HIMALAYAN FOREST RESEARCH INSTITUTE (HFRI), SHIMLA

RESEARCH PROJECTS (PLAN) OF HFRI CONTINUING DURING 2010 -2011

S. No.	Projects	Name of PI	Thrust Area	Current Status
1.	Introduction and performance trials of *Gmelina arborea* for agroforestry in Lower Hills of Himachal Pradesh and Jammu & Kashmir. **5 years (April, 2007)**	Dr. Vijender P. Panwar, Scientist-C	Forest Productivity (Social Forestry, Agroforestry/ Farm Forestry)	Procurement/ collection of seeds have been done through Institute of Forest Productivity, Ranchi, from five locations. HFRI nurseries at Johron (Paonta Sahib) and Bir Palasi (Nalagarh) representing the Low Hill Zone has been used for planting stock production. After field survey four sites in lower hill zone at Puruwala & Kot in HP and Nudh & Basanterbella in J&K measuring 5.0 ha have been identified and experimental trials following RBD design with three replications have been established. Preliminary growth data indicates that the *G. arborea* plants have attained an average range height of 180 to 199 cm after two years at both the locations in Himachal Pradesh. Though very early to compare, however growth comparison of preliminary results shows that *G. arborea* may be a future planting species for the lower hills keeping in view its short rotation period. *G. arborea* nursery at Johron in district Sirmour and four field plantation sites in lower hill zone at Puruwala & Kot in HP and Nudh & Basanterbella in Jammu and Kashmir are being maintained and taken care. Growth data is being recorded. Nurseries of *G. arborea* have been raised and maintained at Johron (Paonta Sahib) representing the Low Hill Zone for planting stock production. Four field plantations have been raised in lower hill zone at Puruwala & Kot in HP and Nudh & Basanterbella following RBD design with three replications. Growth data is being recorded. Though very early to compare, however growth comparison of preliminary results shows that *G. arborea* may be a future planting species for the lower hills keeping in view its short rotation period.

2.	Evaluation of soil fertility status and nutrient return from the important indigenous agroforestry systems in Himachal Pradesh. **5 years (April, 2006)**	Dr. Vijender P. Panwar, Scientist-C	Forest Productivity (Social Forestry, Agroforestry/ Farm Forestry)	Quantitative parameters of agrisilvicultural system have also been recorded for developing correlations and recommendations. The results indicates that the six important agroforestry species (frequency > 56%) selected for taking up the present study are also integral part of the naturally occurring agrisilvicultural agroforestry systems in the region. Collected soil samples (126 Nos.) have been analyzed. Nitrogen has been observed higher in the upper soil horizons which tend to decrease towards lower horizons of soil in most of the agroforestry species under the study. The preliminary results of soil analysis indicate a positive role of agroforestry species in maintaining the fertility status of the soil. Nutrient contents in the litter of major (five) agroforestry species were to be accessed, whereas experimentation on six important agroforestry species i.e., *Grewia optiva, Mours alba, Celtis australis, Bauhinia variegata, Toona ciliata, Albizia chinensis* is being undertaken. Litter samples collected from the experimental area have been further segregated into various litter parts. These are oven dried in hot air oven at 80±2^{o}C till the constant weight reached and are then ground in Wiley Mill for further chemical analysis. Preliminary results of litter production by important agroforestry species indicates that *Grewia optiva, Mours alba, Celtis australis, Bauhinia variegata, Toona ciliata, Albizia chinensis* all together contributed a total of 1346.85 g/m^2 of litter-fall annually through various litter fractions. Pudjiharta and Sallata (1989) made comparison of litter production under stands of *Pinus merkusii* and *Switenia macrophylla* natural forest at Yanlapa, West Jawa and found average monthly leaf litter production of 258.78 and 241.02 gm/m2 respectively. The comparison shows that less amount of litterfall is less in the agroforestry species as compared to evergreen conider species. Results on nutrients contents in litter of agroforestry species preliminarily indicates that leaves of these six important species have higher concentrations of either of the five nutrients (Nitrogen, Phosphorous, Potassium, Calcium and Magnesium) studied, which may be helpful in drawing various correlations/ conclusions at the end of the study.

				Litter samples collected from the experimental area have been further segregated into various litter parts. These are oven dried in hot air oven at 80±2^{o}C till the constant weight reached and are then ground in Wiley Mill for further chemical analysis. Litter-fall recordings have been done. Samples are being analyzed for nutrients contents in litter of agroforestry species. Data is being tabulated. All the samples are being analyzed for nutrients contents in litter of six agroforestry species. Data is also being tabulated and nutrient return calculated. Data will be statistically analyzed.
3.	Identification of superior chemotypes and *ex-situ* conservation of *Podophyllum hexandrum* Royle form Himachal Pradesh and Jammu & Kashmir (Nubra Valley). **5 years (April, 2009)**	Jagdish Singh, Scientist-D	Non-Wood Forest Products (Chemistry of NWFPs, Value Addition and Utilization)	• Carried out extensive survey to identify and select the sites in different geographical location of H.P. and Ladakh (J&K). 25 No sites were selected for collection of medicinal plants samples and other studies. • Geo-referenced the selected sites. Collected the soil samples from the selected sites and analyzed for pH, E.C.(ms), OC%, N (Kg/ ha), K (Kg/ ha) and P (Kg/ha). • After short listing the sites the samples of *P. hexandrum* were collected from the different identified locations of H.P and Ladakh (J&K). • After drying and processing 59 No. samples of *P.hexandrum* collected from different 25 No. geographical locations of H.P and Ladakh (J.K) were sent to IHBT, Palampur for carrying out active ingredient analysis to screen out superior chemo-types. • Development of the nursery sites and establishment of the Field Gene bank at FRS Brundhar. • Propagation trials were laid out at Medicinal Plants Research Nursery, Brundhar to develop user friendly and appropriate propagation methods of the species. Seed propagation trials were initiated in the lab condition also. • Maintained the nursery trials and FGB by carrying out regular weeding & hoeing etc. • Recording of various field data & analysis of a.i. content data to identify the superior genetic stock.

