10 populations of *Rhododendron arboreum* var red, 2 populations of *Taxus wallichiana*, 6 populations of *Quercus semicarpifolia*, 12 populations of *Myrica esculenta* and 2 populations of *Betula utilis*) were sampled from Uttarkashi, Pauri, Almora, Chamoli and Tehri along with their geographical coordinates. The samples of these populations were segregated for chemical examination and DNA fingerprinting. The detail of the sampled populations is given in the following table:

Details of different populations collected

Population	Location	Latitude	Longitude	Altitude
***Rhododendron arboreum* var red**				
RA14	Chaurangi Khal, Uttarkashi, Uttarakhand	30°38'10.00"	78°29'14.04"	2153 m
RA15	Dudatoli, Pauri, Uttarakhand	30°03'12.84"	79°06'53.92"	2349 m
RA16	Peethsen, Pauri, Uttarakhand	29°57'59.29"	79°07'17.31"	2280 m
RA17	Chaurikhal, Chaurikhal, Uttarakhand	30°01'23.97"	78°59'55.97"	2227 m
RA18	Adwani, Pauri, Uttarakhand	30°04'22.31"	78°41'40.02"	1847 m
RA19	Dunagiri, Almora, Uttarakhand	29°49'0.86"	79°26'58.42"	2169 m
RA20	Binsar, Almora, Uttarakhand	29°41'47.06"	79°45'17.43"	2214 m
RA21	Chirbatiya, bhilangana, Tehri, Uttarakhand	30°42'13.02"	78°50'04.03"	2444 m
RA22	Badanital, North Jhakoli, Tehri, Uttarakhand	30°29'41.02"	78°56'46.05"	2443 m
RA23	Chandrabadni, Narendra Nagar, Tehri,Uttarakhand	30°18'32.01"	78°37'04.07"	2119 m
Texas wallichiana				
TB09	Bhukkitop, Uttarkashi, Uttarakhand	31°50'27.00"	78°39'36.09"	2690 m
TB10	Dudatoli, Pauri, Uttarakhand	30°03'17.86"	79°06'51.57"	2320 m
Quercus semicarpifolia				
QS10	Chaurangi Khal, Uttarkashi, Uttarakhand	30°38'53.04"	78°30'17.06"	2651 m
QS11	Bhukkitop, Uttarkashi, Uttarakhand	30°50'28.04"	78°39'37.02"	2688 m
QS12	Dudatoli, Pauri, Uttrakhand	30°03'07.12"	79°06'05.65"	2315 m
QS13	Nainapeek, Uttarakhand	29°24'25.38"	79°26'05.08"	2500 m
QS14	Badanital, North Jhakoli, Tehri, Uttarakhand	30°29'49.08"	78°56'64.01"	2470 m
QS15	Bamni village, Badrinath, Chamoli, Uttarakhand	30°44'21.00"	79°29'21.07"	3184 m
Myrica esculenta				
ME09	Peethsen, Pauri, Uttarakhand	29°58'22.86"	79°07'38.72"	1991 m
ME10	Pabo bazaar 2, Khirsu, Pauri, Uttarakhand	30°06'52.23"	78°50'17.31"	1652 m
ME11	Adwani, Pauri, Uttarakhand	30°04'26.66"	78°41'31.48"	1845 m
ME12	Ranikhet, Almora Uttarakhand	29°37'35.50"	79°21'37.63"	1675 m

ME13	Dunagiri, Almora, Uttarakhand	29°47'11.66"	79°28'01.71"	1869 m
ME14	Kosani, Bageshwar, Uttarakhand	29°50'20.08"	79°35'38.49"	1624 m
ME15	Takula, Almora, Uttarakhand	29°43'56.47"	79°41'52.45"	1442 m
ME16	Seetalakhet, Almora, Uttarakhand	29°35'44.43"	79°33'18.18"	1612 m
ME17	Bhawali, Nainital, Uttarakhand	29°24'54.02"	79°32'18.53"	2022 m
ME18	Mayali forest, Jhakoli range, Rudraprayag, Uttarakhand	30°23'25.06"	78°53'37.5"	1795 m
ME19	Hulanakhal forest, Bhilangana, Tehri, Uttarakhand	30°24'57.07"	78°45'54.8"	2027 m
ME20	Chandrabadni temple, Narendra nagar, Tehri, Uttarakhand	30°18'34.05"	78°36'58.6"	2130 m
Betula utilis				
BU03	Neeti, Chamoli, Uttarakhand	30°46'03.4"	79°50'20.4"	3830 m
BU04	Bamni village, Badrinath, Chamoli, Uttarakhand	30°44'23.6"	79°29'08.5"	3245 m

2. **Genomic DNA extraction**

Genomic DNA has been extracted from the following 19 populations.

Species	DNA extraction done
Rhododendron arboreum var red	RA14, RA15, RA16, RA17, RA18. RA19, RA20, RA21, RA22, RA23
Quercus semicarpifolia	QS10, QS11, QS12, QS15, QS14
Texas wallichiana	TB09
Myrica esculenta	ME09, ME10, ME11, ME15

3. **RNase treatment of Genomic DNA**

The genomic DNA samples with RNA contamination were given RNase treatment using 10mg/l of RNase A. The pellet was re-precipitated, dried and resuspended in TE buffer and quantified again.

4. **Quantitative and Qualitative analysis of Genomic DNA**

The concentration and absorbance ratio (A_{260}/A_{280} nm) of the DNA samples were quantified using Bio photometer (Eppendorf-6131, Germany) and quality of genomic DNA was analyzed on 0.8% agarose gel.

Details of populations for which DNA Quantification has been done:

Species	DNA quantification done
Rhododendron arboreum var red	RA14, RA15, RA16, RA17, RA18, RA19, RA20
Quercus semicarpifolia	QS10, QS11, QS12
Texas wallichiana	TB09

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5. **Preparation of dilutions for PCR**

DNA samples were brought to a uniform concentration in a total volume of 100µl .

6. **Preparation of primer aliquots:**

The aliquots of required concentration (20µM/µl) of SSR primers were prepared by resuspending the stock in pH balanced sterile ultrapure water.

7. **Standardization of PCR amplification conditions:**

Different PCR conditions and cycling parameters were tested for successful amplification of SSR markers. The concentration of various components such as primer, dNTPs, $MgCl_2$, *Taq* DNA polymerase and template DNA was optimized.

8. **Standardization of annealing temperature:**

Annealing temperature was standardized using gradient PCR, where a range of annealing temperatures was used to amplify each primer. 38 SSR markers were screened for amplification, out of which 13 primers amplified in expected size range. Standardization of annealing temperature for rest of the primers is under progress.

Composition of the master mix:

Component	**Volume**	**Final concentration**
H2O	7.04	
Taq Buffer (10X)	1.50	1X
$MgCl_2$ (25mM)	1.80	3mM
dNTPs (2.5mM)	3.00	0.5mM
Forward Primer (20µM)	0.30	0.4 µM
Reverse Primer (20 µM)	0.30	0.4 µM
Taq DNA polymerase (5U)	0.06	0.02U
Template DNA (25ng/ µl)	1.00	25ng/ µl
Total Volume	15.0	

PCR conditions:

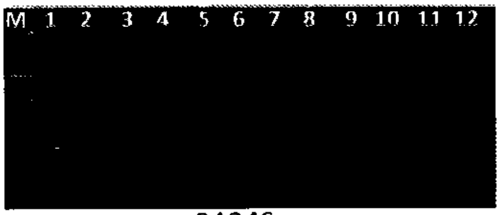
Step 1	Initial denaturation	94°C	3 min. 1X
Step 2	Denaturation	94°C	1 min.
Step 3	Annealing	Primer specific	1 min. } 35 X
Step 4	Extension	72°C	1 min.
Step 5	Final extension	72°C	8 min. 1X

Details of SSR primers showing positive amplification:

S.No.	**Locus**	**Repeat motiff**		**Primer sequence 5' - 3'**	**T_a**	**Product size (bp)**
1	R394	$(TC)_{16}$	Forward	GGAAAGTGTGGGTGTTAGTGC	59	145-165
			Reverse	TTGAGAGATGGCGAGAGAGAG		
2	RE101	$(AG)_{16}$	Forward	GACGGGAATGAGCAAGGTTG	55	210-240
			Reverse	CTTCAATTCTGCAAGCCCGA		
3	RA50	$(TC)_{16}$	Forward	ACTCCCTCCTGTCGTTCCTT	58	216-234
			Reverse	AATCGTGCATCCGTATCCTG		
4	RA346	$(TC)_9$	Forward	CGGAGCAAGCTCTCTTATCG	59	100-116
			Reverse	CCTCTCCTGTGTAGCAAGTCG		
5	RA254	$(CT)_{16}(CT)_{10}$	Forward	AGTAGCAACACCCACACACT	55	150-164
			Reverse	GGAGGGGCTGTAGTCTGATT		
6	RA267	$(GA)_{11}(AG)_{10}$	Forward	ACGGAGAAGCAGTGAGCATT	59	196-200
			Reverse	TGCACAGGAACACCCAATAA		
7	RA272A	$(CT)_8(CT)_{11}$	Forward	GCCCCGGTGACTCATAAAAT	59	188-194
			Reverse	TGGTACAAGTGGGACACGA		
8	R460	$(GA)_{13}(AG)_{12}$	Forward	CCCTACTTCTTTCATCACATACAA	59	188-196
			Reverse	CAACTCCGGTCATTTTTGGT		
9	R97	$(AG)_{10}(AG)_{13}$	Forward	AGCAGCAACAATGGTGTCC	59	188-190
			Reverse	TCTAGAAGGCCTCCCATTCC		
10	RF98	(AG)22	Forward	AATCCCATCCCCTAACTTGG	59	170-196
			Reverse	CCGTGGCTTTACCTTTCACT		
11	RA443	(AG)12	Forward	CCATGCCTGAAGCAAACAC	59	184-200
			Reverse	AGACTCCAAAGTCCTATCTGTGC		
12	R422	(AG)12(GA)13	Forward	GCGGTACTGTTCCGATCAC	55	146-172
			Reverse	TCCCAGCTCATCCACACATA		
13	R25	(AG)12(GA)11	Forward	CCAACAACCCGAGAAAAAGA	55	164-200
			Reverse	AGTGGGTTTCCGAGACAAAG		

RE101

RA50



RA346

RA254

Gel photographs showing amplification of SSR primers (RE101, RA50, RA346, RA254) at different annealing temperatures on 3% agarose gel

Disease Survey

Sample collection:

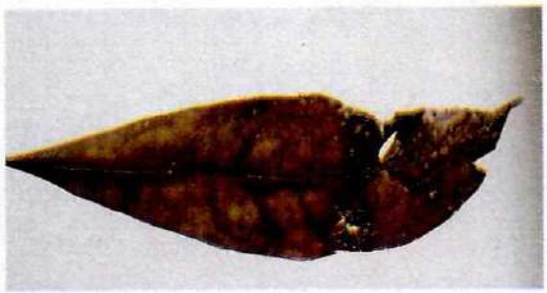
Diseased samples of *Rhododendron arboreum, Myrica esculenta, Betula utilis* and *Quercus semecarpifolia etc.* were collected from the forests around Almora, Nainital, Rudraprayag, Tehri, Chamoli and Srinagar, Uttarakhand.

Work progress:

The samples are being subjected to isolation, pure culturing and identification of associated fungal species.

Isolation of pathogen :

- Isolation of the associated fungal species is in progress from the populations of collected plant species.
- Their pure cultures are being maintained according to laboratory isolation protocol for identification.

Species	Disease occurrence	Observations
Rhododendron arboreum	Leaf spot and blight	
Myrica esculenta	Very low disease incidence	
Betula utilis	some leaf spots were found, associated saprophytic fungi	
Quercus semecarpifolia	Butt rot, heart rot	

Preparation of Eco-distribution maps:

GPS points of tree species and other related information (height, diameter, diseased samples and canopy cover) was recorded during February to June, 2017. The GPS

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coordinates were further used for eco-distribution mapping of different species. DEM (Digital Elevation Model) was used to classify five different zones to show species altitudinal distribution.

Details of species for which GPS points are recorded:

Month	Location	Species recorded
February	Uttarkashi, Uttarakhand	*Texas wallichiana,Quercus semecarpifolia , Rhododendron arboreum*
April	Pauri Garhwal, Uttarakhand	*Quercus semicarpifolia, Rhododendron arboreum , Myrica esculenta, Texas wallichiana*
May	Nainital , Almora, Kumaon, Uttarakhand	*Quercus semicarpifolia, Rhododendron arboreum , Myrica esculenta*
June	Nainital, Chamoli , Almora, Kumaon, Uttarakhand	*Quercus semicarpifolia, Rhododendron arboreum, Betula utilis, Myrica esculenta*

Short listing of 52 FGR species for eco-distribution Mapping was completed with the help of experts of the related field..

S.No .	Botanical Name	Synonyms	Local Name	Family
1.	*Abies spectabilis*	*Abies webbiana*	High level Silver Fir	Coniferae
2.	*Acer ceasium*		Kainju, Bara Kainju, Kainjal	Sapindaceae
3.	*Albizia odoratissima*		Kali Siris	Mimocaceae
4.	*Alnus nitida*		Utis, Kunis	Cupuliferae
5.	*Bauhinia semla*		Semla	Caesalpinaceae
6.	*Betula utilis*		Bhojpatra, Bhuj	Cupuliferae
7.	*Albizia julibrissin*			
8.	*Bombax ceiba*		Simal, Semal	Malvaceae
9.	*Boswellia serrata*		Salai, Salar,	Burseraceae
10.	*Buchanania lanzan*	*Buchanania latifolia*	Piyal, Kath Bhilawa	Anacardiaceae
11.	*Buxus wallichiano*		Papri, Sansadu, Chikri	Euphorbiaceae
12.	*Carallia brachiat a*	*Carallia integerrima*		Rhizophoraceae
13.	*Carpinus viminea*		Shinroi, Shangri, Chamkharik	Coryleae

14.	*Cassine glauca*	*Elaeodendran glaucum*	Dhebri, jangela, Jangel, paniala	Celastraceae
15.	*Cinnamomum tamala*		Dalchini, Gur-andra	Lauraceae
16.	*Cochlaspermum religiosum*		Gejra, Arlu	Cochlospermaceae
17.	*Cornus capitata*		Thanboi, Bhamora	Cornaceae
18.	*Corylus jacquemantii*		Bhutia Badam	Betulaceae
19.	*Dispyras mantana*	*D. montana*	Pinna	
20.	*Diploknema butyracea*	*Bassia butyracea*	Chiura, Phalwana, Phulel, Phuloa	Sapotaceae
21.	*Ficus neriifolia* var. *nemoralis*		Dudhla, Dudhoi, Parphuta	Moraceae
22.	*Flacourtia jangomas* *Fraxinus antholoodes*		Sialu, Katari, Kandhura, Phalama	Capparidaceae
23.	*Fraxinus micrantha*			
24.	*Hoveni adulcis*			Rhamnaceae
25.	*Hymeno dictyonorixense*	*Hymeno dictyonexcelsum*	Bhaulan, Kukurkat	Rubiaceae
26.	*Juglans regia*		Akhrot, Akhor, Okhar	Juglandaceae
27.	*Juniperus macropada*		Dhup, Himalayan Pencil Cidar	Coniferae
28.	*Litsaea glutinosa*		Chandna, Maida-lakri	Lauraceae
29.	*Pterocarpus marsupium*			
30.	*Machilus gamblei*			
31.	*Madhuca longifolia*	*Bassia latifolia*	Mauwa, Mahua, Mohwa	Sapotaceae
32.	*Myrica esculenta*	*Myrica nagi*	Kaiphal, Kaphal	Myricaceae
33.	*Olea cuspidata*		Kahu, Kau	Oleaceae
34.	*Oroxylum indicum*		Tarlu, Pharrai, Pharnat, Tantia	Bignoniaceae
35.	*Ougeiniao ajeinensis*	*Ougeinia dalbergiaides*	Sandan	Pipilionaceae
36.	*Pittosporum napaulense*	*Pittosparum floribundum*		Pittosporaceae
37.	*Populusciliata*		Baion, Sharphara, Tilaunju, Kapasi, Pahari Pipal	Salicaceae