				• **Survey for identification of sites for collection of medicinal plants samples:** Extensive survey were carried out to identify the sites for collection of samples from most probable sites of Himachal Pradesh covering the districts of Shimla, Kullu, Chamba and Kinnour, Lahoul & Spiti, Sirmour and Ladakh (J.K.). • **Collection of medicinal plants samples from the selected sites:** Medicinal plant samples were collected from each selected sites (28 No.) from different geographical locations of Himachal Pradesh and Ladakh (J&K). Geo-referencing of the selected sites was carried out. • **Screening and identification of high active ingredients yielding populations:** Samples of *P. hexandrum* collected from different geographical location of Himachal Pradesh and Laddakh (J&K) have been sent to IHBT, Palampur; after drying and processing for carrying out active ingredient analysis to screen out the superior chemo-types. • **Establishment Field Gene Bank:** Germplasm of selected medicinal plant collected from different locations have been used for establishing Field Gene bank at Medicinal Plants Research Nursery Brundhar, Manali (H.P) • **Propagation trial**: Seeds for *P. hexandrum* were collected from Laddakh, Lahoul & Spiti and Kinnour. Seed germination trials have been initiated at Medicinal Plants Research Nursery Brundhar and Model nursery Baragoan, Shimla to develop user friendly and appropriate propagation methods of the species. Screening of superior chemo-types of *Podophyllum hexandrum* from different geographical locations of Himachal Pradesh and Ladakh (J&K). Establishment of Field Gene Bank of *Podophyllum hexandrum* by using germplasm collected from different geographical locations of Himachal Pradesh and Ladakh (J&K). Initial indicators for developing cost effective and user friendly propagation methods.

4.	Study on Impact of Ban on Green Felling in Deodar, Kail, Fir and Spruce Forests of Uttarakhand and Himachal Pradesh. **3 years (April, 2009)**	Dr. K.S. Kapoor, Scientist-E	Forest Productivity (Silviculture)	❖ Basic information pertaining to study sites from the offices of respective Divisional Officers collected and forests in Chamba, Shimla and Kullu districts identified for the detailed investigations. ❖ Survey undertaken in Chamba, Chopal and Kullu forest Divisions of the identified districts. ❖ Basic information/ details of the forests collected from Compartment History Files from the respective ranges. ❖ After having the basic details, preliminary discussions were held with the concerned Divisional Forest Officers in their respective divisions and the matter was also deliberated upon at the institute as well. It was finalized internally that the institute will propose the sites falling in three districts viz., Chamba, Kullu and Shimla in the state of Himachal Pradesh. Accordingly, sites for carrying out the studies were selected in Naggar Range of Kullu Forest Fivision, Upper Chamba Range in Chamba Forest Division and Chopal Range of Chopal Forest Division. Meeting with the PI and the Head of Silviculture Division were also held for more clarifications and discussions on the issue. Sites in the various ranges/ blocks of the above Forest Division of the identified districts as referred to above were visited with the PI and accordingly, identified for finalization by the team from FRI, Dehradun. Thereafter, basic details of the areas were recorded and literature consulted. Also got the information pertaining to identified sites through Compartment History Files of these forest divisions. ❖ Floristic survey in fir and spruce forests conducted in Riuni & Riyana sites falling in Chopal Forest Division. Padra Riyas Forest aea having Silver, Fir and Spruce forests and Bluepine and deodar forest in Nashala block were investigated for detailed studies. The data thus, obtained was computed. Meeting with the PI and the Head of Silviculture Division for more clarifications and discussions on the issue were also held at FRI, Dehradun. Further refinement of the already designed formats was done at HFRI in consultation with the Forest Officers and Scientists of this institute.

5.	Ecological Assessment of Floristic Diversity in Kalatop Khajjiar Wildlife Sanctuary of District Chamba, Himachal Pradesh. **4 years (April, 2008)**	Dr. R.K. Verma, Scientist-E	Ecosystem Conservation and Management ; Biodiversity	In Dankund to Jyot (2450-2660m), number of tree, shrub and herb species was 6, 9, 62 with the dominance of *Picea smithiana*, *Viburnum erubescens* and *Bergenia ciliata* respectively. The diversity index for tree, shrub and herb species was 1.09, 1.90 and 3.49 respectively. In Dankund to Ala, number of tree species at 2225-2425m and 2425-2650m elevation was 11 and 5 with the dominance of *Picea smithiana* in both the altitudes. Number of shrub species was 18 and 14 with the dominance of *Sarcococca saligna* and *Viburnum erubescens* in the elevations of 2225-2425m and 2425-2650m respectively. Number of herb species was 58 and 61 at the elevations of 2225-2425m and 2425-2650m with the dominance of *Valeriana jatamansii* in both the elevations. The diversity index for herb species was 3.45 and 3.62 at the elevations of 2225-2425m and 2425-2650m respectively. In Matuni to Kakala, number of tree species at 1950-2150m and 2150-2400m elevation was 14 and 10 with the dominance of *Picea smithiana* in both the altitudes. Number of shrub species was 23 and 19 at 1950-2150m and 2150-2400m elevations with the dominance of *Sarcococca saligna*. Number of herb species was 62 and 54 at the elevations of 1950-2150m and 2150-2400m with the dominance of *Valeriana jatamansii* in both the elevations. The diversity index for herb species was 3.30 and 3.45 at the elevations of 1950-2150m and 2150-2400m respectively. In Madrani to Khajiar, number of tree species at 1975-2200m and 2200-2425m elevation was 6 and 11 with the dominance of *Persea duthiei* and *Picea smithiana* respectively. Number of shrub species was 9 and 22 at 1975-2200m and 2200-2425m elevations with the dominance of *Sarcococca saligna* and *Viburnum erubescens* respectively. Number of herb species was 60 and 54 at the elevations of 1975-2200m and 2200-2425m with the dominance of *Persicaria capitata* and *Bergenia ciliata* respectively. The diversity index for herb species was 2.78 and 3.64 at the elevations of 1975-2200m and 2200-2425m respectively. In Dankund to Khadgot, number of tree species at 2025-2225m, 2225-2425m and 2425-2625m elevation was 5, 7 and 5 with the dominance of *Cedrus deodara, Picea smithiana,* and *Picea smithiana* respectively. Number of shrub species was 19, 22 and 10 at 2025-2225m, 2225-2425m and 2425-2625m elevations with the dominance

				of *Sorbaria tomentosa*, *Sorbaria tomentosa* and *Viburnum erubescens* respectively. Number of herb species was 57, 63 and 52 at the elevations of 2025-2225m, 2225- 2425m and 2425-2625m with the dominance of *Rumex napalensis, Valeriana jatamansi* and *Erigeron bellidioides* respectively. The diversity index for herb species was 3.56, 3.45 and 3.37 at the elevations of 2025-2225m, 2225- 2425m and 2425-2625m respectively. In Kalatop to Kakala area, number of tree species at 1800-2000m, 2000-2200m and 2200-2400m elevation was 6, 6 and 8 with the dominance of *Quercus leucotrichophora, Cedrus deodara* and *Cedrus deodara* respectively. Number of shrub species were 16, 13 and 18 with the dominance of *Quercus leucotrichophora* (s), *Sarcococca saligna* and *Sarcococca saligna* in the elevations of 1800-2000m, 2000-2200m and 2200-2400m respectively. Number of herb species was 46, 46 and 45 at the elevations of 1800-2000m, 2000-2200m and 2200-2400m with the dominance of *Berberis aristata* (r), *Valeriana jatamansii* and *Valeriana jatamansii* respectively. The diversity index for herb species was 3.54, 3.58 and 3.26 at the elevations of 1800-2000m, 2000-2200m and 2200-2400m respectively. Khajiar to Parel, number of tree species at 1200-1400m, 1400-1600m, 1600-1800m and 1800-2000m elevation was 15, 10, 9 and 11 with the dominance of *Pinus roxburghii, Pinus roxburghii, Quercus leucotrichophora* and *Quercus leucotrichophora* repsectively. Number of shrub species were 22, 22, 21 and 19 with the dominance of *Randia tetrasperma, Myrsine Africana, Berberis aristata* and *Rhododendron rboreum* in the elevations of 1200-1400m, 1400-1600m, 1600-1800m and 1800-2000m respectively. Number of herb species was 56, 50, 51 and 64 at the elevations of 1200-1400m, 1400-1600m, 1600-1800m and 1800-2000m with the dominance of *Anaphalis triplinervis, Anaphalis triplinervis, Nasturtium officinale* and *Begonia picta* respectively. The diversity index for herb species was 3.54, 3.58 and 3.26 at the elevations of 1800-2000m, 2000-2200m and 2200-2400m respectively. In Lakadmandi to Khajiar, number of tree species at 2000-2200m and 2200-2400m elevation was 11 and 13 with the dominance of *Quercus leucotrichophora* and *Cedrus deodara* repsectively. Number of shrub species was 20 and 28 with the

				dominance of *Sarcococca saligna* and *Sorbaria tomentosa* in the elevations of 2000-2200m and 2200-2400m respectively. Number of herb species was 48 and 52 at the elevations of 2000-2200m and 2200-2400m with the dominance of *Bergenia ciliata* and *Valeriana jatamansi* respectively. The diversity index for herb species was 3.54 and 3.19 at the elevations of 2000-2200m and 2200-2400m respectively. In Gate to Jyot, number of tree species at 1850-2050m, 2050-2250m and 2250-2450m elevation was 15, 6 and 3 with the dominance of *Quercus leucotrichophora, Picea smithiana* and *Picea smithiana* repsectively. Number of shrub species was 25, 17 and 15 with the dominance of *Berberis aristata, Cotoneaster microphyllus* and *Sarcococca saligna* in the elevations of 1850-2050m, 2050-2250m and 2250-2450m respectively. Number of herb species was 50, 45 and 50 at the elevations of 1850-2050m, 2050-2250m and 2250-2450m with the dominance of *Rumex nepalensis, Valeriana jatamansi* and *Valeriana jatamansi* respectively. The diversity index for herb species was 3.67, 3.52 and 3.48 at the elevations of 1850-2050m, 2050-2250m and 2250-2450m respectively. In Kalatop to Talai area, number of tree species at 1800-2000m, 2000-2200m and 2200-2400m elevation was 7, 5 and 4 with the dominance of *Cedrus deodara* in all the altitudes. Number of shrub species were 26, 21 and 23 with the dominance of *Berberis aristata*, *Sarcococca saligna* and *Sarcococca saligna* in the elevations of 1800-2000m, 2000-2200m and 2200-2400m respectively. Number of herb species was 60, 58 and 53 at the elevations of 1800-2000m, 2000-2200m and 2200-2400m with the dominance of *Bergenia ciliata, Valeriana jatamansi* and *Pilea scripta* respectively. The diversity index for herb species was 2.93, 3.73 and 3.64 at the elevations of 1800-2000m, 2000-2200m and 2200-2400m respectively. In Gate to Khajiar (1800-2000m), number of tree, shrub, herb species was 18, 28, 43 with the dominance of *Quercus leucotrichophora*, *Berberis aristata* and *Rumex nepalensis* respectively. The diversity index for tree, shrub and herb species was 2.31, 2.77 and 3.15 respectively. In Madrani to Madigala area, number of tree species at 1800-2000m, 2000-2200m and 2200-2400m elevation was 11, 9 and 9