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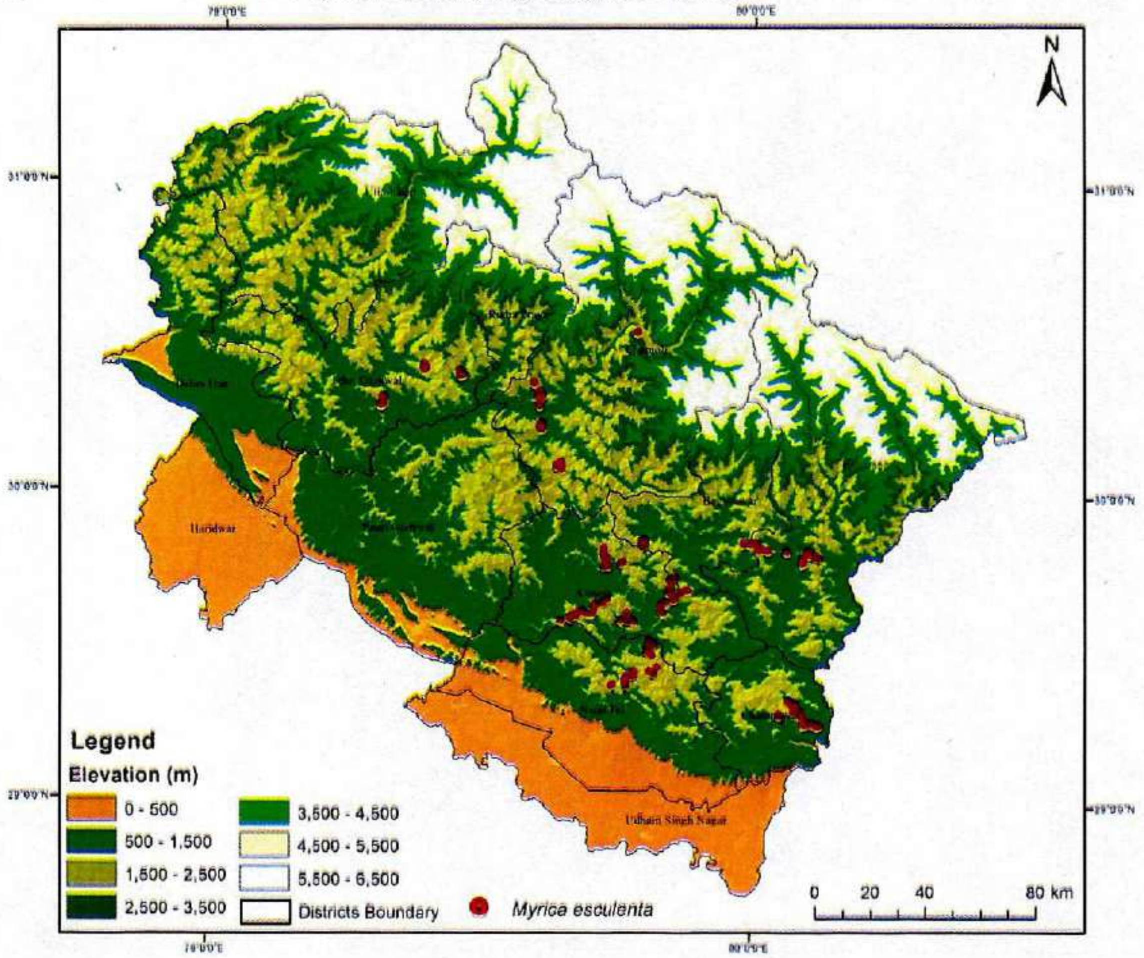
38.	*Premnalatifolia*		Bakar, Bakarcha	Verbenaceae
39.	*Prunus cerasoides*		Padam, Phaja	Rosaceae
40.	*Pterospermum acerifolium*		Mayeng, Kanakchampa	Sterculiaceae
41.	*Quercus glauca*		Phanat, Inai, Bani	Fagaceae
42.	*Quercus lanata*		Banj	Fagaceae
43.	*Quercus semicarpifolia*		Kharshu	Fagaceae
44.	*Rhododendron arboreum*		Burans	Ericaceae
45.	*Semecarpus anacardium*		Bhilawa, Marking Nut tree	Anacardiaceae
46.	*Stereospermum chelonaides*		Padal	Bignoniaceae
47.	*Taxus baccata*		Thuner, Thuniara	Coniferae
48.	*Terminalia chebula*		Har, Harr, Hararh	Combretaceae
49.	*Trema orientalis*		Jiban	Urticaceae
50.	*Tsugadumosa*		Tansen	Coniferae
51.	*Ulmus wallichiana*		Emroi, Imroi	Urticaceae
52.	*Ulmus laevigata*			
53.	*Symplocoscratae gaides*			

Population Sampling of *Myrica esculenta*



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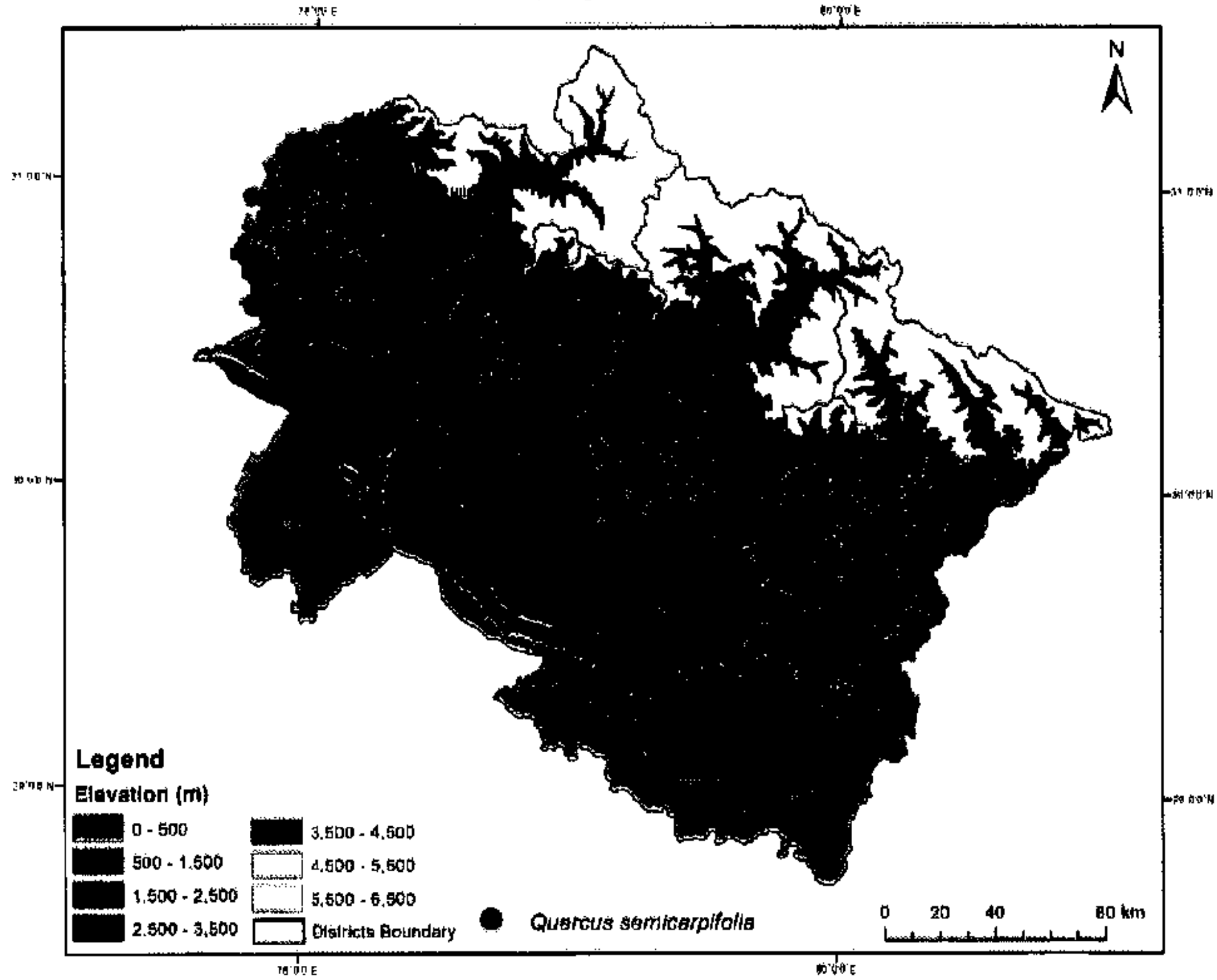
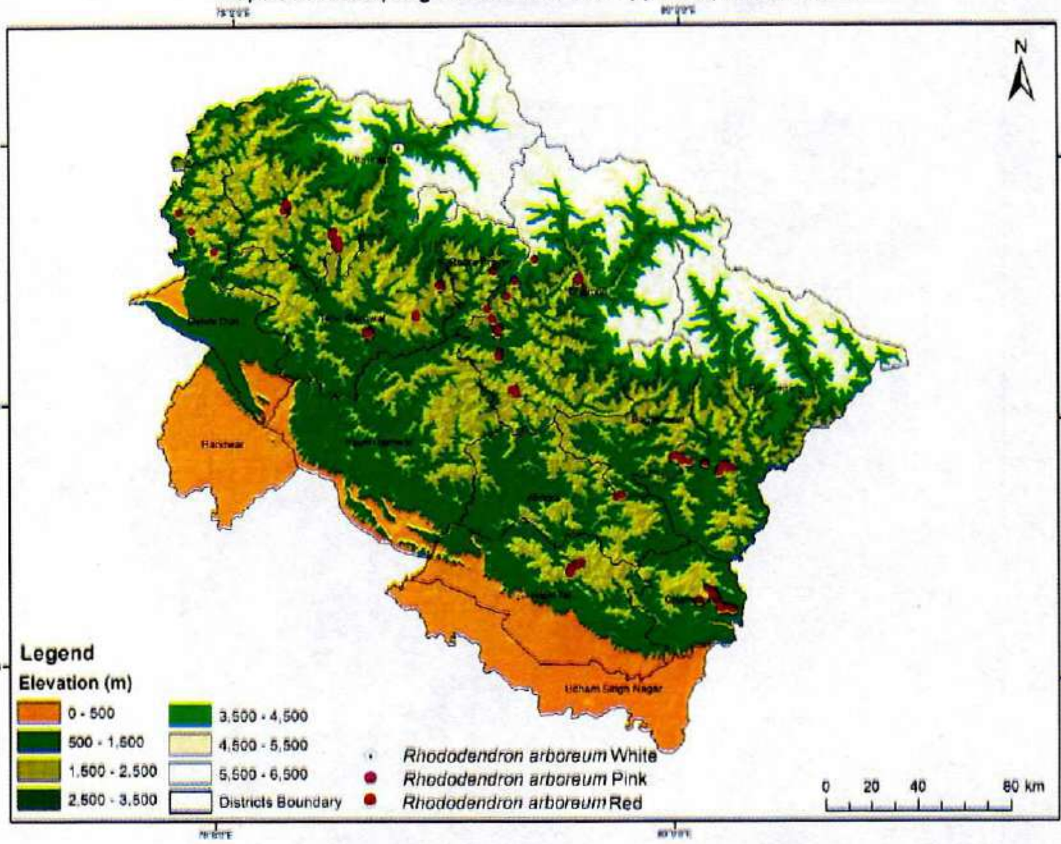
Population Sampling of *Quercus semicarpifolia*



Population Sampling ofRhododendron Spp. Pink, Red and White



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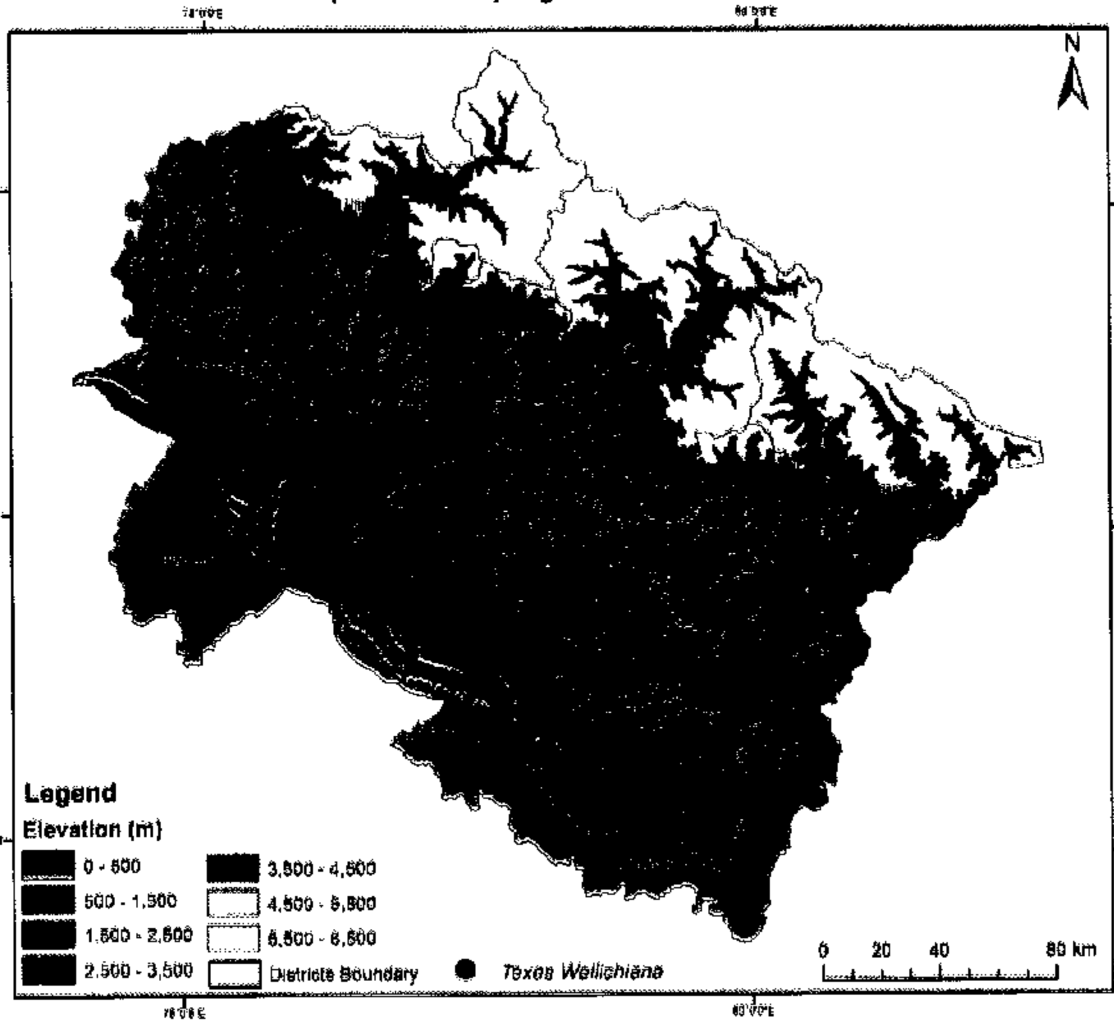
Population Sampling of *Texas wallichiana*



CHEMICAL CHARACTERIZATION

Species	Biochemical characterization	Population	TFCs (mg rutin equivalent/g extract)
Rhododendron arboreum	Total Flavonoid Content	RA15	50.64 ±1.11 to 69.45± 0.08 (mean value 59.74 ±6.34)
		RA17	63.84 ±0.11 to 85.17 ±0.44 (mean value 71.36±8.23)
		RA14	ongoing
		RA16	ongoing
		RA18	ongoing
		RA19	ongoing
		RA20	Ongoing
Species	**Biochemical characterization**	**Population**	**TPCs (mg GAE/g extract)**
Myrica esculenta	Total Phenolic Content	ME05	411.03 ±2.34
		ME06	586.84 ±0.98
		ME07	635.81±1.36
		ME08	523.72 ±0.83
Species	**Biochemical characterization**	**Population**	**TTPs**
Betula utilis	Tri-terpenoid Content	BU01	ongoing
		BU02	ongoing
		BU03	ongoing
		BU04	Ongoing
Species	**Biochemical characterization**	**Population**	**Chemical analysis**
Quercus semecarpifolia	Leaves are lyophilized and milled	QS07	ongoing
		QS08	ongoing
		QS09	ongoing
		QS010	ongoing
		QS011	ongoing
		QS012	ongoing
Texas wallichiana	Leaves are lyophilized and milled	TB05	ongoing
		TB06	ongoing
		TB07	ongoing
		TB08	ongoing
		TB09	ongoing
		TB10	Ongoing
Species	**Biochemical characterization**	**Population**	**Chemical analysis**
Diploknema butyracea	Leaves are lyophilized and milled and stored for chemical examination	DB01	-

D. FGR Conservation

Survey of the natural populations of *Taxus wallichiana, Myrica esculenta* and *Rhododendron arboreum* var red was done in different forest ranges of Uttarkashi, Pauri, Almora, Nainital and Tehri districts. Two population of *T. walichiyana*, twelve population of *M. esculenta*, and ten populations of *R. arboretum* were marked with the GPS location for FGR conservation through establishment of field gene bank. Kaddukhal

Nursery of Narendra Nagar Forest Division has also been visited for the propagation of the prioritized species.

Texas wallichiana				
TW09	Bhukki top, Uttarkashi, Uttarakhand	31^{0}50’27.00”	78^{0}39’36.09”	2773 m
TW10	Dudatauli, Pauri, Uttarakhand	30^{0}03’17.86”	79^{0}06’51.57”	2320 m
Myrica esculenta				
ME09	Peethsen, Pauri, Uttarakhand	29^{0}58’22.86”	79^{0}07’38.72”	1991 m
ME10	Pabo bazaar 2, Khirsu, Pauri, Uttarakhand	30^{0}06’52.23”	78^{0}50’17.31”	1652 m
ME11	Adwani, Pauri, Uttarakhand	30^{0}04’26.66”	78^{0}41’31.48”	1845 m
ME12	Ranikhet, Almora Uttarakhand	29^{0}37’35.50”	79^{0}21’37.63”	1675 m
ME13	Dunagiri, Almora, Uttarakhand	29^{0}47’11.66”	79^{0}28’01.71”	1869 m
ME14	Kosani, Bageshwar, Uttarakhand	29^{0}50’20.08”	79^{0}35’38.49”	1624 m
ME15	Takula, Almora, Uttarakhand	29^{0}43’56.47”	79^{0}41’52.45”	1442 m
ME16	Seetalakhet, Almora, Uttarakhand	29^{0}35’44.43”	79^{0}33’18.18”	1612 m
ME17	Bhawali, Nainital, Uttarakhand	29^{0}24’54.02”	79^{0}32’18.53”	2022 m
ME18	Mayali forest, Jhakoli range, Rudraprayag, Uttarakhand	30^{0}23’25.06”	78^{0}53’37.5”	1795 m
ME19	Hulanakhal forest, Bhilangana, Tehri, Uttarakhand	30^{0}24’57.07”	78^{0}45’54.8”	2027 m
ME20	Chandrabadni temple, Narendra nagar, Tehri, Uttarakhand	30^{0}18’34.05”	78^{0}36’58.6”	2130 m
***Rhododendron arboreum* var red**				
RA14	Chaurangi Khal, Uttarkashi, Uttarakhand	30^{0}38’10.00”	78^{0}29’14.04”	
RA15	Dudatoli, Pauri, Uttarakhand	30^{0}03’12.84”	79^{0}06’53.92”	2349 m
RA16	Peethsen, Pauri, Uttarakhand	29^{0}57’59.29”	79^{0}07’17.31”	2280 m
RA17	Chaurikhal, Chaurikhal, Uttarakhand	30^{0}01’23.97”	78^{0}59’55.97”	2227 m
RA18	Adwani, Pauri, Uttarakhand	30^{0}04’22.31”	78^{0}41’40.02”	1847 m
RA19	Dunagiri, Almora, Uttarakhand	29^{0}49’0.86”	79^{0}26’58.42”	2169 m
RA20	Binsar, Almora, Uttarakhand	29^{0}41’47.06”	79^{0}45’17.43”	2214 m
RA21	Chirbatiya, bhilangana, Tehri, Uttarakhand	30^{0}42’13.02”	78^{0}50’04.03”	2444 m
RA22	Badanital, North Jhakoli, Tehri, Uttarakhand	30^{0}29’41.02”	78^{0}56’46.05”	2443 m
RA23	Chandrabadni, Narendra Nagar, Tehri,Uttarakhand	30^{0}18’32.01”	78^{0}37’04.07”	2119 m

Cumulative Progress Report till 30th June, 2017

Background Information

Forest Genetic Resources (FGRs) constitute a very important sub-set of biodiversity Conserving FGR is vital, as they are unique and irreplaceable resources for the future. In India alone, more than 340 million people are estimated to be dependent upon the FGRs for their livelihoods. There is a definite need to address the FGR related issues through a comprehensive FGR conservation and development strategy and implementation plan.