				with the dominance of *Quercus leucotrichophora, Quercus leucotrichophora* and *Picea smithiana* respectively. Number of shrub species were 19, 15 and 24 with the dominance of *Rhododendron arboreum*, *Berberis aristata*, and *Indigofera heterantha* in the elevations of 1800-2000m, 2000-2200m and 2200-2400m respectively. Number of herb species was 64, 46 and 62 at the elevations of 1800-2000m, 2000-2200m and 2200-2400m with the dominance of *Begonia picta, Urtica dioica* and *Gerardiana diversifolia* respectively. The diversity index for herb species was 3.98, 3.59 and 3.63 at the elevations of 1800-2000m, 2000-2200m and 2200-2400m respectively. In Lakadmandi to Talai area, number of tree species at 1800-2000m, 2000-2200m and 2200-2400m elevation was 7, 7 and 9 with the dominance of *Cedrus deodara* in all the altitudes. Number of shrub species were 26, 24 and 16 with the dominance of *Berberis aristata, Sarcococca saligna* and *Sarcococca saligna* in the elevations of 1800-2000m, 2000-2200m and 2200-2400m respectively. Number of herb species was 60, 54 and 38 at the elevations of 1800-2000m, 2000-2200m and 2200-2400m with the dominance of *Begonia picta, Rumex napalensis* and *Valeriana jatamansi* respectively. The diversity index for herb species was 3.85, 3.52 and 2.92 at the elevations of 1800-2000m, 2000-2200m and 2200-2400m respectively. The maximum number of species was in Khajiar to Parel (129) followed by Madrani to Madigala (122), Kalatop to Talai (115), Lakadmandi to Talai (114) and Dankund to Khadgot (109). The threatened plant species recorded from the areas were; *Podophyllum hexandrum, Taxus wallichiana, Zanthoxyllum armatum, Cinnamonum tamala.* Plants of medicinal importance recorded were:*, Bergenia ciliata, Valeriana jatamansi, Verbascum thapsus, Viola canescens, Podophyllum hexandrum, Rubia cordifolia, Hedychium spicatum, Dioscorea bulbifera, Achyranthes aspera, Acorus calamus, Solanum nigrum, Taraxacum officinale, Zanthoxyllum armatum, Solanum xanthocarpum, Cinnamonum tamala, Thymus linearis, Malaxis muscifera* etc. Conducted the ethnobotanical study in 13 villages and documented 45 plant species used for different purposes.

6.	Management of insect borer complex in Chir-Pine [HFRI-035/06(FPT-08)PLAN/2006-2011] **5 years (April, 2006)**	Dr. Ranjeet Singh	Forest Protection/ Insect pests, Diseases and Control.	In total 12 species of Insects attacking Chir pine stem has been reported. 4 Species of insect were graded as serious and they are *Polygraphus longifolia, Platypus biformis, Cryptorhynchus rufescens and Sphaenoptera aterrima.* Out of them, *Polygraphus longifolia* was graded as most destructive insect bark borers. Trees falling under the girth range 90-180 cm were found to be highly susceptible to infestation in comparison with young (Below 90 cm) and Mature (above 180 cm) stands. Fire incidence and excessive resin tapping increased the susceptibility of trees to Insect Stem-borers incidence. Tree-trap with 95 – 110 cm L X90 - 100 cm GBH and 25 to 35 % moisture content is found to be effective to attract the beetles. Stem treatment with Grownim @ 5.0%, Neem ban @ 5.0%, Neem Oil @ 10.0 and endosulfan @ 0.1 %. was evaluated in the field for their effectiveness to contain the pest under control. Preliminary Data showed that Neem oil is more effective to prevent the beetles attack. 2 training has been conducted to the frontline staff of SFD in Solan and Hamirpur Forest Division. Brochure on Chir Pine weevil was published. Observation on number of beetle entrapped in each trap were made every day continuously for a period of 3 weeks. The collected data is being computerized for analysis. Effective trap and dose of pheromones shall be analyzed from experiment.
7.	Management of Indian Gypsy Moth (*Lymantria obfuscata*) in Himachal Pradesh. [HFRI-041/06(FPT-09) Plan/2008-2013] **5 years (April, 2008)**	Dr. S. Chakrabarti, Scientist E	Forest Protection/ Insect pests, Diseases and Control.	10+15 egg-mass were collected and 7500 eggs were available experiment for the year. Sufficient diseased larvae were collected cross-infection with baculovirus. Bioassay experiment using 5 dilutions from stock solutions of baculovi and control, has been initiated using 5 larvae in each test. Altogether larvae were tested. 90% mortality were observed. Pheromone was extracted from the abdominal glands of 100 adult fema using acetone solvent and stored. This would be applied during n breeding season. Dose-mortality bioassay experiment was conducted using 7 serially dilu doses of stock solution. The data obtained were subjected to Pro Analysis using SPSS Ver. 16. LD50 & LD90 of LONPV is determir out the analysis. The result indicates that; First field trial was conducted at selected spots in oak forest located

				Charwag area of Sarahan. Mist spray was applied over oak foliage dur night for 2 days. The effect of baculovirus is assessed by counting number of egg-mass recorded during July-August and comparing numeric strength with the record of egg-mass during last 2 years. This v found that there is a reduction of production of egg-mass measuring 92% First field trial of Sex-Pheromone was conducted in some selected spots Shamshi. Altogether 50 traps were mounted on the ground and pheromo ampule was filled with 1microlit. of the extracted pheromone. The site v revisited after 15 days and the catch of male moths from all traps w counted. In virto culture experiment of LONPV growth on artificial media will repeated and and protocol would be standardized. Data obtained from Field trial of LONPV would be analyzed a evaluated. Final protocol for field release of baculovirus would developed. Similarly, extent of catch of male IGM killed in pheromone trap obtained from first field trial of pheromone of female IGM would be analyzed and evaluated. Final protocol for field release of IGM sex pheromone would also be standardized.
8.	Assessment of nutritional status of most preferred wild edible plants of Kinnaur District, Himachal Pradesh.HFRI-043/07(NWFP-02) PLAN/2008-2011. **3 years (April, 2008)**	Dr. A. RAJASEKARAN, Scientist-C	Non-Wood Forests Products / Chemistry of NWFPs, Value Addition & Utilization	Questionnaire for documentation of wild edibles was developed and used for the documentation of wild edible plants. Information on wild edible plants was collected from different region of Kinnaur viz Baspa valley (Raksham, Chhitkul, Batseri, Chansu & Boring sarin), Nichar area (Nichar & Bari), Ropa Valley (Shyaso, Giabong), Rupi Valley (Majgaon) and Sutlej valley (Kalpa, Pangi, Akpa, Jungi, Lippa, Asarang, Labrang & Pooh & Mabber). To document the wild edible plants, 104 People were interviewed (82 Male + 22 Female) and 110 wild edible plant species were documented. For prioritizing most preferred wild edible plant species, different weightages were assigned to parameters such as no. of people use the plant, seasonal availability, abundance, scope of market and other traditional usage and species were prioritized for nutritional analysis. Among the prioritized wild edible species, fruits samples of *Elaegnus umbellata, Malus baccata* and *Rosa webbiana* were collected for nutritional analysis. To disseminate the research findings to stakeholders, an interactive workshop on wild edible plants was organized and a pamphlet on wild

				edible plants was prepared and distributed to create awareness among the people. Information on wild edible plants was collected from Rupi (Majgaon, Naling-I, Gurguri, Shingarcha, Hurua), Nichar (Beri, Ponda, Garang) and Bhabha valley (Yangpa, Hanthoi, Shangoa, Hurum, Grabu). To document the wild edible plants, 178 people in total were interviewed (136 Male + 42 Female) and 114 wild edible plant species were documented so far. Some of the wild edible plants have multiple uses including medicinal uses. Information on wild edible mushroom/fungi has been collected from Nichar area and samples of wild edible fungi/mushroom such as *Sparassis crispa, Helvella esculenta, Ramaria sp* and *Hygrophorus sp* have been collected. Within the edible plants, fruits (33%) and leaves (27%) are the most widely used plant parts followed by roots and fruiting body with 11% and 6%, respectively. Within the edible plants, herbs (58%) and shrubs (22%) are the most widely used growth forms followed by trees with 16%. Among the plant families, Rosaceae (15 species), Polygonaceae (6 species) and Saxifragaceae (6 Species) are the important wild edible plant families in Kinnaur district. As per the suggestion of RAG, plant species were prioritized for nutritional analysis. *Prunus cornuta* which was cited by 71 % of the informant had highest score of 5.75% followed by *Elaeagnus umbellata, Hippophoe salicifolia, Malus baccata, Morchella esculenta* and *Angelica glauca* with 5.25 score each. *Fragaria indica* which was the second most cited species (61% of the informant) had 5.00 score. However, for nutritional analysis, among the prioritized wild edible plants, species which were not studied earlier by other authors were given priority. Accordingly, fruit samples of *Elaegnus umbellata* and *Malus baccata* were collected and their nutritional status analyzed.
9.	Assessment of optimum harvest limits of *Picrorhiza kurroa* and *Valeriana jatamansi* in Himachal Pradesh. [HFRI-047/07(NWFP-03) PLAN/2009-2014]. **5 years (April, 2009)**	Dr. A. RAJASEKARAN, Scientist-C	Non-Wood Forest Products ; Sustainable Harvesting and Management	Reconnaissance survey was carried out in different Forest Divisions of the State and study sites were selected for laying experimental harvesting trials. For *Picrorhiza Kurrooa*, two sites such as Tino forests in Lahaul Forest Division and Banseru Dhar in Kullu Forest Division were selected for the study. For *Valeriana jatamansi*, two sites such as Jagatsukh forests in Kullu Forest Division and Tikkar forests in Rampur Division were selected for the study. Fenced sample