As per present state of knowledge, 18,236 higher plant species (18,159 Angiosperms and 77 Gymnosperms) documented from India so far (*BSI, 2015: Plant Discoveries 2014*). More than 80% of this higher plant diversity is contained in the forest habitats (≈14,500 species). About half of this forest plant diversity constitutes FGRs (≈7,250 species), the remaining being herbaceous flora including soft climbers, twiners, herbs, and grasses. FGRs contain a huge potential in ensuring food and health security of the country's burgeoning human population and its livestock.

To generate understanding and knowledge on FGR, and to develop and strengthen in situ and ex situ FGR conservation programmes, the National CAMPA Advisory Council (NCAC) of Ministry of Environment and Forests & Climate Change, Govt. of India has sanctioned a project entitled "National Program for Conservation and Development of Forest Genetic Resources: Pilot Project Proposal to be implemented at FRI on Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)". The second instalment of the project 146.25 lakh was received in third week of March 2017. A brief progress of activities for the period till March 2017 as per the action plan of the project has been summarized in the following points :

Progress of Works

As per the action plan of the project, activities were initiated and following four working groups have been created in FRI to achieve the targets of the project :

i. FGR Documentation
ii. FGR Seed and Germplasm Storage
iii. FGR Characterization Cell
iv. FGR Conservation Cell

The targets under the projects have been assigned to each of the working groups on individual scientist basis which is being closely monitored by the Coordinator of the project. The contractual staff required under the project has been appointed an now is in position. All the working groups have started their activities as per the assigned action plan. The brief description of the activities so far taken up has been detailed below:

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A. **FGR documentation**

1. **Upgradation of DD Herbarium**

a) Purchase of mobile herbarium compactors:

Detailed specifications for purchase of herbarium compactors were made. The whole process of tendering was repeated three times and finally the supply order was placed. Mobile herbarium compactors have been procured and installed in the recently renovated herbarium building. With the completion of renovation work of new herbarium hall, voluminous task of transferring Dicotyledonous floral specimens was initiated since February, 2017 following the Bentham & Hooker classification. So far 20% specimens have been transferred & remaining shall be done in the subsequent quarters.

b) Renovation of herbarium building

Detailed measurement and estimation of civil and electrical work with the help of Engineering Cell was prepared. As per the expert opinion, keeping in view the load of compactors per square meter, these compactors could be installed in the herbarium section at the ground floor only with certain modifications in the present internal structure which was considered by the engineering cell. All civil work and super structural activities including flooring, false roofing, plastering and tile work, window panel fixation, and electrical work etc. has been completed. Construction of Scanning and Digitization Chambers are under process.

c) Digitization of DD Herbarium

In addition to the 114 families already entered in the database, four more families (Columelliaceae) have been entered with complete details, whereas the entry of 4 families viz. Gesneriaceae, Bignoniaceae, Pedalineae and Acanthaceae is under progress. Hence 118 families have been entered and work on 4 families is under progress. A total of 5250 high quality digital photographs captured; 5000 digital images processed to remove parallax error involved because of level of camera, improper lighting, image sharpness, contrast, wear and tear involved in old herbarium specimens etc. using Photoshop elements or other image processing applications to get the high quality images and image in two sizes viz. thumbnail image (8 KB) and large view image (~800 KB); 457 fully data based material with high quality images have been entered in to Digital Herbarium Specimen Database.

d) Shifting of Herbarium specimens:

Renovation of new Herbarium hall has been completed. Voluminous task of transferring Dicotyledonous floral specimens has been initiated since February, 2017 following the Bentham & Hooker classification. The objectives have successfully completed by 30% transfer of specimens & remaining shall be done following scheduled time duration.

2. **Documentation of FGR species**

a) **Listing and Prioritization of the FGR Species**

A list of 250 priority species (141- tree species, 29 shrubs, 15 lianas/woody climbers and 65 RET species) has been prepared. Out of which 50 species have been selected for the preparation of eco-distribution maps. Distribution of 200 species has been traced from DD herbarium, BSI herbarium and working plans. List of remaining 50 species is under progress with the consultation from expert members/working plans of the respective divisions/literary work from respective areas etc.

b) **FGR distribution records**

DD Herbarium and BSI Herbarium (Northern Circle) was consulted. Detailed information about projects species was collected. For distribution of selected FGR species, distribution record from literature has been consulted.

c) **Field Survey for distribution and regeneration**

Field survey of different districts of Uttarakhand viz. Dehradun (Narendra Nagar, Chakrata) Haridwar, Champawat, Almora, Pithoragarh, Chamoli (Kedarnath W.L.S., Valley of flowers W.L.S.), East Terai (Kishenpur, Dolly range, Surai range) and Tehri Forest Division, Nainital, Uttarkashi, Rudraprayag were carried out. Enumeration of species in strategic locations was carried out and regeneration of priority species was recorded. Field data was collected from Dehradun, Haridwar, Champawat, Almora and Pithoragarh forest divisions. Field survey for distribution of prioritized species was carried out in three forest divisions: Chamoli (Kedarnath W.L.S., Valley of flowers W.L.S.); East Terai (Kishenpur, Dolly range, Surai range) and Tehri Forest Division.

Pithoragarh (Dharchula, Didihat askot Gangolihat and Pithoragarh) and Champawat (Lohaghat and Champawat):

Abies spectabilis, Acer oblongum, Aesculus indica, Albizia chinensis, Albizia procera, Albizia lebbeck, Alnus nepalensis, Boehmeria rugulosa, Carpinus viminea, Cassia fistula, Cedrus deodara, Celtis tetrandra, Cinnamomum tamala, Cornus capitata, Diospyros montana, Diploknema butyracea, Engelhardtia colebrookiana, Erythrina suberosa, Ficus racemosa, Ficus rumphii, Ficus semicordata, Grewia optiva, Juglans regia, Litsaea monoptela, Litsaea glutinosa, Machilus odoratissima, Mangifera indica, Mitragyna parvifolia, Myrica esculenta, Oroxylum indicum, Ougeinia oojeinensis, Pinus roxburghii, Pinus wallichiana, Prunus cerasaides, Quercus floribunda, Quercus glauca, Quercus leucotrichophora, Quercus semecarpifolia, Rhododendron arboreum, Sapium insigni, Sterculia villosa, Syzygium cuminii, *Terminalia arjuna, Terminalia bellirica, Toona ciliate, Toona serrata, Ziziphus mauritiana.*

In shrub and climber layer:
Adhatoda vasica, Asparagus adscendens, Callicarpa macrophylla, Debregeasia hypoleuca, Elaeagnus latifolia, Helicteres isora, Indigofera cassioides, Catunaregam spinosa, Prinsepia utilis, Zanthoxylum armatum, Chonemorpha macrophylla, Clematis gouriana, and. *Stephania glabra*

Rare Endangered and Threatened taxa:
Brassiopsis aculeata Cinnamomum glanduliferum (Champawat Range),, *Datisca cannabina* (Near Tapowan, Dharchula),, *Indopapdenia oudhensis* (Champawat), *Macranga pustulata* (Pithoragarh range), *Sterculia colorata* (Near Dharchula), *Neolitsea pallens* (Manch), *Uncaria pilosa* (Near Jalujibi), *Cyathea spinulosa* and *Ilex pseudo-* *odorata* (Shandev), *Trachycarpus takil* (Near Thal)

Nainital [Ram Nagar Forest Division (Kaladungi, Dehchauri, Kotta and Kosi) and West Tarai Forest Division]:

Acacia nilotica ssp. *indica* (*Acacia arabica*), *Acacia catechu, Adina cordifolia, Aegle marmelos, Albizia lebbeck, Albizia procera, Alstonia scholaris, Anogeissus latifolia, Bauhinia racemosa, Bauhinia semla, Bischofia javanica, Bombax ceiba, Bridelia retusa, Buchanania lanzan, Butea monosperma, Careya arborea, Cassia fistula, Celtis tetrandra, Citrus medica, Cordia dichotoma, Crateva adansonii* ssp. *Odoraa, Dalbergia sissoo, Diospyros Montana, Emblica officinalis, Erythrina suberosa, Ficus auriculata, Ficus bengalensis, Ficus racemosa, Ficus rumphii, Ficus semicordata, Grewia optiva, Hymenodictyon orixense, Kydia calycina, Lagerstroemia parviflora, Lannea coromandelica, Litsaea glutinosa, Machilus duthiei, Madhuca longifolia, Mangifera indica, Melia azedarcach, Mitragyna parvifolia, Ougeinia oojeinensis, Pinus roxburghii, Pterospermum acerifolium, Putranjiva roxburghii, Schleichera oleosa, Semecarpus anacardium, Shorea robusta, Syzygium cuminii, Terminalia arjuna, Terminalia bellirica, Terminalia tomentosa, Toona ciliate, Ziziphus mauritiana*

In shrub and climber layer:
Adhatoda vasica, Asparagus adscendens, Callicarpa macrophylla, Catunaregam spinosa, Vitex negundo, Bauhinia vahlii, Celastrus paniculatus, Chonemorpha macrophylla, Clematis gouriana, Smilex ovalifolia, Cryptolepis buchanani

Rare Endangered and Threatened taxa:
Gardenia turgid, Heteropanax fragrans

Nainital (Nandhaur wildlife sanctuary, Nainital Forest Division, Haldwani Forest Division and Ramnagar Forest Division):

Data on distribution of species have been collected from different forest divisions of the district. Species reported from the area are:

Acer oblongum, Aesculus indica, Albizia lebbeck, Albizia pracera Acacia catechu, Adina cardifolia, Bauhinia semla, Bombax ceiba, Bauhinia racemosa Bischafia javanica Ficus racemasa, Holaptelia integrifolia, Anogeissus latifolia, Trema orientalis, Toona ciliata, Litsaea monoptela ,Mangifera indica, Putranjiva raxburghii, Ougeinia oojeinensis, Wendlandia heynei, Garuga pinnata, Shorea robusta, Terminalia tomentosa, Terminalia bellirica, Hymenodictyon orixense, Ficus rumphii, Ficus auriculata , Ficus semicordata, Olea paniculata, Lagerstroemia parviflora, Salix tetrasperma, Albizia odoratissima, Melia azedarcach, Pinus roxburghii, Bridelia retusa, Buchanania lanzan, Schleichera oleosa, Sapium insigni, Pistacia integerrima, Boehmeria rugulosa, Lannea coromandelica, Cinnamomum tamala, Machilus gamblei, Engelhardtia colebrookiana, Machilus odoratissima, Populus ciliate, Fraxinus micrantha, Quercus floribunda, Myrica esculenta, Cornus capitata, Rhododendron arboreum, Prunus cerasoides, Betula alnoides, Quercus semicarpifolia, Quercus lanata, Carpinus viminea, Abies pindrow in tree layer.

In shrub layer: *Vitex negundo, Debregeasia hypoleuca* and *Catunaregam spinosa.*
In climbers: *Bauhinia vahlii, Pueraria tuberosa, Ventilago denticulata, Cryptolepis buchanani*
Rare: *Marsdenia lucida* and *Butea pellita*

Uttarkashi (Tons Forest Division, Gobind Wildlife sanctuary):

Data on distribution of species have been collected from different forest divisions of the district. Species reported from the area are:

Abies pindrow, Acer oblongum, Aesculus indica, Albizia chinensis, Alnus nepalensis, Bauhinia semla, Betula alnoides, Carpinus viminea, Celtis australis, Celtis tetrandra, Cedrus deodara, Cornus capitata, Corylus jacquemontii, Dalbergia sissoo, Ficus auriculata, Ficus neriifolia var. *nemoralis, Ficus semicordata, Fraxinus micrantha, Grewia optiva, Hovenia dulcis, Hymenodictyon orixense, Juglans regia, Machilus duthiei, Myrica esculenta, Picea smithiana, Pinus wallichiana, Pinus roxburghii, Pistacia integerrima, Populus ciliata, Prunus cerasoides, Punica granatum, Pyrus pashia, Quercus floribunda, Quercus glauca, Quercus leucotrichophora, Rhododendron arboreum, Salix tetrasperma, Sapium insigne, Sterculia villosa, Toona ciliate, Toona serrata, Ulmus wallichiana* in tree layer;

In shrub layer: *Berberis lyceum, Elaeagnus latifolia, Picrasma quassioides, Rhus parviflora.*
In climbers: *Pueraria tuberosa.*
Chamoli (Badrinath and Niti and Mandal):

Data on distribution of species have been collected from different forest divisions of the district. Species reported from the area are:

Abies pindrow, Acer ceasium, Aesculus indica, Acer sterculiaceum , Alnus nepalensis, Prunus cornuta, Betula alnoides, Betula utilis, Buxus wallichiana, Cedrus deodara, Cupressus torulosa, Dodecadenia grandiflora, Juniperus macropoda m Juglans regia, Machilus odoratissima, Picea smithiana, Pinus wallichiana, Pinus roxburghii, Populus ciliata, Quercus leucotrichaphora, Hippophae cerasifolia, Quercus floribunda,

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Quercus semicarpifolia, Rhododendron arboreum, Taxus baccata, Toona serrata in tree layer.

In shrub layer: *Ephedra gerardiana.*
Rare: *Michelia kisopa, Fraxinus xanthoxyloides*

3. **Development of Eco-distribution maps of important FGRs**
   Mapping methodology was developed by discussions with the experts of this field. Sampling methodology was developed for collection of GPS points. The methodology was tested by carrying out field visits in the Mohand and Sukhblock of Chilllawalii Range, Rajaji National Park, Dehradun (Uttrakhand). Mapping was done and the estimation was quite similar to the FSI Forest Type Report (Satellite Image LISS III used) and working plan (methodology not known to us) for Rajaji National Park indicating the reliability and accurateness of the adopted methodology.

B. FGR seed and germplasm storage

1. **Collaboration with NBPGR, New Delhi**
   - Explored the possibility of utilizing long term storage facility of NBPGR for storage of forestry species
   - Obtained information about drying process of seeds, various storage chambers, cryopreservation cell etc.
   - As per the request of FRI, National Bureau of Plant Genetic Resources (NBPGR) New Delhi organised a training course on "Techniques for of Conservation of Plant Genetic Resources" from 27th June to 2nd July, 2016. Ten Scientists and research personnel working in various components of CoFGR-CAMPA project, participated in the training.
   - A draft MOU has been developed between FRI Dehradun and NBPGR New Delhi for utilizing the genebank space of NBPGR for the long term storage of the FGR species.

2. **Survey of populations for seed collection**
   It is intended to collect seeds of 90 important FGR species in this project for their storage and conservation. Surveys were conducted for demarcation of populations of important FGR species and availability of their seeds.

Forest Range	Species surveyed
Timli Forest Range	*Syzygium cuminii, Terminalia bellerica, Holoptelia integrifolia, Dalbergia sisoo, Albizzia procera (kalasirus)*
Ramgarh park Range/Forest Range	*Terminalia chebula, Ougenia aajensis, Aegle marmelos, Syzygium cuminii, Toona ciliata*
Lachhiwala Range	*Acacia catechu, Dalbergia sisoo*

Rajaji Tiger Reserve, Motichur	*Ougenia oojeinensis, Toona ciliate, Bombex ceiba, Terminalia chebula, Terminalia bellerica*
Kansro Forest Range, Dehradun Forest Division	*Adina cordifolia, Aegle marmelos, Albizzia procera, Holaptelia integrifolia, Lonnea grandis, Schleichera oleosa, Terminalia bellerica*
Rishikesh Forest Range, Dehradun Forest Division	*Aegle marmelos, Albizzia procera, Bombex ceiba, Haloptelia integrifolia,*
Gaula Forest Range, Haldwani Forest Division	*Albizzia odaratissima Acacia catechu*
Kishanpur Forest Range, Haldwani Forest Division	*Bombex ceiba, Lagerstroemia porviflora*
Haldwani Forest Range, Central Tarai Forest Division, Haldwani	*Adina cordifolia, Albizzia procera*
Chhakata Range, East Tarai Forest Division, Haldwani	*Acacia catechu, Adina cordifolia, Holaptelia integrifolia,*
Tanda Forest Range, Central Tarai Forest Division, Haldwani	*Acacia catechu, Garuga pinnata, Mallotus philippensis, Toona ciliata*
Pipalpadav Forest Range, Central Tarai Forest Division, Haldwani	*Acacia catechu, Bombex ceiba*
Fatehpur Forest Range, Ramnagar Forest Division	*Adina cordifolia, Aegle mormelos, Anogeissus latifolia, Bombex ceiba, Dalbergia sisoo, Holaptelia integrifolia, Desmodium oojeinensis, Schleichera oleosa, Terminalia bellerica, Toona ciliata*
Bhakhra Forest Range, Central Tarai Forest Division, Haldwani	*Aegle marmelos, Emblica officinalis*
Barhani Forest Range, Central Tarai Forest Division, Haldwani	*Acacia catechu, Aegle marmelos, Bombex ceiba, Holoptelia integrifolia, Mallotus philippensis,*
Nandhaur Forest Range, East Tarai Forest Division, Haldwani	*Acacia catechu, Adina cordifolia, Dalbergia sisao, Dioscorea bulbifera, Desmodium oojeinensis, Schleichera oleosa,*
Barakoli Forest Range, Sitarganj, East Tarai Forest Division, Haldwani	*Acacia catechu, Dalbergia sisoo, Holoptelia integrifolia, Schleichera oleosa,*
Kaladhoongi Forest Range, Ramnagar Forest Division	*Adina cordifolia, Anogeissus latifolia, Lannea grandis, Schleichera oleosa,*
Almora Forest Range, Almora Forest Division	*Myrica esculenta, Quercus leucotrichophora, Toona ciliata*
Ranikhet Forest Range, Almora Forest Division	*Myrica esculenta, Quercus leucotrichophora,*
Mandapur, Raipur Range	*Cinnamomum tamala*
Buranshkhanda, Mussoorie FD	*Buxus wallichiana*
Motichur F. Rest House	*Celtis tetrandra*
Pashimi beat, jamun Khata, Motichur TR	*Diospyros exculeata*
Kansro range, Motichur	*Schleichera oleosa*
Koyalpura, Kansro, Rajaji TR	*Careya arborea*
Kansro, Rajaji TR	*Buchanania lanzan, Albizia odoratissima*
Jamunchata,Kansro Rajaji TR	*Gmelina arborea*
Mansa devi temple, Haridwar	*Dalbergia lanceolaria*
Buranskhanda, Dhaunalti	*Fraxinus micrantha*

Shyampur Forest Range, Haridwar	*Alangium salvifolium*

3. Collection of seeds of FGRs

The team visited Radi Top area, Barkot for survey and seed collection of *Rhododendron arboreum* and Asnolgad near Foolchatti for collection of *Hippophae salicifolia* seeds.