				plots were established in Jagatsukh and Tikkar forests. To collect population data of medicinal plants, quadrat studies were conducted in Jagatsukh, Tino, Tikkar and Banseru Dhar sites. As per the suggestion of RAG and RPC, one additional site for *Valeriana jatamansi* was selected in Chail and population data on all the plants in the area has been collected. Experimental harvesting trials of *P.kurrooa* have been established in Lahaul Forest Division. For *V.jatamansi*, experimental harvesting trials have been established in Jagatsukh, Tikkar and Chail forests. Population status of all the medicinal plants in these areas was assessed using quadrat studies. Data on number of leaves, height of the plant, diameter of the stem, diameter of rhizome/root, length and breadth of leaf, height of the inflorescence, etc of the study species were collected from the different experimental area. Population status of all the medicinal plants in the study area is being investigated.
10.	Productivity enhancement through selection of superior clones of *Dalbergia sissoo*. (Planting Stock Improvement Programme) [HFRI-038/05(SFG-09) PLAN/2007-2012]. **5 years (April, 2007)**	Dr. Rajesh Sharma	Genetic Improvement ; Tree Improvement	The project envisages selection of superior clones to enhance productivity. To achieve the objectives of the project growth data of clones planted in clonal orchard was statistically analysed for selection of best performers. These clones were also observed for their flowering and fruiting behaviour. These selected clones (16) were subjected to genetic variation studies using isozyme technique with five stable enzyme systems namely MDH, 6PGDH, IDH, SKDH and MNR. In order to study the stress resistance observations with regard to water potential of these selected clones along with control were observed in the orchard. Experiments were also laid out to test the resistance of these clones against insect attack in the field and identified defoliators were studied in the lab. These selected clones were field planted at Jawalaji in the state of HP and at Basanterbela in the state of J&K during August 2009. The survival and growth data of clones in these orchards is being recorded. Analysis of electrophoresis data for genetic differences using isozymes, stress resistance and insect resistance is being done. The casualty replacement was carried out during August 2010.

				The growth data of the clones raised at Jawalaji were recorded quarterly. High mortality occurred at Basantarbela in J&K due to biotic interference (nomads). Casualty replacement at Jawalaji was done during August 2010. The electrophoresis for the enzyme system MDH was repeated for some of the clones to get stability of the gene loci. Two measurements for water potential of the selected clones for stress resistance were also recorded during this period. The electrophoresis data stress and insect resistance data were compiled and analysed. The analysis of data and interpretation of the result is being carried out to find out clones with more genetic variation and resistance against stress and insect attack. The clonal orchards raised in HP and J&K would be maintained and growth data will be recorded to see their growth performance.
11.	Population genetic analysis and characterization of *Cedrus deodara* germplasm through DNA based markers)HFRI-044/05(SFG-14) PLAN/2008-2011 **3 years (April, 2008)**	Dr. Rajesh Sharma	Genetic Improvement ; Tree Improvement	Twenty two population (each population consisting of fifty individuals) of *Cedrus deodara* have been collected from different geographical region of Uttrakhand, Himachal and Jammu and Kashmir. The passport details, which also include geographical locations of all the collected germplasm was also recorded, and all samples, were stored at -80^0 C.The DNA extraction protocol was standardized using the method of Doyle and Doyle Stange *et al.,* (1998) with some modifications for the isolation of total genomic DNA from the needles of *Cedrus deodara*. The quality of isolated DNA (according to the modified protocol) was also checked by the Biophotometer and 1% agarose gel electrophoresis. Ratio of total genomic DNA was obtained between1.6 - 2.0 and gave a sharp band on to the gel. The DNA from all the collected germpalsm has been extracted and quantified for the further investigation. SSR protocol Vandramin *et al* (1996) was standardized for *Cedrus deodara*. Concentration of PCR constituents like $MgCl_2$, Taq Buffer, Primer concentration, dNTPs concentration and Taq DNA polymerase along with the cycling parameters were standardized. Apart from this a number of SSR primers for cross genus amplification were screened polymorphic primers were then selected for amplification in all the populations. PCR amplification on 16 populations with 10 primers has

				been completed and the gels have been scored and analysed. The samples were collected from two populations from the state of Himachal Pradesh during this period as the DNA of these populations got degenerated. More primers were used for polymorphism in the populations that are being assayed for genetic diversity. The data is being compiled for interpretation of results. Genotyping of 8000 samples representing sixteen populations and their DNA fingerprints have been generated. A database format has been developed by IT cell FRI and the information is being uploaded in the database. Efforts would be made to complete PCR amplification on remaining populations and genetic diversity estimates for the remaining populations will be worked out.
12.	Determination of Morphological and Physiological Quality Parameters of Nursery Stock of Deodar (*Cedrus deodara)* and Ban Oak (*Quercus leucotrichophora*). [HFRI-037/05(SFG-12)/ PLAN/ 2007-2012] **5 years (April, 2007)**	Dr. Sandeep Sharma	Forest Productivity / Silviculture.	Raised and maintained nursery stock of Deodar (6,000) and Ban Oak (24,000) at Model Nursery Shimla and Shilly nursery Solan respectively. Visited nurseries (35 no.) of Forest Department of Himachal Pradesh and collected information from field functionaries regarding nursery raising and quality parameters adopted in Deodar and Ban Oak nursery stock in the field. Sites selected for carrying out experimental plantations in Shimla and Solan Forest Divisions. Experimental plantations carried out as per morphological parameters of these species during August 2008 & 2009 on six sites three for each species. To achieve first objective of the project, interim minimum standards of quality of Deodar and Ban Oak nursery stock has to be developed as interim measure only through interviews of regular producers and users of nursery stock of those forestry species. Conducted extensive survey in various Deodar & Ban Oak nurseries of State Forest Department (H.P.) regarding Physical Quality parameter of Deodar and Ban Oak nursery stock for grading stock as superior /inferior or selecting stock for planting out on the basis of physical parameters. The survey has been done through structured interview and questionnaire has been developed for that purpose. It has been found that only one physical parameter is adopted in the SFD's nurseries for measuring the quality of Deodar and Ban Oak nursery stock *i.e.* height (shoot length) of the nursery stock. The stock is considered fit for planting or marked as quality stock if the height is 9"