Species	Site of seed collection
Ougenia oojensis	Rajaji Tiger Reserve, Dehradun Forest Division
Toona ciliata	Rajaji Tiger Reserve, Dehradun Forest Division, Almora Forest Range, Almora Forest Division
Aegle marmelos	Kansro Forest Range, Dehradun Forest Division, Fatehpur Forest Range, Ramnagar Forest Division,
Terminolia bellerica	Kansro Forest Range, Dehradun Forest Division,
Holoptelia integrifolia	Kansro Forest Range, Dehradun Forest Division, Timli Forest Range, Dehradun Forest Division
Desmadium oojeinensis	Rajaji Tiger Reserve, Dehradun Forest Division
Schleichera oleosa	Chilla Range, Gohri Range, Kalsi, Narendra Nagar
Fraxinus xanthoxyloides	Kailashpur, Malari Beat, Joshimath Range
Alnus nepalensis	Kiskot Village, Champawat Range
Aristolochia elegans	Jauljivi, Pithoragarh FD
Bischofia javanica	Jauljivi, Pithoragarh FD
Pyrus pashia	Narayanswami, Pithoragarh Range
	Champawat Range
Pinus wallichiana	Tanta Village, Dharchula Range
Cedrus deodara	Patal-Bhuwneswar, Gangolihaat
Carpinus vimineo	Chopta-Mandal Forest
Albizia julibrissin	Arakot, Chamba
Acacia catechu	Thano range
Dalbergia sissoo	Thano range
Leucomeris spectabilis	Kaddukhal, Mussoorie FD
Engelhardtia spicata	Dugadda, Raipur
Careya arborea	Motichur range, Rajaji TR
Gmelina arborea	Sushila Tiwari Herbal Garden, Rishikesh

4. Procurement and repair of lab equipments

E tender was floated for procurement of seed drier and incubator. Repairing of few laboratory equipments is under progress.

5. Seed extraction and processing

Seeds were extracted from the ripened fruits of all the species, cleaned and processed for further tests. Initial parameters on seed weight, seed dimensions, seed moisture content, seed germination, etc. were recorded.

6. Seed Handling

Collected seeds were pre-cleaned and the impurities, foreign materials, soil particles, twigs and leaves which are detrimental to seed viability, were removed. Purity of the seed lot was calculated.

7. Seed Drying and Storage

Seeds of *S. oleosa* were kept in storage at ambient room temperature for after-ripening. Seeds were desiccated to lower moisture levels with silica gel and stored under low temperature (5°C) in Low Temperature Storage Cabinet. Seeds were dried in cool air dryer at low temperature 15^0C and 15 percent relative humidity for slow desiccation to safe moisture levels for storage. Dried seeds of *Aristolochia elegans, Bischofia javanica, Carpinus viminea, Cedrus deodara,* Pinus *wallichiana, Pyrus pashia, Dalbergia sissoo, Acacia catechu, Albizia julibrissin, Alnus nepalensis, Engelhardtia spicata, Leucomeris spectabilis, Gmelina arbarea* and *Careya arborea* were stored in under controlled environmental condition.

8. Quarterly Viability testing of seeds

Germination test were conducted on the stored seeds of different species viz. *Desmodium oojeinensis, Toona ciliata, Aegle marmelos, Hippophae salicifolia, Rhadodendron arboreum, Holoptelia integrifolia, Acacia catechu, Albizia julibrissin, Bischofia javanica, Pyrus pashia, Pinus wallichiana* and *Aristolochia elegans.*

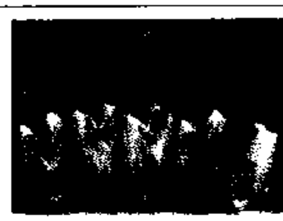
9. *In-vitro* storage of FGR species

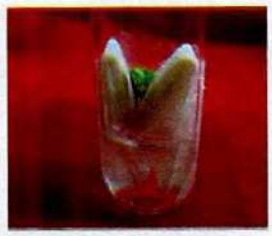
Activities planned:

- Developing protocols for in vitro storage of germplasm of FGR species of very high conservation concern and ones having recalcitrant seeds
- Developing protocols for storage of germplasm of red listed species of FGR in the form of 'pollens'
- Maintaining minimal growth cultures and embryo cultures
  Explants of *Taxus contorta* and *Rhododendron arboreum* were collected from forest near deovan (Chakrata) and area near Kaddukhal (Tehri/Musoorie) respectively and micropropagation trial initiated.

1.	***Rhododendron arboreum***	
	Mussourie and Chakrata area of Dehradun and Mazgaon (Tehri Garhwal), Uttarakhand.	
i)	**Culture Initiation from nodal explants**	
	In vitro response: Nodal segments did not show any axillary or adventitious bud break or callus formation in cultures. Bacterial and fungal contamination in cultures was a challenge in the establishment of in vitro cultures. Standardization of effective concentration of sterilants, duration of treatments and concentrations of plant growth regulator etc. is further ongoing in order to overcome the problem of microbial contaminations.	
ii)	**Culture Initiation from leaf explants:**	
	In vitro response: Callus formation was initiated in some of the cultures and these are now under multiplication and will be used to induce somatic embryogenesis or organogenesis.	
iii)	**Modifications in culture Initiation from nodal explants:** The young buds and nodal segments were separated from the stem cuttings. and treated with few drops of cetrimide for 15 minutes and further treatments were given	
	In vitro response: Due to severe fungal and bacterial contamination all the cultures were damaged and no observations could be made.	
2.	***Taxus contorta***	
	Deoban, Chakrata area of Dehradun, Uttarakhand	
i)	**Culture initiation from nodal explants:**	
	In vitro response: Explants cultured on Medium 7 (½ MS + 3% sucrose + 6.8gm/L Agar + 2.5 mg/L BAP + 100 mg/L $AgNO_3$ + 1 gm/L AC) showed best in vitro response with new buds opening up to generate new shoots. Explants cultured on Medium 3 and Medium 6 also showed some response. Further experiments will be carried out to ascertain the best medium for in vitro shoot propagation of *T. contorta*.	
ii)	**Chemical induction of adventitious root formation in stem cuttings:**	

	In vitro response: The results of the experiment will be recorded after 11 weeks.	
iii)	***In vitro* multiplication**	
	In vitro response: Yellowing of leaves was observed after 4 weeks hence the shoots were again transferred to fresh media with different combinations. Results awaited for this.	
iv)	***In vitro* growth and multiplication of calli**	
	In vitro response: Excessive release of phenolics observed in cultures within 24 hours of culture initiation. Incorporation of 0.5% PVP into the medium controlled the release of phenolics to some extent. However no in vitro axillary bud induction or callus initiation was observed in any of the treatments.	
iv)	***In vitro* embryo isolation and calli culturing**	
	In vitro response: Very few seeds had a viable embryo in them rest were already dead. Due to severe contamination no observations could be made. The experiment will be repeated if more seeds could be collected in future.	
v)	***In vitro* bud induction and shooting**	
	In vitro response: Response for bud induction could be seen in all but Media 1 (Basal ½ MS + 1 gm/L AC) Media 6 (½ MS + 2.5 mg/L BAP + 1 gm/L AC) showed best bud induction percentage. Further experiments have been planned.	
3.	***Myrica esculenta***	
	VMG in Botany Division of FRI	
i)	**Culture initiation from nodal explants**	

	In vitro response: Excessive release of phenolics observed in cultures within 24 hours of culture initiation. Incorporation of 0.5% PVP into the medium controlled the release of phenolics to some extent. However no *in vitro* axillary bud induction or callus initiation was observed in any of the treatments.	
ii)	**Culture initiation from leaf explants**	
	In vitro response:	
4.	***Quercus semecarpifolia***	
	Kanatal (Tehri Garhwal)	
i)	**Culture initiation from nodal explants**	
	In vitro response: The cultures are being observed for any in vitro bud induction.	
5.	***Quercus floribunda***	
	Kanatal (Tehri Garhwal)	
i)	**Culture initiation from nodal explants**	
	***In vitro* response:** The cultures are being observed for any *in vitro* bud induction.	
6.	***Desmodium oojeinensis***	
	Seeds were procured from Forest tree seed laboratory, Silviculture Division, FRI.	
i)	**In vitro seed germination**	
	***In vitro* response:** In all the cases predominant seed browning was observed along with slight emergence of radical which ultimately died after few days.	
	Further modifications:	
	***In vitro* response:** The seeds germinated well in both the conditions and cotyledons emerged after 5 days.	

	 ***D. oojeinensis* hypocotyls, epicotyl and cotyledonary segments cultured onto different culture media**	
	 **Somatic organogenesis from calli originated from hypocotyls of *D. Oojeinensis***	
ii)	**Culture Initiation from nodal explants**	
	Near Bambusetum, Forest Research Institute, Dehradun	
	***In vitro* response:** After a week all NaOCl treated cultures were contaminated with bacterial and fungal growth. The $HgCl_2$ set had less contamination but no bud break was observed.	
iii)	***In vitro* seed germination and culture**	
	***In vitro* response:** After 15 days, *in vitro* seed germination was observed in some of the cultures.	
iv)	**Callus Culture:**	
	calli generated from cotyledons, epicotyls and hypocotyls of *in vitro* germinated seedlings	
	The calli were cultured in MS medium with 1 mg/l BAP to prevent drying. The revived and green calli were cultured in MS medium supplemented with 1mg/l BAP and 10 mg/l AgNO3	
v)	**Subculture of *in vitro* grown micro shoots**	
	***In vitro* response:**	

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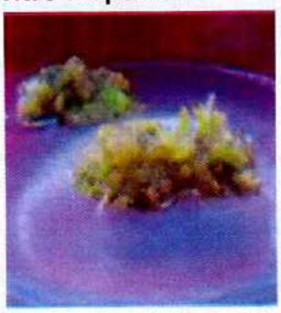
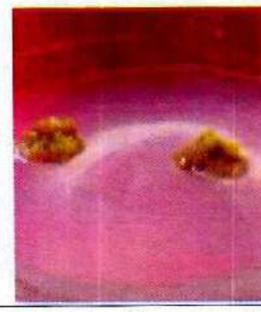
Organogenesis in callus cultures: Microshoots multiplication

vi) **Subculture of Calli:**

***In vitro* response:**


Formation of shoot initials in MS + 0.5 (mg/l) NAA+ 2.5 (mg\l) BAP


Formation of compact callus in MS + 0.5 (mg/l) TDZ+ 0.5 (mg\l) BAP


Formation of brown calli in MS + 1.0 (mg/l) TDZ+ 1.5 (mg\l) BAP



Multiplication of callus in different MS medium combinations

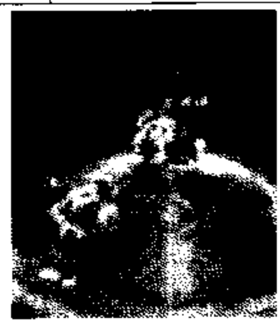
7. ***Hippophae salicifolia***

i) ***In vitro* Seed germination**

procured from seed laboratory of Forest Research Institute, Dehradun

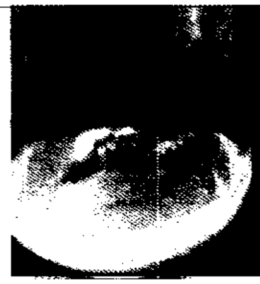
***In vitro* response:**
40 % seed germination was observed in the seeds treated with 0.1%KNO_3 whereas 89 % seed germination was observed in untreated seeds.

ii)	***In vitro* multiplication of shoots**
	***In vitro* response:** *In vitro* subcultured shoots are healthy and further experiments are planned.  *In vitro* multiplication of *H. salicifolia* shoots
iii)	***In vitro* somatic embryogenesis**
	***In vitro* response:** Experiment is ongoing and results are awaited
8.	***Acacia catechu***
	Procured from seed laboratory of Forest Research Institute, Dehradun.
i)	***In vitro* seed germination and culture**
	***In vitro* response:** 70 % seed germination was observed. 
9.	***Diploknema butyracea***
	Stem cuttings from nursery of Silviculture Division, Forest Research Institute, Dehradun.
i)	**Culture Initiation from nodal segments**
	***In vitro* response:** Due to severe fungal and bacterial growth many cultures were contaminated and no observations could be made. Browning was also predominantly present in all the cultures.
10.	***Dodecadenia grandiflora***
	The stem cuttings were brought from Dhanaulti area, Mussoorie forest division.
i)	**Induction of nodal segments**
	***In vitro* response:** The nodes were then inoculated under the laminar air flow in MS media containing 1.0(mg\l) and 2.0 (mg\l) BAP.
11.	***Diploknema butyraceae***
	The leaves were collected from the nursery of the Silviculture division of Forest Research Institute, Dehradun.
i)	**Induction of *calli* from leaves**
	***In vitro* response:**

<table>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>MS + 4.44 (μM) BAP+1.13 (μM) 2,4-D</td><td>MS Basal</td><td>MS+4.44 (μM) BAP+2.62 (μM) 2,4-D</td></tr>
<tr><td></td><td colspan="2"></td><td></td></tr>
<tr><td></td><td colspan="2">MS+4.44 (μM) BAP+3.92 (μM) 2,4-D</td><td>MS+4.44 (μM) BAP+4.53 (μM) 2,4-D</td></tr>
<tr><td>12</td><td colspan="3">Albizzia julibrisin</td></tr>
<tr><td></td><td colspan="3">Seeds procured from Seed lab in FRI were used for the experiments. The seeds were soaked in hot water 80 – 90 °C and left in the same for twenty four hours.</td></tr>
<tr><td>i)</td><td colspan="3">In vitro seed germination</td></tr>
<tr><td></td><td colspan="2">In vitro response:

Very high germination rate (80%) was observed in the seeds of A. Julibrisin.</td><td></td></tr>
<tr><td>ii)</td><td colspan="3">In vitro subculture of seedlings</td></tr>
<tr><td></td><td colspan="3">In vitro response:
The roots when subcultured showed formation of callus and this calli further regenerated into shoots. Similar results were noted with hypocotyle region where the callus formed differentiated into shoots. The shoot apex however upon subculturing grew normally with increase in plant biomass as well as rooting formation was observed in some shoots.</td></tr>
</table>

			
	Callus formation and shoot regeneration from	Callus formation and shoot regeneration from hypocotyle	Callus formation and initial shoot formation
13.	***Betula utilis***		
	The seeds were collected from Kedarnath forest division.		
i)	***In vitro* germination of seeds**		
	***In vitro* response:** The germination rate of the seeds in very low with only one to two seeds showing germination in around 50 seeds inoculated. The seeds germinated are being maintained for seedling growth. Further experiments will be planned once the biomass of the seedling has increased.		
14.	***Aristilochia punjabensis***		
	Seeds of *A. punjabensis* were procured from Seed lab, FRI.		
i)	***In vitro* and normal seed germination**		
	***In vitro* response:** No seed germination could be seen after 4-6 weeks of seed inoculation. To check the germination of seeds, some seeds were also potted in pots in the green house. The seeds in the green house germinated but the percentage was very low (40 %). Further experiments will be planned once the seedlings are big enough to extract expalnts.		
15.	***Butea pellita***		
	Stem cuttings and leaves of *Butea pellita* Syn *Meizotropis pellita* were collected from Patwadangar, Manora forest range, Waldiyakhan, Nainital		
i)	***In vitro* callus induction**		

	***In vitro* response:** After 4 weeks callus formation could be observed in the leaves. Further experiments have been planned once the calli has grown to a substantial amount.	

Pollen Stage Experiments

Preliminary studies have been initiated for pollen storage experiments.

1.	***Diploknema butyraceae***	
	Pollens from flower buds of *Diploknema butyraceae* growing in FRI campus were collected.	
	Microscopic studies:	
	The samples collected were used to observe the stage of nucleus; microscopic slides were prepared by staining the pollens in dilute acetocarmine solution and observed under light microscope under different magnifications.	
	Observations and Results: More optimization of staining protocols is however required and other stains would also be tried for the same.	
2.	***Buteo pellita* Syn *Meizotropis pellita***	
	Pollens from flower buds of growing in FRI campus were collected.	
	Microscopic and pollen studies:	
	To ascertain the viability of the pollen grains, in vitro pollen germination was also attempted by simply keeping fresh pollens in a drop of water over a microscopic slide and observing under light microscope under different magnifications. More methods of in vitro viability assessment will also be tried. Stem cuttings bearing unopened buds were also kept in growth room with their ends dipped in water, to initiate opening of buds and anther dehiscence.	
	Observations and Results: Pollen tubes of different lengths were observed clearly showing viability of the pollens. However the cuttings could not survive under these conditions and dried off with time.	

	 Floral buds of different sizes Stems bearing floral buds
	 Pollen tube growth in *B. pellita* pollens observed under light microscope(arrow heads indicate elongated pollen tube)

Training at National Bureau of Plant Genetic Resources (NBPGR)

In order to get hands-on experience about the pollen storage experiments, the techniques involved etc., scientists in NBPGR have been approached and a visit is planned for the same in the month of July 2017 itself. This will help in proper establishment of experiments in tissue culture lab at FRI.

C. FGR Characterization

MOLECULAR CHARACTERIZATION

1. Collection of samples

Extensive survey and sampling work has been initiated in Uttarakhand hills for the selected species. Samples of seven species (*Rhododendron arboreum* var red, *Rhododendron arboreum* var pink, *Texas wallichiana, Quercus semicarpifolia, Myrica esculenta, Diploknemma butyracea* and *Betula utilis*) have been collected from their natural zone of occurrence and stored at -80˚C. A total of 30-35 samples/trees were collected from each population in all the species. So far 78 populations have been sampled from Uttarakhand along with their geographical coordinates. The samples of these populations were segregated for chemical examination and DNA fingerprinting. The detail of the sampled populations is given in the following table:

Species	Population	Location
***Rhododendron orboreum* var red**	RA01	Kanchula Kharg, Chamoli, Uttarakhand
	RA02	Chopta, Chamoli, Uttarakhand
	RA03	Janglat Chowki, Chakrata, Dehradun, Uttarakhand
	RA04	Budher, Chakrata, Dehradun, Uttarakhand
	RA05	Near Nagthala, Churani, Chakrata, Dehradun, Uttarakhand
	RA06	Mohankhal, Nagnath, Kedarnath, Chamoli, Uttarakhand
	RA07	Kedarnath, Chamoli, Uttarakhand
	RA08	Dhanpur range, Kedarnath, Chamoli, Uttarakhand
	RA09	Chinapani, Champawat, Uttarakhand
	RA10	Siutal, Champawat, Uttarakhand
	RA11	Kamlake, Berinag, Pithauragarh, Uttarakhand
	RA12	Devdhula, Didihaat, Pithauragarh, Uttarakhand
	RA13	Raditop, Ranwai, Uttarkashi, Uttarakhand
	RA14	Chaurangi Khal, Uttarkashi, Uttarakhand
	RA15	Dudatoli, Pauri, Uttarakhand
	RA16	Peethsen, Pauri, Uttarakhand
	RA17	Chaurikhal, Chaurikhal, Uttarakhand
	RA18	Adwani, Pauri, Uttarakhand
	RA19	Dunagiri, Almora, Uttarakhand
	RA20	Binsar, Almora, Uttarakhand
	RA21	Chirbatiya, bhilangana, Tehri, Uttarakhand
	RA22	Badanital, North Jhakoli, Tehri, Uttarakhand
	RA23	Chandrabadni, Narendra Nagar, Tehri,Uttarakhand
***Rhododendron orboreum* var pink**	RP01	Kanchula Kharg, Chamoli, Uttarakhand
	RP02	Chopta, Chamoli, Uttarakhand
	RP03	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	RP04	Auli, Joshimath, Chamoli, Uttarakhand
Texos wollichiono	TB01	Kanchula Kharg, Chamoli, Uttarakhand
	TB02	Chopta, Chamoli, Uttarakhand
	TB03	Devban, Chakrata, Dehradun, Uttarakhand
	TB04	Bhujkoti, Chakrata, Dehradun, Uttarakhand
	TB05	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	TB06	Auli, Joshimath, Chamoli
	TB07	Harshil, Cholmi, Uttarkashi, Uttarakhand

Species	Population	Location
***Rhododendron arboreum* var red**	RA01	Kanchula Kharg, Chamoli, Uttarakhand
	RA02	Chopta, Chamoli, Uttarakhand
	RA03	Janglat Chowki, Chakrata, Dehradun, Uttarakhand
	RA04	Budher, Chakrata, Dehradun, Uttarakhand
	RA05	Near Nagthala, Churani, Chakrata, Dehradun, Uttarakhand
	RA06	Mohankhal, Nagnath, Kedarnath, Chamoli, Uttarakhand
	RA07	Kedarnath, Chamoli, Uttarakhand
	RA08	Dhanpur range, Kedarnath, Chamoli, Uttarakhand
	RA09	Chinapani, Champawat, Uttarakhand
	RA10	Siutal, Champawat, Uttarakhand
	RA11	Kamlake, Berinag, Pithauragarh, Uttarakhand
	RA12	Devdhula, Didihaat, Pithauragarh, Uttarakhand
	RA13	Raditop, Ranwai, Uttarkashi, Uttarakhand
	RA14	Chaurangi Khal, Uttarkashi, Uttarakhand
	RA15	Dudatoli, Pauri, Uttarakhand
	RA16	Peethsen, Pauri, Uttarakhand
	RA17	Chaurikhal, Chaurikhal, Uttarakhand
	RA18	Adwani, Pauri, Uttarakhand
	RA19	Dunagiri, Almora, Uttarakhand
	RA20	Binsar, Almora, Uttarakhand
	RA21	Chirbatiya, bhilangana, Tehri, Uttarakhand
	RA22	Badanital, North Jhakoli, Tehri, Uttarakhand
	RA23	Chandrabadni, Narendra Nagar, Tehri,Uttarakhand
***Rhododendron arboreum* var pink**	RP01	Kanchula Kharg, Chamoli, Uttarakhand
	RP02	Chopta, Chamoli, Uttarakhand
	RP03	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	RP04	Auli, Joshimath, Chamoli, Uttarakhand
Texas wallichiana	TB01	Kanchula Kharg, Chamoli, Uttarakhand
	TB02	Chopta, Chamoli, Uttarakhand
	TB03	Devban, Chakrata, Dehradun, Uttarakhand
	TB04	Bhujkoti, Chakrata, Dehradun, Uttarakhand
	TB05	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	TB06	Auli, Joshimath, Chamoli
	TB07	Harshil, Cholmi, Uttarkashi, Uttarakhand

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	TB08	Sukhitop, Uttarkashi, Uttarakhand
	TB09	Bhukkitop, Uttarkashi, Uttarakhand
	TB10	Dudatoli, Pauri, Uttarakhand
Quercus semicarpifalia	QS01	Kanchula Kharg, Chamoli, Uttarakhand
	QS02	Chopta, Chamoli, Uttarakhand
	QS03	Devban, Chakrata, Dehradun, Uttarakhand
	QS04	Bhujkoti, Chakrata, Dehradun, Uttarakhand
	QS05	Lokhandi, Chakrata, Dehradun, Uttarakhand
	QS06	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	QS07	Auli, Joshimath, Chamoli, Uttarakhand
	QS08	Yamunotri, Uttarkashi, Uttarakhand
	QS09	Raditop, Uttarkashi, Uttarakhand
	QS10	Chaurangi Khal, Uttarkashi, Uttarakhand
	QS11	Bhukkitop, Uttarkashi, Uttarkhand
	QS12	Dudatoli, Pauri, Uttarkhand
	QS13	Nainapeek, Uttarakhand
	QS14	Badanital, North Jhakoli, Tehir, Uttarakhand
	QS15	Bamni village, Badrinath, Chamoli, Uttarakhand
Betula utilis	BU01	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	BU02	Harshil, Cholmi, Uttarkashi, Uttarakhand
	BU03	Neeti, Chamoli, Uttarakhand
	BU04	Bamni village, Badrinath, Chamoli, Uttarakhand
Myrica esculenta	ME01	Anusuya devi temple, Hans bugyal, Chamoli, Uttarakhand
	ME02	Gairsain, Kedarnath, Uttarakhand
	ME03	Nagnath, Kedarnath, Chamoli, Uttarakhand
	ME04	Dhanpur range, Kedarnath, Chamoli, Uttarakhand
	ME05	Chinapani, Champawat, Uttarakhand
	ME06	Siutal, Champawat, Uttarakhand
	ME07	Kamlake, Berinag, Pithauragarh, Uttarakhand
	ME08	Devdhula, Didihaat, Pithauragarh, Uttarakhand
	ME09	Peethsen, Pauri, Uttarakhand
	ME10	Pabo bazaar 2, Khirsu, Pauri, Uttarakhand
	ME11	Adwani, Pauri, Uttarakhand
	ME12	Ranikhet, Almora Uttarakhand
	ME13	Dunagiri, Almora, Uttarakhand
	ME14	Kosani, Bageshwar, Uttarakhand
	ME15	Takula, Almora, Uttarakhand
	ME16	Seetalakhet, Almora, Uttarakhand

	ME17	Bhawali, Nainital, Uttarakhand
	ME18	Mayali forest, Jhakoli range, Rudraprayag, Uttarakhand
	ME19	Hulanakhal forest, Bhilangana, Tehri, Uttarakhand
	ME20	Chandrabadni temple, Narendra nagar, Tehri, Uttarakhand
Diploknemma butyracea	DB01	Lohaghat, Champawat, Singda, Uttarakhand

2. **Genomic DNA extraction**

Genomic DNA has been extracted from the following 57 populations.

Details of populations from which DNA has been extracted:

Species	DNA extraction done
Rhododendron arboreum var red	RA01, RA02, RA03, RA04, RA05, RA07, RA08, RA09, RA10, RA11, RA12, RA13, RA14, RA15, RA16, RA17, RA18, RA19, RA20, RA21, RA22, RA23
Rhododendron arboreum var pink	RP01, RP02, RP03, RP04
Texas wallichiana	TB01, TB02, TB03, TB04, TB05, TB06, TB07, TB08, TB09
Quercus semicarpifolia	QS01, QS02, QS03, QS04, QS05, QS06, QS07, QS08, QS09, QS10, QS11, QS12, QS13, QS14
Myrica esculenta	ME01, ME02, ME03, ME09, ME10, ME11, ME15
Diploknemma butyracea	DB01

3. **RNase treatment of Genomic DNA**

The genomic DNA samples with RNA contamination were given RNase treatment using 10mg/l of RNase A. The pellet was re-precipitated, dried and resuspended in TE buffer and quantified again.

4. **Qualitative and Quantitative analysis of Genomic DNA**

The concentration and absorbance ratio (A_{260}/A_{280} nm) of the DNA samples were quantified using Biophotometer (Eppendorf-6131, Germany). So far DNA quantification has been done for 51 populations. The quality of genomic DNA extracted from genotypes of all the species was analyzed on 0.8% agarose gel. Detail of populations for which DNA quantification has been done is given in the following table:

Details of populations for which DNA Quantification has been done:

Species	DNA quantification done
Rhododendron arboreum var red	RA01, RA02, RA03, RA04, RA05, RA07, RA08, RA09, RA10, RA11, RA12, RA13, RA14, RA15, RA16, RA17, RA18, RA19, RA20, RA21, RA22, RA23

Rhododendron arboreum var pink	RP01, RP02, RP03, RP04
Texas wallichiana	TB01, TB02, TB03, TB04, TB05, TB06, TB07, TB08, TB09
Quercus semicarpifolia	QS01, QS02, QS03, QS04, QS05, QS06, QS07, QS08, QS09, QS10, QS11, QS12
Myrica esculenta	ME01, ME02, ME03
Diploknemma butyracea	DB01

5. Preparation of dilutions for PCR

DNA samples were brought to a uniform concentration in a total volume of 100µlusing the following formula, $C_1V_1= C_2V_2$

6. Preparation of primer aliquots:

The aliquots of required concentration (20µM/µl) of SSR primers were prepared by re-suspending the stock in pH balanced sterile ultrapure water.

Details of SSR primers used in the study:

S.No.	Locus	Repeat motiff		Primer sequence 5' - 3'	T_a	Product size (bp)
1	R394	$(TC)_{16}$	Forward	GGAAAGTGTGGGTGTTAGTGC	59	145-165
			Reverse	TTGAGAGATGGCGAGAGAGAG		
2	RE101	$(AG)_{16}$	Forward	GACGGGAATGAGCAAGGTTG	55	210-240
			Reverse	CTTCAATTCTGCAAGCCCGA		
3	RA50	$(TC)_{16}$	Forward	ACTCCCTCCTGTCGTTCCTT	58	216-234
			Reverse	AATCGTGCATCCGTATCCTG		
4	RA346	$(TC)_9$	Forward	CGGAGCAAGCTCTCTTATCG	59	100-116
			Reverse	CCTCTCCTGTGTAGCAAGTCG		
5	RA254	$(CT)_{16}(CT)_{10}$	Forward	AGTAGCAACACCCACACACT	55	150-164
			Reverse	GGAGGGGCTGTAGTCTGATT		
6	RA267	$(GA)_{11}(AG)_{10}$	Forward	ACGGAGAAGCAGTGAGCATT	59	196-200
			Reverse	TGCACAGGAACACCCAATAA		
7	RA272A	$(CT)_8(CT)_{11}$	Forward	GCCCCGGTGACTCATAAAAT	59	188-194
			Reverse	TGGTACAAGTGGGACACGA		
8	R460	$(GA)_{13}(AG)_{12}$	Forward	CCCTACTTCTTTCATCACATACAA	59	188-196
			Reverse	CAACTCCGGTCATTTTTGGT		
9	R97	$(AG)_{10}(AG)_{13}$	Forward	AGCAGCAACAATGGTGTCC	59	188-190
			Reverse	TCTAGAAGGCCTCCCATTCC		
10	RF98	(AG)22	Forward	AATCCCATCCCCTAACTTGG	59	170-196
			Reverse	CCGTGGCTTTACCTTTCACT		
11	RA443	(AG)12	Forward	CCATGCCTGAAGCAAACAC	59	184-200
			Reverse	AGACTCCAAAGTCCTATCTGTGC		
12	R422	(AG)12(GA)13	Forward	GCGGTACTGTTCCGATCAC	55	146-172

			Reverse	TCCCAGCTCATCCACACATA		
13	R25	(AG)12(GA)11	Forward	CCAACAACCCGAGAAAAAGA	55	164-200
			Reverse	AGTGGGTTTCCGAGACAAAG		

7. Standardization of PCR amplification conditions:

Different PCR conditions and cycling parameters were tested for successful amplification of SSR markers. The concentration of various components such as primer, dNTPs, $MgCl_2$, *Taq* DNA polymerase and template DNA was optimized.

8. Standardization of annealing temperature

Annealing temperature was standardized using gradient PCR, where a range of annealing temperatures was used to get best amplification with each primer. Standardization of annealing temperature for rest of the primers is under progress.

Disease Survey

Sample collection:

Diseased samples of *Rhododendron arboreum, Myrica esculenta, Betula utilis* and *Quercus semecarpifolia etc.* were collected from the forests around Almora, Nainital, Rudraprayag, Tehri, Chamoli and Srinagar, Uttarakhand.

Work progress:

The samples are being subjected to isolation, pure culturing and identification of associated fungal species.

Isolation of pathogens :

Isolation of the associated fungal species is in progress from the populations of collected plant species. Their pure cultures are being maintained according to laboratory isolation protocol for identification.

Species	Disease occurrence	Observations
Rhododendron arboreum	Leaf spot and blight	

Myrica esculenta	Very low disease incidence	
Betula utilis	some leaf spots were found, associated saprophytic fungi	
Quercus semecarpifolia	Butt rot, heart rot	

Preparation of Eco-distribution maps:

GPS points of tree species and other related information (height, diameter, diseased samples and canopy cover) was recorded during February to June, 2017. The GPS coordinates were further used for eco-distribution mapping of different species. DEM (Digital Elevation Model) was used to classify five different zones to show species altitudinal distribution.

Details of species for which GPS points are recorded:

Month	Location	Species recorded
February	Uttarkashi, Uttarakhand	*Texas wallichiana,Quercus semecarpifolia , Rhododendron arboreum*
April	Pauri Garhwal, Uttarakhand	*Quercus semicarpifolia, Rhododendron arboreum , Myrica esculenta, Texas wallichiana*
May	Nainital , Almora, Kumaon, Uttarakhand	*Quercus semicarpifolia, Rhododendron arboreum , Myrica esculenta*
June	Nainital, Chamoli , Almora, Kumaon, Uttarakhand	*Quercus semicarpifolia, Rhododendron arboreum, Betula utilis, Myrica esculenta*

Short listing of 52 FGR species for eco-distribution Mapping was completed.