				or more. The root collar diameter, type of production system (polybag or bare root), age, site conditions of plantation area etc. are also important for selecting stock for planting which are not considered in the field presently. On the basis of field discussions interim minimum standards for nursery stock of Deodar and Ban Oak has been proposed for further discussions and finalization. For achieving second objective of the project out planting has been carried out during 2008 and 2009 rains based on morphological grading of nursery stock of Ban Oak and Deodar. The experimental sites which are located in Shimla and Solan districts of H.P. received very less snow fall/rains during 2008 and 2009 followed by continuous drought like conditions during summer resulted in large scale mortality in experimental plantations of Deodar and Ban Oak. In the current year i.e. July-August 2010 experiments will be repeated in the nursery by out planting the graded stock in Gunny bags to have greater control over such situation. - Maintained about 24,000 plants of Deodar (6,000) and Ban Oak (24,000) at Model Nursery, Shimla and Shilly nursery, Solan respectively. - Maintained Deodar and Ban Oak Plantations carried out during 2008, 2009 rains and data pertaining to survival & growth recorded. - Fresh trails based on morphological parameters for Deodar and Ban Oak nursery stock repeated in the nursery in gunny bags. - Root Growth Potential (RGP) studies in Deodar and Ban Oak nursery stock initiated. Nursery stock of Deodar and Ban Oak is being maintained in the nurseries. Seeds of Deodar and Ban Oak will be collected for further raising nursery stock. Also bed preparation and sowing will be carried out for raising stock of these species in the nursery for studying physiological parameters. Experimental plantations as well as out-planting is being done in gunny bags and will be maintained including recording of growth and survival data. Studies of root carbohydrate in the nursery for determining quality of nursery stock of these species will be initiated

13.	Development of Techniques for Raising Deodar (*Cedrus deodara)* Plantations through Tall Plants [HFRI-045/04(SFG-15)/ PLAN/ 2008-2011] **3 years (April, 2008)**	Dr. Sandeep Sharma	Forest Productivity / Silviculture.	Selected one site near Shillaru for establishing pilot scale experiment by using Deodar Wildlings/tall plants. Also selected sites in Shillaru and Kandyali forests for extracting wildling for experimental purposes. Carried out experimental plantation of Deodar tall wildlings during August'08, Feb'09 & again during August 2009. Wildling plantations were carried out in rainy as well as in winter season. Wildlings are planted on the basis of height and root collar diameter classes. Experiments were also carried out on the basis of Root Exposure Time and Root Desiccation Protecting Substances while extracting and planting wildling directly in the field as well as in the nursery in Gunny bags. Nursery studies initiated during March 2009 as per the availability of tall plants in nursery beds. First Deodar seedlings are being raised in nursery beds and after attaining height of two feet transplanted to gunny bags or plastic buckets for further growth and development in the nursery. Experiments are also being conducted on pruning, root exposure time during transplanting and root desiccation protecting substances similarly as being done in case of direct planting. Experimental plantations are being maintained in the field intensively. The data pertaining to field survival recorded regularly. The project is at midway stage. The plantation success through wildling is still a critical issue and is being investigated properly. Raising of tall plants in nursery in big containers such as gunny bags, plastic containers etc are in progress. - Carried out experimental plantation at Kandiyali forest in Kotgarh Forest Division of Himachal Pradesh on 0.5 ha area again during August 2010. - Maintained Deodar tall plant experiments in the field as well as in the nursery and data pertaining to survival recorded. - Initiated Deodar tall planting experiments in the nursery in gunny bags with Gel Grow. - Carried out pilot scale out planting of Gunny bags raised nursery stock of Deodar.