S.No.	**Botanical Name**	**Synonyms**	**Local Name**	**Family**
1.	*Abies spectabilis*	*Abies webbiana*	High level Silver Fir	Coniferae
2.	*Acer ceasium*		Kainju, Bara Kainju, Kainjal	Sapindaceae
3.	*Albizia odoratissima*		Kali Siris	Mimocaceae
4.	*Alnus nitida*		Utis, Kunis	Cupuliferae
5.	*Bauhinia semla*		Semla	Caesalpinaceae
6.	*Betula utilis*		Bhojpatra, Bhuj	Cupuliferae
7.	*Albizia julibrissin*			
8.	*Bombax ceiba*		Simal, Semal	Malvaceae
9.	*Boswellia serrata*		Salai, Salar,	Burseraceae
10.	*Buchanania lanzan*	*Buchanania latifalia*	Piyal, Kath Bhilawa	Anacardiaceae
11.	*Buxus wallichiana*		Papri, Sansadu, Chikri	Euphorbiaceae
12.	*Carallia brachiata*	*Carallia integerrima*		Rhizophoraceae
13.	*Carpinus viminea*		Shinroi, Shangri, Chamkharik	Coryleae
14.	*Cassine glauca*	*Elaeadendron glaucum*	Dhebri, jangela, Jangel, paniala	Celastraceae
15.	*Cinnamamum tamala*		Dalchini, Gur-andra	Lauraceae
16.	*Cochlospermum religiosum*		Gejra, Arlu	Cochlospermaceae
17.	*Cornus capitata*		Thanboi, Bhamora	Cornaceae
18.	*Corylus jacquemontii*		Bhutia Badam	Betulaceae
19.	*Dispyros mantana*	*D. montana*	Pinna	
20.	*Diploknema butyracea*	*Bassia butyracea*	Chiura, Phalwana, Phulel, Phuloa	Sapotaceae
21.	*Ficus neriifolia* var. *nemaralis*		Dudhla, Dudhoi, Parphuta	Moraceae
22.	*Flacourtia jangomas* *Fraxinus antholoodes*		Sialu, Katari, Kandhura, Phalama	Capparidaceae
23.	*Fraxinus micrantha*			
24.	*Hoveni adulcis*			Rhamnaceae
25.	*Hymeno dictyonorixense*	*Hymeno dictyonexcelsum*	Bhaulan, Kukurkat	Rubiaceae
26.	*Juglans regia*		Akhrot, Akhor, Okhar	Juglandaceae
27.	*Juniperus macropoda*		Dhup, Himalayan Pencil Cidar	Coniferae
28.	*Litsaea glutinosa*		Chandna, Maida-lakri	Lauraceae
29.	*Pterocarpus*			

	marsupium			
30.	*Machilus gamblei*			
31.	*Madhuca longifolia*	*Bassia latifolia*	Mauwa, Mahua, Mohwa	Sapotaceae
32.	*Myrica esculenta*	*Myrica nagi*	Kaiphal, Kaphal	Myricaceae
33.	*Olea cuspidata*		Kahu, Kau	Oleaceae
34.	*Oroxylum indicum*		Tarlu, Pharrai, Pharnat, Tantia	Bignoniaceae
35.	*Ougeiniao ojeinensis*	*Ougeinia dalbergioides*	Sandan	Pipilionaceae
36.	*Pittosporum napaulense*	*Pittosporum floribundum*		Pittosporaceae
37.	*Populusciliata*		Baion, Sharphara, Tilaunju, Kapasi, Pahari Pipal	Salicaceae
38.	*Premnalatifolia*		Bakar, Bakarcha	Verbenaceae
39.	*Prunus cerasoides*		Padam, Phaja	Rosaceae
40.	*Pterospermum acerifolium*		Mayeng, Kanakchampa	Sterculiaceae
41.	*Quercus glauca*		Phanat, Inai, Bani	Fagaceae
42.	*Quercus lanata*		Banj	Fagaceae
43.	*Quercus semicarpifolia*		Kharshu	Fagaceae
44.	*Rhododendron arboreum*		Burans	Ericaceae
45.	*Semecarpus anacardium*		Bhilawa, Marking Nut tree	Anacardiaceae
46.	*Stereospermum chelonoides*		Padal	Bignoniaceae
47.	*Taxus baccata*		Thuner, Thuniara	Coniferae
48.	*Terminalia chebula*		Har, Harr, Hararh	Combretaceae
49.	*Trema orientalis*		Jiban	Urticaceae
50.	*Tsugadumosa*		Tansen	Coniferae
51.	*Ulmus wallichiana*		Emroi, Imroi	Urticaceae
52.	*Ulmus laevigata*			
53.	*Symplocoscrataegoides*			

CHEMICAL CHARACTERIZATION

Biochemical characterization of *Rhododendron arboreum* population lines is being carried out with respect to the total flavonoid contents (TFCs), determined in their flowers using spectrophotometric method. *Myrica esculenta* population lines are being characterized with respect to the total phenolics content (TPCs), determined in their stem bark using spectrophotometric method. Further stem bark samples collected from four population lines (BU 01, BU02, BU03 and BU04) of *Betula utilis*, and leaves samples collected from six population lines (QS 07, QS 08, QS 09, QS 10, QS 11 and QS 12) of Quercus semicarpifolia were freeze dried and milled for their chemical analyses. Needle samples collected from six population lines (TB 05, TB 06, TB 07, TB 08, TB 09, and TB 10) of *Taxus wallichiana* were lyophilized and milled. Chemical analysis of these samples was initiated and continued. Leaves samples collected from one population line (DB 01) of *Diploknema butyracea* were lyophilized, milled and stored for chemical examination.

Biochemical characterization performed in different species:

Species	Biochemical characterization	Population	TFCs (mg rutin equivalent/g extract)
Rhododendron arboreum	Total Flavonoid Content	RA03	38.06 ±0.36 to 214.41± 4.04 (mean value 111.26 ±1.21)
		RA04	42.06 ±0.22 to 141.44± 1.98 (mean value 97.97 ±1.47)
		RA05	70.96 ±1.33 to 224.44 ±0.88 (mean value 128.66 ±1.35)
		RA15	50.64 ±1.11 to 69.45± 0.08 (mean value 59.74 ±6.34)
		RA17	63.84 ±0.11 to 85.17 ±0.44 (mean value 71.36±8.23)
		RA14	ongoing
		RA16	ongoing
		RA18	ongoing
		RA19	ongoing
		RA20	Ongoing
Species	**Biochemical characterization**	**Population**	**TPCs (mg GAE/g extract)**
Myrica esculenta	Total Phenolic Content	ME05	411.03 ±2.34
		ME06	586.84 ±0.98
		ME07	635.81±1.36
		ME08	523.72 ±0.83
Species	**Biochemical characterization**	**Population**	**TTPs**
Betula utilis	Tri-terpenoid Content	BU01	ongoing
		BU02	ongoing
		BU03	ongoing
		BU04	Ongoing
Species	**Biochemical characterization**	**Population**	**Chemical analysis**
Quercus semecarpifolia	Leaves are lyophilized and milled	QS07	ongoing
		QS08	ongoing
		QS09	ongoing
		QS010	ongoing
		QS011	ongoing
		QS012	ongoing
Texas wallichiana	Leaves are lyophilized and milled	TB05	ongoing
		TB06	ongoing
		TB07	ongoing

		TB08	ongoing
		TB09	ongoing
		TB10	Ongoing
Species	**Biochemical characterization**	**Population**	**Chemical analysis**
Diploknema butyracea	Leaves are lyophilized and milled and stored for chemical examination	DB01	-

D. FGR conservation

Five priority species have been short listed for FGR conservation as per the target of the project. The species are *Cinnamomum tamala, Diploknema butyracea, Rhododendron arboretum, Myrica esculanta* and *Taxus wallichiana.* The survey and review and literature through records were conducted to know distribution and status of prioritized species. Scientists have visited forest areas at Chakrata area for exploring the possibility of field gene banks. Preliminary survey of all the species selected for conservation was completed in both lower and middle Himalaya. A detailed survey of *Taxas wallichiana* and *Rhadodendron arboretum* was made in different forest ranges at (Devban, Kanasar range; Bhujkoti, Riknar range; Lokhandi village, Kanasar range of Chakrata Forest Division and some locations of Kedarnath Wildlife Sanctuary). The GPS location of the intact promising populations was recorded. Six populations of *Diploknema butyracea* have been located in Distt Pithoragarh at altitudinal range of 780 to 1290 m.

Survey of the natural populations of *Taxus wallichiana, Myrica esculenta* and *Rhododendron arboreum* var red was also completed in different forest ranges of Uttarkashi, Pauri, Almora, Nainital and Tehri districts. Two population of *T. wallichiana*, twelve population of *M. esculenta*, and ten populations of *R. arboreum* were marked with the GPS location for FGR conservation through establishment of field gene bank. Two nursery sites have been tentatively identified each in Garhwal and Kumaon Division for propagation and multiplication of FGR prioritized species. One site i.e. Kaddukhal Nursery of Narendra Nagar Forest Division is likely to be finalized very soon.

Species	Population	Location	Latitude	Longitude	Altitude
Texas wallichiana	TWCH1	Devban, Kanasar range, Chakrata	30^{0}44'52.4"	77^{0}51'58.3"	2818 m
	TWCH2	Bhujkoti, Riknar range, Chakrata	30^{0}47'14.2"	77^{0}55'24.2"	2693 m
	TWCH3	Near Hans bugyal on rudranath trekking route, Gopeshwar	30^{0}29'34"	79^{0}18'40.1	3135 m
	TWKN1	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	30^{0}27'11.5"	79^{0}14'29.9"	2577 m
	TWKN2	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	30^{0}28'51.9"	79^{0}11'52.3"	2937 m
	TWUK01	Harshil, Chholmi, Uttarkashi, Uttarakhand	31^{0}01.31.9	78^{0}44.700"	3139 m
	TWUK02	Sukhitop, Uttarkashi,	31^{0}00'9.7"	78^{0}41'42.5"	2795 m

		Uttarakhand			
	TW09	Bhukki top, Uttarkashi, Uttarakhand	31°50'27.00"	78°39'36.09"	2773 m
	TW10	Dudatauli, Pauri, Uttarakhand	30°03'17.86"	79°06'51.57"	2320 m
***Rhododendron arboreum* var Red**	CHRA-01	Janglat Chowki, Kanasar range, Chakrata	30°43'43.7"	77°51'52.5"	2363 m
	CHRA-02	Budher, Kanasar range, Chakrata	30°45'43.5"	77°47'08.8"	2442 m
	CHRA-03	Near Nagthala, River range, Chakrata,	30°35'25.1"	77°56'16.3"	2161 m
	KNRA-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	30°27'11.5"	79°14'29.9"	2577 m
	KNRA-02	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	30°28'51.9"	79°11'52.3"	2937 m
	KNRA(P)-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	30°27'11.5"	79°14'29.9"	2577 m
	KNRA(P)-02	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	30°28'51.9"	79°11'52.3"	2937 m
	GRA(P)-03	Near Hans bugyal on rudranath trekking route, Gopeshwar	30°29'34"	79°18'40.1"	3135 m
	RACW01	Siutal, Champawat, Uttarakhand	29°17'40.75"	80°11'2.10"	1769 m
	RAPG02	Kamlake, Berinag, Pithauragarh, Uttarakhand	29°50'55.70"	80°0'41.55"	1993 m
	RAPG03	Devdhula, Didihaat, Pithauragarh, Uttarakhand	29°48'59.09"	80°13'6.64"	1691 m
	RAUK04	Raditop, Ranwai, Uttarkashi, Uttarakhand	30°46'15.7"	78°15'23.3"	2233 m
	RA14	Chaurangi Khal, Uttarkashi, Uttarakhand	30°38'10.00"	78°29'14.04"	
	RA15	Dudatoli, Pauri, Uttarakhand	30°03'12.84"	79°06'53.92"	2349 m
	RA16	Peethsen, Pauri, Uttarakhand	29°57'59.29"	79°07'17.31"	2280 m
	RA17	Chaurikhal, Chaurikhal, Uttarakhand	30°01'23.97"	78°59'55.97"	2227 m
	RA18	Adwani, Pauri, Uttarakhand	30°04'22.31"	78°41'40.02"	1847 m
	RA19	Dunagiri, Almora, Uttarakhand	29°49'0.86"	79°26'58.42"	2169 m
	RA20	Binsar, Almora, Uttarakhand	29°41'47.06"	79°45'17.43"	2214 m
	RA21	Chirbatiya, bhilangana, Tehri, Uttarakhand	30°42'13.02"	78°50'04.03"	2444 m
	RA22	Badanital, North Jhakoli, Tehri, Uttarakhand	30°29'41.02"	78°56'46.05"	2443 m
	RA23	Chandrabadni, Narendra Nagar, Tehri,Uttarakhand	30°18'32.01"	78°37'04.07"	2119 m
***Rhododendron arboreum* var Pink**	KNRA(P)-01	Kanchula Kharg, Kedarnath wildlife sanctuary, Gopeshwar	30°27'11.5"	79°14'29.9"	2577 m
	KNRA(P)-02	Chopta, Kedarnath wildlife sanctuary, Gopeshwar	30°28'51.9"	79°11'52.3"	2937 m
	GRA(P)-03	Near Hans bugyal on	30°29'34"	79°18'40.1"	3135 m

		rudranath trekking route, Gopeshwar			
Myrica esculenta	MECW01	Chinapani, Champawat, Uttarakhand	29°17'25.13"	80°6'28.04"	1726 m
	MECW02	Siutal, Champawat, Uttarakhand	29°17'40.70"	80°11'2.24"	1766 m
	MEPG03	Kamlake, Berinag, Pithauragarh, Uttarakhand	29°50'53.04"	80°0'22.68"	2001 m
	MEPG04	Devdhula, Didihaat, Pithauragarh, Uttarakhand	29°48'58.73"	80°13'5.37"	1695 m
	ME09	Peethsen, Pauri, Uttarakhand	29^{0}58'22.86"	79^{0}07'38.72"	1991 m
	ME10	Pabo bazaar 2, Khirsu, Pauri, Uttarakhand	30^{0}06'52.23"	78^{0}50'17.31"	1652 m
	ME11	Adwani, Pauri, Uttarakhand	30^{0}04'26.66"	78^{0}41'31.48"	1845 m
	ME12	Ranikhet, Almora Uttarakhand	29^{0}37'35.50"	79^{0}21'37.63"	1675 m
	ME13	Dunagiri, Almora, Uttarakhand	29^{0}47'11.66"	79^{0}28'01.71"	1869 m
	ME14	Kosani, Bageshwar, Uttarakhand	29^{0}50'20.08"	79^{0}35'38.49"	1624 m
	ME15	Takula, Almora, Uttarakhand	29^{0}43'56.47"	79^{0}41'52.45"	1442 m
	ME16	Seetalakhet, Almora, Uttarakhand	29^{0}35'44.43"	79^{0}33'18.18"	1612 m
	ME17	Bhawali, Nainital, Uttarakhand	29^{0}24'54.02"	79^{0}32'18.53"	2022 m
	ME18	Mayali forest, Jhakoli range, Rudraprayag, Uttarakhand	30^{0}23'25.06"	78^{0}53'37.5"	1795 m
	ME19	Hulanakhal forest, Bhilangana, Tehri, Uttarakhand	30^{0}24'57.07"	78^{0}45'54.8"	2027 m
	ME20	Chandrabadni temple, Narendra nagar, Tehri, Uttarakhand	30^{0}18'34.05"	78^{0}36'58.6"	2130 m

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Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority

Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in IA No.1337 with IA Nos.827, 1122, 1216, 1473 in WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003

Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 18th August 2017.**

The Country Representative – India,
IUCN India Country Office,
C.10 Gulmohar Park, **New Delhi 110 049.**

Sub.: **CAMPA/ NCAC – Assistance to IUCN – Developing a tool kit for Restoration of Mining Sites in India.**

Sir,

Please refer to your letter dated the 16th May 2017 on the subject mentioned above, addressed to Shri Rajagopal Prashant, then Asstt Inspector Genreal of Forests, Ministry of Environment Forest and Climate Change, Government of India.

2. As you are aware, the IUCN Team led by you had made a presentation before the Director General of Forests & Special Secretary to the Government of India on 17th May 2017, when certain suggestions for improvement in the Tool Kit for Restoration of Mining Sites in India. It will be appropriate that the suggestions made in the above Presentation are incorporated in the Tool Kit, a revised draft form of which may please be presented early. The question of refunding the balance amount etc could be considered taking into account the position that emerges once this requirement is finalised.

3. As the Project has overrun its original schedule, this may kindly be treated as Immediate.

Yours faithfully,

(Naresh Kumar)
Deputy Inspector General of Forests
Tel No. 24695389

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Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 18th August 2017.**

Note.

Sub.: **CAMPA/ NCAC – Assistance for Pilot Project : "Centre of Excellence on Forest Genetic Resources" at FRI, Dehradun.**

Reference is invited to Ministry of Environment Forest and Climate Change Office Memorandum No.17-15/2015-RT dated the 29th May 2017 on the subject mentioned above informing, in the context of the Quarterly Progress Reports on the subject Project, as received from the FRI, Dehradun; that "the achievements are field related, so comments of the RT Division is infructuous".

2. The matter has been placed before the Director General of Forests & Special Secretary to the Government of India/ Chairman, Ad-hoc CAMPA, who has approved that as the subject matter Division concerned with the Project, the RT Division are expected to forward substantial inputs on the progress of the Project vis-à-vis the avowed objectives, and in that context, the suggestions for mid course corrections/ interventions, etc.

3. A copy of the Quarterly Progress Report in respect of the subject Project for the period ending June 2017, received from the Director, FRI, ICFRE, Dehradun vide letter No.9-108/DGTP-CoFGR/FRI.2016 dated the 4th August 2017 is enclosed.

4. It is requested that comments on the progress of the Project, as mentioned in paragraph 2 above may kindly be expedited. This may be treated as Urgent, as the FRI Dehradun have requested for urgent release of further instalments and the request in this behalf will be considered only upon receipt of the inputs from the RT Division, MoEF&CC.

(Naresh Kumar)
Deputy Inspector General of Forests
Tel No. 24695389

To

Deputy Inspector General of Forests (RT)
(Dr Suneesh Buxy)
Ministry of Environment Forest & Climate Change.

Encl.: a.a.

Copy for information to The Director, Forest Research Institute, Indian Council of Forestry Research and Education, P.O.New Forest, **Dehradun 248006**, with reference to letter No.9-108/DGTP-CoFGR/FRI.2016 dated the 4th August, 2017.

(Naresh Kumar)
Deputy Inspector General of Forests
Tel No. 24695389

(95)

Dr. Suneesh Buxy, IFS
Dy. Inspector General of Forests (RT)
E-mail – digfrt-mef@nic.in
Tel :- 011-24695233

Government of India
Ministry of Environment, Forest & Climate Change
Agni Wing, 3rd Floor, Indira Paryavaran Bhawan, Jor Bagh Road, New Delhi – 110003

F. No. 17-15/2015-RT **Dated: 24.08.2017**

OFFICE MEMORANDUM

Sub: CAMPA/NCAC- Assistance for the Pilot Project "Centre of Excellence of Forest Genetic Resources" at FRI Dehradun –reg.

Please refer to your note no. 13-17/2012-CAMPA dated 18.08.2017 on the subject mentioned above. In this context, this is to inform you that the achievements are field related so comments of RT Division are infructuous as already communicated vide O.M's dated 02.03.2017& 29.05.2017.

2. This is for your kind information and further necessary action please.

24.8.17

(Dr. Suneesh Buxy)
Dy. Inspector General of Forests (RT)

1323/campa-117
29/08/2017

To:-

Shri Naresh Kumar, DIGF (FC),
MoEF&CC, New Delhi

OSD

29/8

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Compensatory Afforestat[illegible] ent and Planning Authority
Constituted by the Hon'ble S[illegible] a, by Order dated 5th May 2006 in
IA No.1337 with IA Nos.827, 1122, 1216, 1473 in
WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 17th November 2017.**

The Manager Incharge,
Corporation Bank, Lodhi Complex Branch,
Ground Floor, Block No.11, CGO Complex,
Lodi Road, **New Delhi 110 003.**

Sub.: **CAMPA / NCAC – assistance to Centre of Excellence on Forest Genetic Resources at FRI Dehradun.**

Sir,

This is to request that :

(1) an amount of Rs.2,45,00,000.00 (Rs Two crore and forty five lakhs only) may kindly be transferred immediately from SB/ Flexi A/c No.037100301120068 in your Bank in the name of Compensatory Afforestation Fund Main Account, to SB A/c No037100101024054 in the name of National CAMPA Advisory Council, in your Bank ;
(2) an amount of Rs.2,45,00,000.00 (Rs Two crore and forty five lakhs only) may kindly be transferred from SB A/c No.037100101024054 in the name of National CAMPA Advisory Council in your Bank, to Account No.496902010088596 in the name of Director, FRI in Union Bank of India, FRI Dehradun [IFSC Code UBIN0549690, MICR Code 248026003).

Yours faithfully,

(D K Sinha)
Inspector General of Forests,
Chief Executive Officer, Ad-hoc CAMPA
Member Secretary National CAMPA Advisory Council

Copy to The Director, Forest Research Institute, Dehradun, with reference to her letter No.9-108/DGTP-CoFGR/FRI2016 dated the 4th August 2017.

2. The releases follow the deliberations in the meeting taken by the DGF&SS/ Chairman, Ad-hoc CAMPA on 07 11 2017. It is requested that Progress Reports may kindly be sent to this Office regularly.

(D K Sinha)
Inspector General of Forests,
Chief Executive Officer, Ad-hoc CAMPA
Member Secretary National CAMPA Advisory Council

Copy to Deputy Inspector General of Forests (RAT), Ministry of Environment Forests & Climate Change, IPB, New Delhi 110003.

(D K Sinha)
Inspector General of Forests,
Chief Executive Officer, Ad-hoc CAMPA
Member Secretary National CAMPA Advisory Council

95

Ad-hoc

Compensatory Afforestation Fund Management and Planning Authority

Constituted by the Hon'ble Supreme Court of India, by Order dated 5th May 2006 in IA No.1337 with IA Nos.827, 1122, 1216, 1473 in WP (Civil) No.202 of 1995 : T N Godavarman Thirumalpad Vs Union of India & Ors.

4th floor, Block No.3, CGO Complex, New Delhi – 110 003
Tel No.(011) 24368006. FAX No.(011) 24368007. E-mail : adhoc-campa-mef@nic.in

No.13-17/2012-CAMPA **Dated the 17th November 2017.**

The Country Representative – India,
IUCN India Country Office,
C.10 Gulmohar Park, **New Delohi 110049.**

Sub.: **CAMPA/ NCAC – Assistance to IUCN – Developing Tool Kit for restoration of mining sites in India.**

Sir,

In referring to the deliberations in the meeting taken by the Director General of Forests & Special Secretary/ Chairman, Ad-hoc CAMPA in his Office in New Delhi on Tuesday, the 7th November 2017, this is to request that :

(1) 50 copies of the subject document may kindly be provided to this Office, for the needful;

(2) Balance of unspent amounts, if any, together with interested may kindly be transferred to A/c No.037100101024054 maintained in the name of National CAMPA Advisory Council in the Corporation Bank of India, Lodhi Complex Branch, Ground Floor, Block No.11, CGO Complex Phase I, Lodi Road, New Delhi 110001 immediately, under intimation to the undersigned.

Yours faithfully,

(D K Sinha)
Inspector General of Forests (FC),
Ministry of Env Forest & CC, Govt of India,
Chief Executive Officer, Ad-hoc CAMPA,
Member Secretary, National CAMPA Advisory Council.

दूरभाष/Phones :
कार्यालय/Offi. : 0135-2755277
0135-2224444
निवास/Resi. : 0135-2751679
0135-2224513
फैक्स/FAX : 91-0135-2756865
E-mail : dir_fri@icfre.org

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डॉ० सविता, भा.व.से.
निदेशक व.अ.सं.
एवं
कुलपति व.अ.सं. सम विश्वविद्यालय
Dr. SAVITA, IFS
Director FRI
and
Vice-Chancellor FRI Deemed University

वन अनुसंधान संस्थान
(भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद्)
(पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार की एक स्वायत्त परिषद्)
डाकघर न्यू फॉरेस्ट, देहरादून—248006
FOREST RESEARCH INSTITUTE
(Indian Council of Forestry Research and Education)
(An autonomous body of Ministry of Environment, Forests & Climate Change Govt. of India)
P.O. New Forest, Dehra Dun—248006

अ०शा०सं० D.O.No 9-108/DGTP-CoFGR/FRI 2016

दिनांक Dated, the Date 17-11-2017

To,

The Inspector General of Forests /
Chief Executive Officer (CEO), Ad-hoc CAMPA
Ministry of Environment, Forest and Climate Change
Indira Paryavaran Bhavan
Jorbagh Road
New Delhi - 110 003

Kind attention: Shri Rajagopal Prashant, AIG (FC)

1955/CAMPA/17
29/11/17

E 135023
Date 24.11.2017

Sub : Adhoc CAMPA project - National Program for Conservation and Development of Forest Genetic Resources: Pilot Project "Centre of Excellence on Forest Genetic Resources" at FRI, Dehradun –Progress Report reg.

Sir,

Kindly find enclosed herewith two copies of the Progress Report on the subject cited project, for the quarter ending September 2017. You are further requested to kindly release the second year's budget as per the project outlay at the earliest as many of the activities and procurements are under process.

Kind regards,

Yours faithfully
17/11/2017
(Dr. Savita)
Director

Encl. As above

23/11

DIG (ME)
OSD CAMPA
24/11

National Program for
Conservation and Development of Forest Genetic Resources

Pilot Project
(Implemented at FRI, Dehradun)

On

Creation of Centre of Excellence on Forest Genetic Resources (FGR) of India (CoFGR)

Funded under
Adhoc CAMPA Fund
Ministry of Environment, Forest & Climate Change
(2016-2020)

Progress Report
(July-September 2017)

Submitted by

Forest Research Institute (FRI),
New Forest P.O., Dehradun 248 006

9/7

PROJECT SUMMARY

Title of the Project:	National Program for Conservation and Development of Forest Genetic Resources: Pilot on 'Creation of Centre of Excellence on Forest Genetic Resources (CoFGR)'at FRI Dehradun
Funding Agency:	Adhoc CAMPA Fund Ministry of Environment, Forest & Climate Change, Govt. of India
Project Outlay:	Rs. 861.20 lakhs (January 2016 – 31 December 2020)
Project Period:	5 years
Grants released:	1st installment - 146.25 lakhs
	2nd installment - 146.25 lakhs
Date of release:	1st installment on 21st January 2016
	2nd installment on 22th March 2017
Project Executing Authority:	Director Forest Research Institute, Dehradun
Period of present progress report:	Quarterly report (July 2017- September 2017)
	Cumulative progress up to 30th September 2017

Progress report (July 2017-Sept 2017)

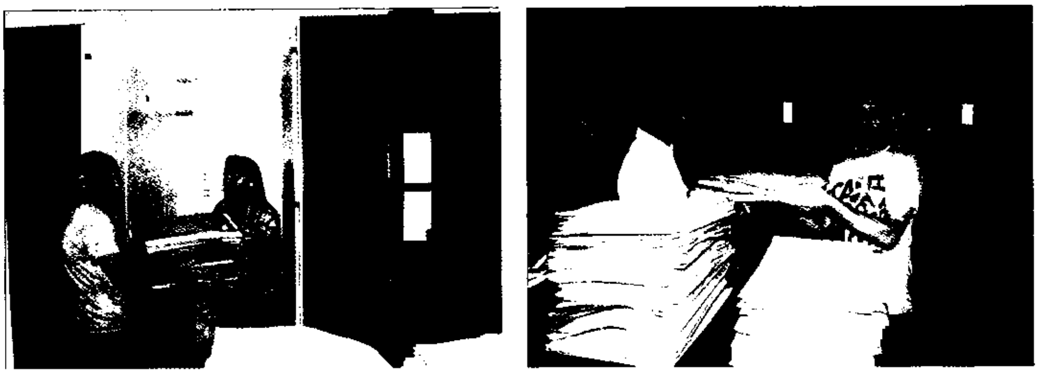
A brief progress of activities for the period of **July 2017 –Sept 2017** as per the action plan of the project has been summarized in the following points:

A. FGR Documentation

1. Upgradation and Digitization of DD Herbarium:-

a) Shifting of Herbarium specimens

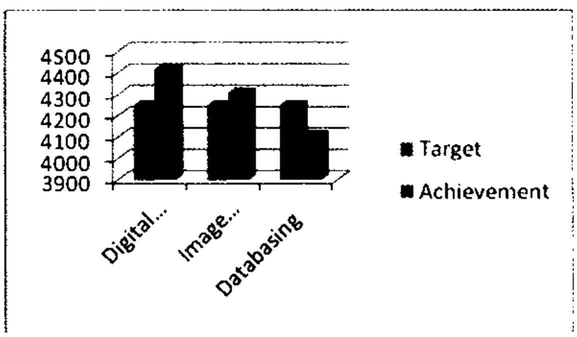
Renovation of new Herbarium hall has been completed. Voluminous task of transferring Dicotyledonous floral specimens has been successfully completed by 30% transfer of specimens.



Relocation of Herbarium specimens following Bentham & Hooker's System of Classification

b) Digitization of DD Herbarium:

The targeted specimens to be digitized under current quarter are **4250** specimens. A total of **4416** high quality digital photographs have been captured; **4308** digital images have been processed and **4106** fully data based specimens with high quality images have ben entered in to *Digital Herbarium Specimen Database* http://10.1.250.237/hadmin/harbarium.php (currently available at FRI intranet).



Growth of the DD dataset under current quarter (April to June, 2017)

4.7.1

II. Documentation of FGR species

a) FGR distribution records

The information related to the distribution of FGR species have been extracted from literature. The documents consulted for this purpose were FRI herbarium, BSI herbarium and working plans.

b) Field Survey for distribution

Field surveys have been conducted in different districts of Uttarakhand viz. Bagehwar, Chamoli, Dehradun, Pithoragarh to collect field data of several FGR species.

Chakrata Forest Division
Tree Layer: *Pinus roxburghii, Alnus nitida, Quercus leucotrichaphara, Pinus raxburghii, Albizia chinensis, Albizia chinensis Pyrus pashia, Lannea caromadelica, Buxus wallichiana, Pistacia integerrima Celtis tetandra Celtis australis Cedrus deodara Quercus floribunda, Cornus macrophylla, Cornus capitata, Mahania jausarensis, Papulus ciliata, Carnus oblonga, Juglan regia,* **RET:** *Mahonia jausarensis,*
Chamoli (Badrinath Forest Division, Joshimath Forest Division including valley of flowers)
Tree Layer: *ablangum, Aesculus indica, Pinus wallichiana, Abies spectabilis, Acer caesium, Acer sterculiaceum, Albizza julibrissin, Alnus nepalensis, Bauhinia purpurea, Betula alnoides, Betula utilis, Carpinus viminea, Cedrus deodara, Corylus jacquemontii, Daphniphyllum himalayense, Picea smithiana, Prunus cornuta Rhododendron arbareum Taxus baccata Taona serrata Berberis chitria, Hippaphae cerasifalia, Picrasma quassioides, Pyrus pashia, Albizia chinensis, Celtis tetrandra, Ulmus wallichiana, Papulus ciliata* **Shrub Layer:** *Berberis asiatica, B.lycium, Prinsepia utilis*
Bageshwar Forest Division (Bageswar Range, Kapkot Range, Glacier range, Dharampur Range):
Tree Layer: *Carnus capitata , Grewia optiva, Albizia chinensis, Albizia pracera, Bauhinia purpurea, Bauhinia semla, Betula alnoides, Alnus nepalensis, Baehmeria*

rugulosa, Bombax ceiba, Carpinus viminea, Celtis australis, Ficus auriculata, Emblica officinalis, Ficus neriifolia var. *nemoralis, Ficus semicordata, Juglans regia, Pinus roxburghii, Pittosporum napaulense, Daphniphyllum himalayense, Berberis chitria, Quercus lanata, Quercus leucotrichophora, Quercus semicarpifolia Sapium insigni, Ougeinia oojeinensis, Machilus gamblei, Morus alba, Engelhardtia colebrookiana, Buxus wallichiana, Syzygium cuminii, Melia azedarcach, Cinnamomum tamala, Dalbergia sissoo, Diploknema butyracea, Myrica esculenta, Pistacia integerrima, Fraxinus micrantha, Taxus baccata, Machilus odoratissima,* **Shrub Layer:** *Vitex negundo, Zanthoxylum armatum,* **Climber Layer:** *Cryptolepis buchanani, Stephania glabra, Aristolochia dilatata* **RET:** *Marsdenia lucida*
Almora Forest Division (Binsar Wildlife sanctuary, Chakodi Rane):
Albizia julibrissin, Aesculus indica, Acer oblongum, Acer caesium, Acer acuminatum Cedrus deodara, Quercus glauca, Quercus leucotrichophora Ficus auriculata, Ficus neriifolia var. *nemoralis, Populus ciliata, Toona serrata, Albizza julibrissin, Carpinus viminea, Cornus macrophylla, Cornus capitata, Machilus duthiei, Prunus carnuta, Daphniphyllum himalayense, Cinnamomum tamala, Diploknema butyracea, Syzygium cumini, Mangifera indica, Hymenodictyon excelsum, Pistacia integerrima, Prunus cerasoides.*
Nainital: Ramnagar Forest Division (Mohan Range)
Tree Layer: *Cassia fistula, Holaptelia integrifolia, Sapium insigne, Adina cordifolia, Schleichera oleosa, Daphniphyllum himalayense, Lagerstraemia parviflora, Haloptelia integrifolia, Terminalia tomentosa, Careya arborea, Semecarpus anacardium, Anogeissus latifolia, Shorea robusta, Terminalia bellirica, Syzygium cuminii, Ficus bengalensis, Ficus auriculata* **Shrub Layer:** *Adhatoda vasica Asparagus adscendens, Randia dumetorum* **Climber Layer:** *Bauhinia vahlii, Celastrus paniculatus, Cryptolepis buchanani*
Pithoragarh Forest Division (Munsiyari range, Thal Range):
Tree Layer: *Abies pindrow, Acer ceasium, Acer oblongum, Fraxinus micrantha, Acer acuminatum, Aesculus indica, Albizia chinensis, Neolitsea umbrosa Alnus*

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nepalensis, Betula utilis, Buxus wallichiana, Carpinus viminea, Cedrus deodara, Celtis tetrandra, Cupressus torulosa, Engelhardtia colebrookiana, Ficus nervosa Ficus semicordata, Machilus odoratissima, Myrica esculenta, Pinus roxburghii, Prunus cerasoides, Quercus floribunda, Quercus glauca, Quercus leucotrichophora, Quercus semicarpifolia, Rhododendron arboretum, Daphniphyllum himalayense, Toricellia tiliifolia

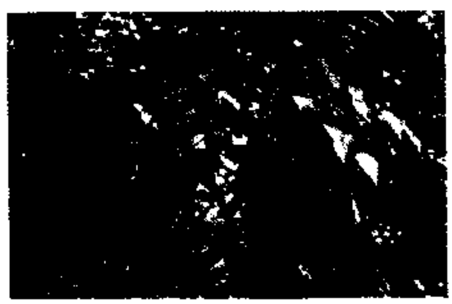
Shrub Layer: *Uraria acumina*

RET: *Trachycarpus takil, Dodecadenia grandiflora*

Kathiyan (Chakrata Forest Division)

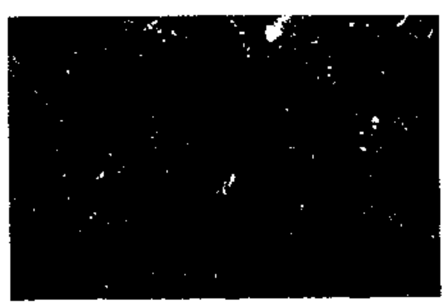
Alnus nitida

Spruce Forest (*Picea smithiana*) on the way to valley of flowers



***Picrasma quassioides* at Gobindghat**

***Marsdenia lucida* (Liti, Bageshwar)**



***Pittosporum nepalense* (Kapkot Bageshwar)**

960

Ficus nervosa

Dodecadenia

Preparation of Eco-distribution maps:

50 FGR species were finalised in this quarter. Observations were taken on parameters such as spatial parameters (altitude, latitude and longitude); morphological parameters such as DBH, canopy cover, plant height, disease and insect-pest incidence; physical parameters like aspect and slope and other related information during months from July to September 2017. Geo-coordinates of tree species were further used for eco-distribution mapping. DEM (Digital Elevation Model) was used to classify seven different altitude zones in Uttarakhand to show species altitudinal gradient.