				Experimental plantation as well as nursery experiments are being maintained and survival and growth data is being collected. Fresh seeds of Deodar will be collected for raising Deodar tall plants. Bed preparation and sowing will be done. Physiological parameters will be recorded in Deodar Tall Planting experimental plantations.
14.	Standardization of Methodology for Seed Collection, Seed Handling, Storage and Breaking Seed Dormancy in *Juniperus polycarpos* C. Koch and *Fraxinus xanthoxyloides* (Wall. ex G. Don) DC. (HFRI-036/03(SFG-11) PLAN/2006-2011) **5 years (April, 2006)**	Sh. P. S. Negi, Research Officer	Genetic Improvement ; Conservation of Forest Genetic Resources	The project was initiated from April 2006. During this period, literature consulted. Extensive field visits conducted for carrying out survey and selection of sites for seed collection of *Juniperus polycarpos* and *Fraxinus xanthoxyloides* in their natural zone of occurrence in Kinnaur and Lahaul & Spiti district (H.P.). The sites having good seed bearing trees of *Juniperus polycarpos* were selected at Labrang Kanda, Ropa Kanda and Keylong and *Fraxinus xanthoxyloides* at Thopan, Kirankhud, Spilo, Labrang etc. in Kinnaur district of Himachal Pradesh. The berries of *Juniperus polycarpos* and samaras of *Fraxinus xanthoxyloides* were collected from the selected sites. After collection, freshly collected berries of *Juniperus polycarpos* and samaras of *Fraxinus xanthoxyloides* were packed in the sealed paper bag and brought to the laboratory. The berries and samaras were then dried in the shade for a week period. The berries were soaked in water containing 5% Lye solution (Na OH) for 3 days period and seeds were separated from the pulp by macerating the berries on wire mesh. Seeds of *Fraxinus xanthoxyoides* were separated from the samaras manually. After extraction from the berries and samaras, seeds were spread on the filter paper and dried for a week's period in shade under room temperature. As *Juniperus polycarpos* seeds contain large number of impurities besides empty seeds, hence precautions were taken during seed extraction to avoid mixing of impurities with pure seeds. The seeds were separated from the impurities with the help of seed blowers. The seeds were then treated with different pre sowing treatments i.e., Gibberellic acid, citric acid and stratification in moist sand and cowdung for different time periods. Germination studies to overcome seed dormancy and to find out the optimum time of seed collection in *Juniperus polycarpos* and *Fraxinus xanthoxyloides* initiated. Moisture content of seeds under different collection dates taken in the laboratory. The moisture content

				of *Juniperus polycarpos* and *Fraxinus xanthoxyloides* seeds were recorded 9% and 8% respectively. Seed storage trials also initiated by using different storage containers and storage environment. The studies on causes of seed dormancy and delayed germination in *Fraxinus xanthoxyloides* revealed that seed dormancy and delayed germination is due to the presence of some inhibiting substances and restrictions placed upon the embryo by the enveloping layers. The removal of pericarp resulted in earlier onset of germination. The trials to overcome seed dormancy and to find the optimum time of seed collection in *Fraxinus xanthoxyloides* and *Juniperus polycarpos* were maintained, continuously monitored and germination data recorded periodically. The germination data of *Fraxinus xanthoxyloides* seeds treated with different conc. of gibberellic acid ranging from 500ppm to 3000ppm statistically analyzed and maximum 74% germination was recorded in seeds treated with 1500ppm gibberellic acid as compared to control which registered only 19.66% germination. The seed storage trial in *Fraxinus xanthoxyloides* and *Juniperus polycarpos* by using different type of storage containers/storage environment was maintained and viability test carried out periodically. Seed viability studies in *Fraxinus xanthoxyloides* seeds stored in different type of containers/ storage environment showed decreasing trend in seed viability. The seeds stored in air tight polysac container placed in refrigerator (<5.0C) retained >70% viability after 18months of storage. Similarly, *Juniperus polycarpos* seeds also showed decreasing trend in seed viability and seeds stored in air tight polysac container placed in refrigerator (<5^0c) retained >50% viability after 18 months storage compared to other storage container/storage environment which showed decreasing trend in seed viability. *Juniperus polycarpos* cones were screened in the laboratory for studying insect-pest and after analysis of the samples; it has been observed that in some of the trees about 65% of cones were found to be infected on tree itself. Three different species of cone borer moths of family GELECHIDAE (Lepidoptera) were reared in the laboratory. 2 species of Phytophagous hymenopterus parasites were also found to be borer viz. *Megastigmatus dorsalis* and *Torymus* sp. (Hymenoptera: Chalcidoidea). One natural enemy, *Stetoda* sp. (Spider Family;

				Theridiidae) found as a predator in the tree. The trials to overcome seed dormancy and to find the optimum time of seed collection in *Juniperus polycarpos* and *Fraxinus xanthoxyloides* were maintained and continuously monitored. The germination data of *Juniperus polycarpos* seeds treated with different presowing treatment viz., citric acid, stratification in cowdung, sand and goatdung for different periods recorded maximum 70% germination in seeds stratified with cowdung for 60 days as compared to control which registered 40% germination. The germination data of the trials laid to find the optimum time of seed collection in *Fraxinus xanthoxyloides* and *Juniperus polycarpos* revealed that in *Juniperus polycarpos,* seed collected during November gives maximum 40% germination whereas in *Fraxinus xanthoxyloides,* seed collected during October gives maximum 26.66% germination. The seed storage trials in *Fraxinus xanthoxyloides* and *Juniperus polycarpos* by using different type of storage containers/storage environment was maintained and seed viability test carried our periodically. Seed viability studies in *Fraxinus xanthoxyloides* seeds stored in different type of containers/ storage environment showed declining trend in seed viability and seeds stored in air tight polysac container placed in refrigerator (<5.0C) retained >70% viability even after 24 months of storage compared to other storage container/storage environment which showed decreasing trend in seed viability. Similarly, *Juniperus polycarpos* seeds also showed decreasing trend in seed viability and seeds stored in air tight polysac container placed in refrigerator (<5^0c) retained >50% viability after 24 months storage compared to other storage container/storage environment which showed decreasing trend in seed viability. Data is being analyzed and compiled. Extension material is being published.