Details of species for which GPS points are recorded:

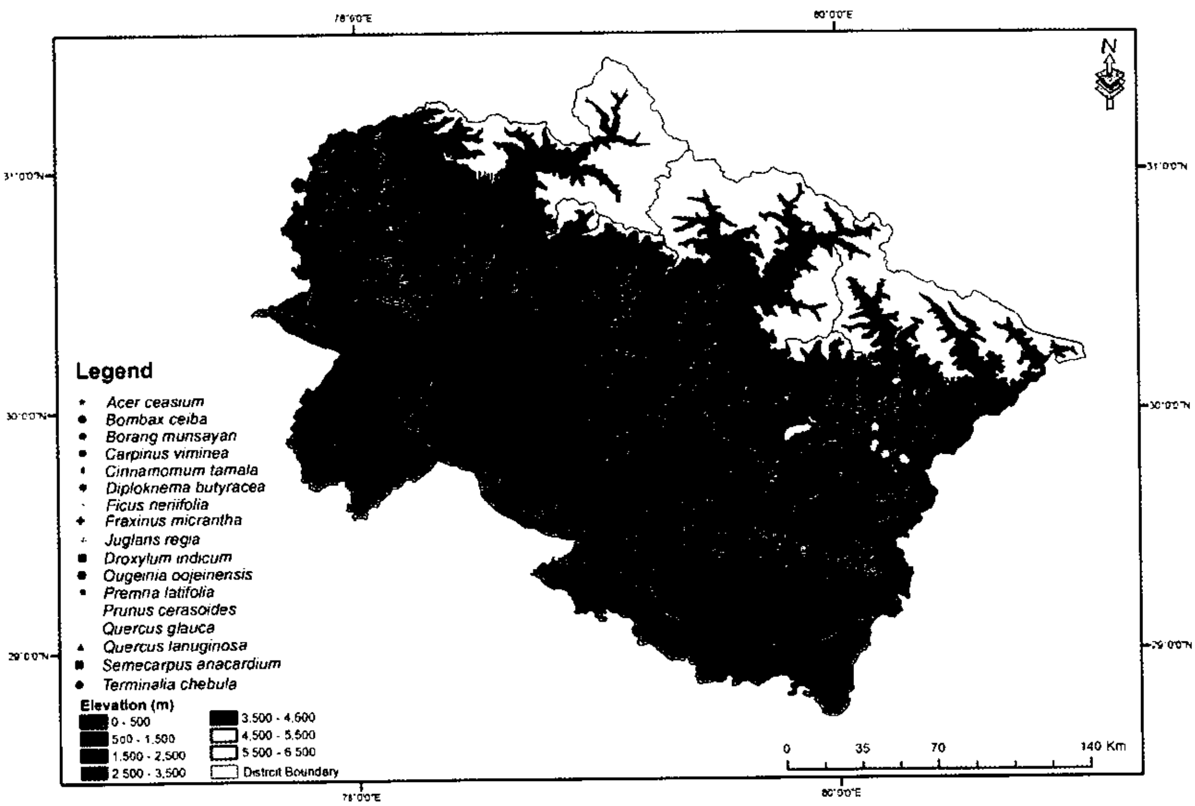
Month	Location	Species recorded
August	Munsyari (Pithoragarh), Uttarakhand	*Betula utilis, Quercus semecarpifolia* and *Rododendronarboreum*
September	Pauri Garhwal, Tehri and Dehradun,Uttarakhand	*Quercus semicarpifolia, Rhododendron arboreum, Myricaesculenta and Texas wallichiana*

Out of 50 FGRs, the data of 17 species was collected from Kumaun Himalayas.

S.No.	Botanical Name	Synonyms	Local Name	Family
1.	*Acer ceasium*		Kainju, Bara Kainju,	Sapindaceae
2.	*Bombax ceiba*	*Bombax malabaricum*	Simal, Semal	Malvaceae
3.	*Carpinusviminea*		Chamkharik	Coryleae
4.	*Cinnamomumtamala*		Dalchini, Gur-andra	Lauraceae
5.	*Diploknemabutyracea*	*Bassiabutyracea*	Chiura, Phalwana, Phulel, Phuloa	Sapotaceae
6.	*Ficusneriifoliavar.nemoralis*		Dudhla, Dudhoi, Parphuta	Moraceae

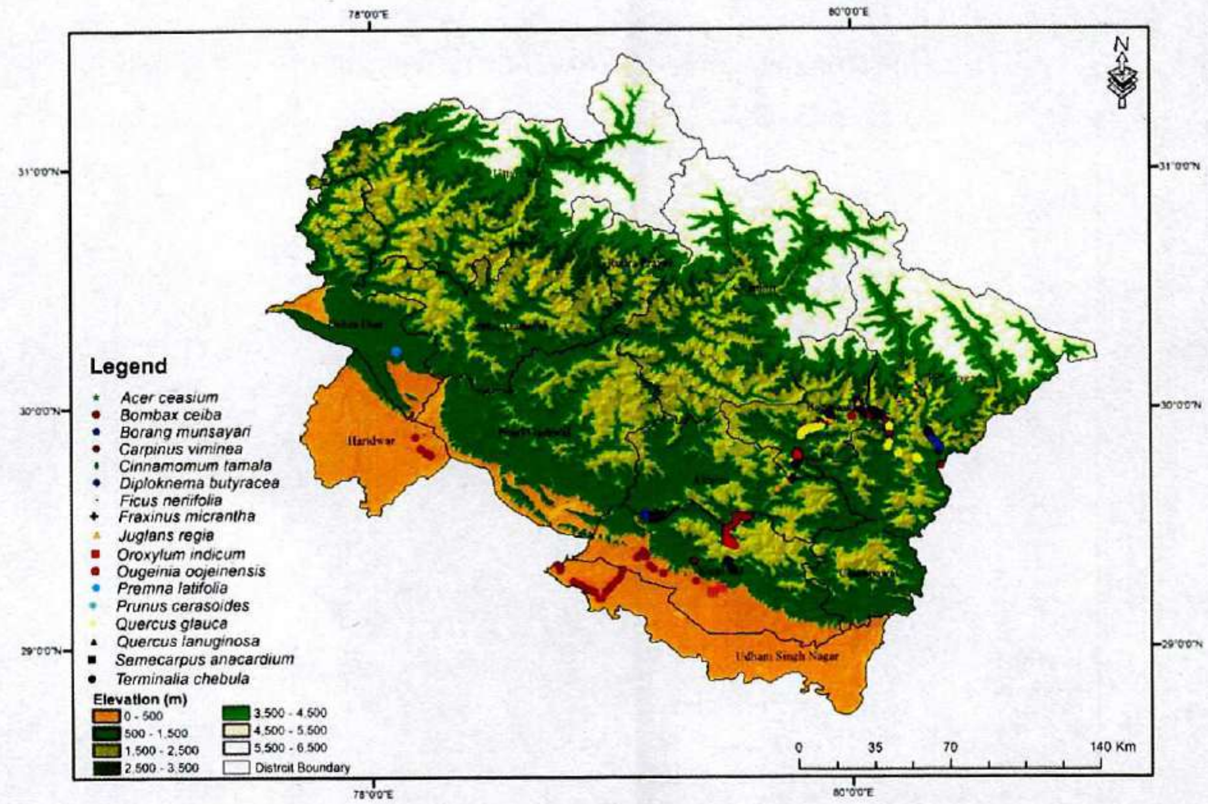
7.	*Fraxinusmicrantha*			
8.	*Juglans regia*		Akhrot, Akhor, Okhar	Juglandaceae
9.	*Oroxylumindicum*		Tarlu, Pharrai, Pharnat, Tantia	Bignoniaceae
10.	*Ougeiniaoojeinensis*	*Ougeiniadalbergioides*	Sandan	Pipilionaceae
11.	*Premnalatifolia*		Bakar, Bakarcha	Verbenaceae
12.	*Prunus cerosoides*		Padam, Phaja	Rosaceae
13.	*Quercus glauca*		Phanat, Inai, Bani	Fagaceae
14.	*Quercus lanuginosa*		Banj	Fagaceae
15.	*Semecarpusanacardium*	*Anacardiumorientale*	Bhilawa, Marking Nut tree	Anacardiaceae
16.	*Taxus baccota*		Thuner, Thuniara	Coniferae
17.	*Terminalia chebula*		Har, Harr, Hararh	Combretaceae

Comprehensive mapping of 17 FGRs

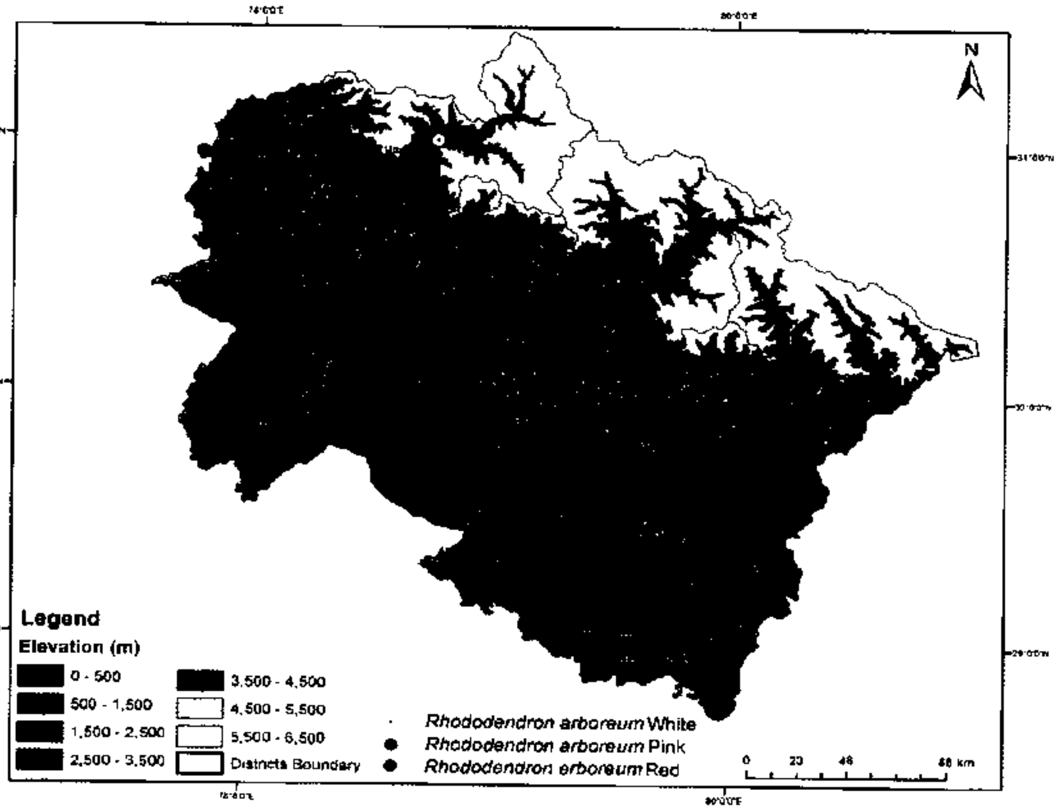


7.	*Fraxinusmicrantha*			
8.	*Juglans regia*		Akhrot, Akhor, Okhar	Juglandaceae
9.	*Oroxylumindicum*		Tarlu, Pharrai, Pharnat, Tantia	Bignoniaceae
10.	*Ougeiniaoojeinensis*	*Ougeiniadalbergioides*	Sandan	Pipilionaceae
11.	*Premnalatifolia*		Bakar, Bakarcha	Verbenaceae
12.	*Prunus cerasoides*		Padam, Phaja	Rosaceae
13.	*Quercus glauca*		Phanat, Inai, Bani	Fagaceae
14.	*Quercus lanuginosa*		Banj	Fagaceae
15.	*Semecarpusanacardium*	*Anacardiumorientale*	Bhilawa, Marking Nut tree	Anacardiaceae
16.	*Taxus baccata*		Thuner, Thuniara	Coniferae
17.	*Terminalia chebula*		Har, Harr, Hararh	Combretaceae

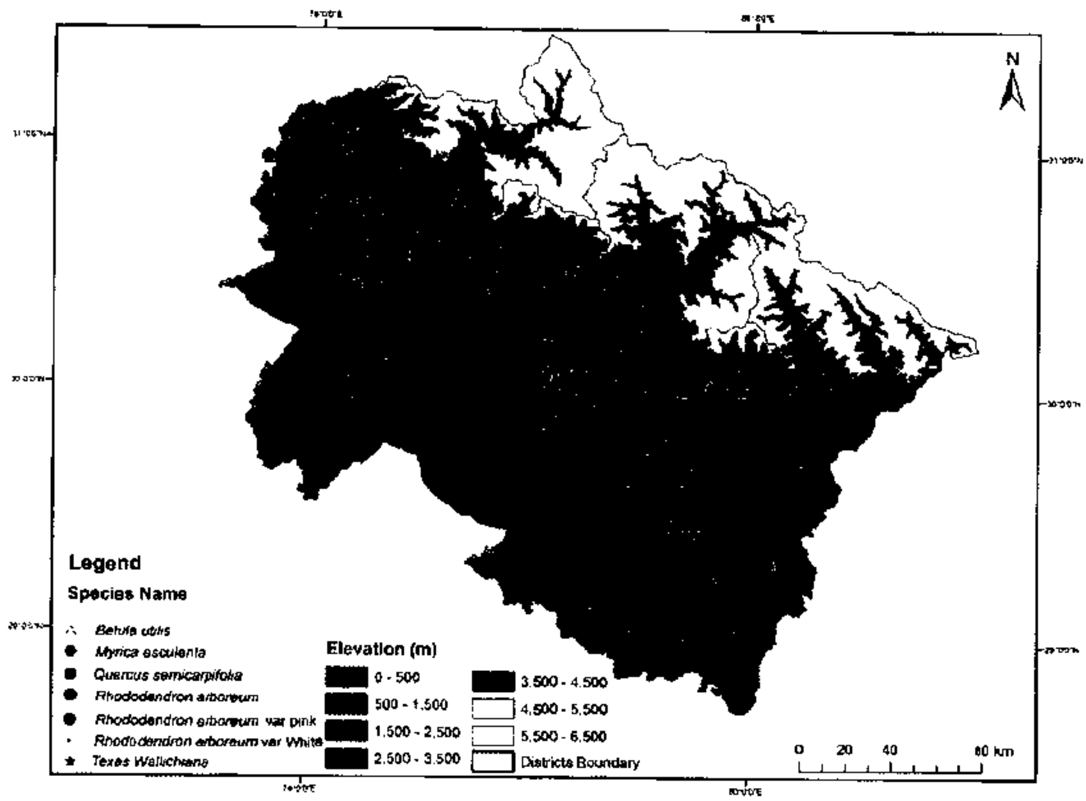
Comprehensive mapping of 17 FGRs



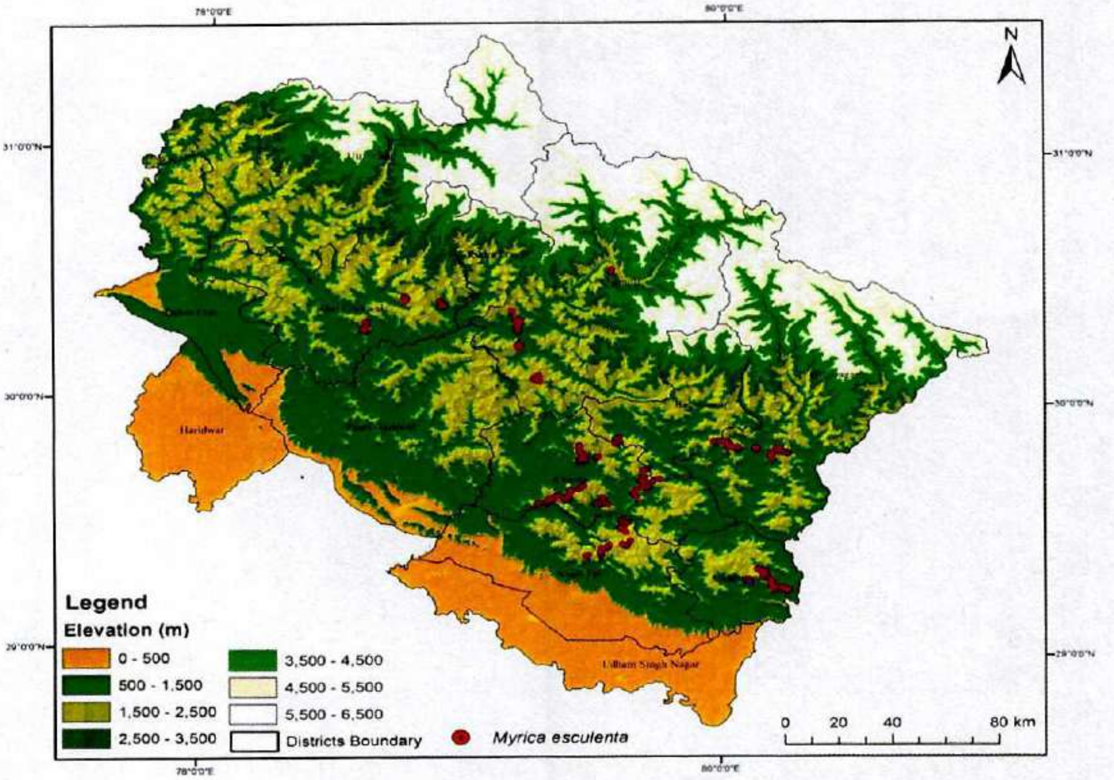
Eco-distribution mapping and sampling sites of *Rhododendron* Species.



Population sampling of FGRs (July to Sept, 2017)



Eco-distribution mapping and samplingsites of *Myrica esculenta*



Eco-distribution mapping and sampling sites of *Betula utilis.*