

2.6 Non Wood Forest Products

Overview

Researches on medicinal plants focusing on survey, development of Organic cultivation technology, its post harvest processing including development of value addition processes, bioactivity evaluation, sustainable management and resource development through forest enrichment with natural species have been undertaken by various institutes of ICFRE. Research studies focusing on chemical profiling of wild edibles and other useful NWFPs have been undertaken. Researches have also been undertaken on Tree borne oil seeds including chemical analysis of fatty oils yielded thereof. National Multiplicational trials of different provenances and clones of *Jatropha curcas* in various states under jurisdiction of ICFRE institutes have been undertaken. Chemical analysis of various NTFPs have been undertaken to develop processes for their commercial utilization. Planting materials of various NTFP species including medicinal plants have been raised and supplied to farmers for encouraging their cultivation.

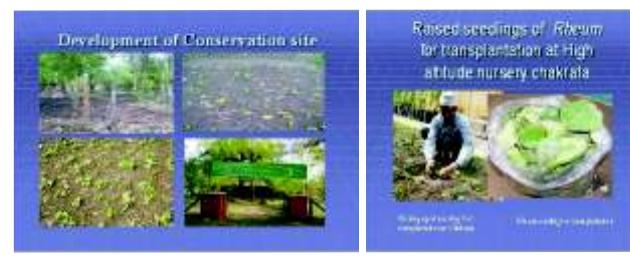
Projects under the theme

Project	Projects Completed During the Year	Ongoing Projects	New Projects Initiated During the Year
Plan	9	20	12
Externally Aided	5	17	1
Total	14	37	13

2.6.2. Resource Development of NWFPs

Organic Cultivation of tulsi (*Ocimum sanctum*), shatavar (*Asparagus racemosus*) and sarpagandha (*Rauvolfia serpentina*) have been developed. As many as 65 diseases affecting 49 species of important medicinal and aromatic

plants in Uttarakhand, have been identified out of which 28 are new diseases.



Development of Conservation Site

Rheum australe Transplantation



Bergenia ligulata



Picrorhiza kurrooa



Valeriana wallichii

Extensive survey for identification of superior chemotypes and *ex-situ* conservation of *Podophyllum hexandrum* Royle from Himachal Pradesh and Jammu & Kashmir (Laddakh Valley) have been carried out.



Podophyllum hexandrum Study at Triloknath (H.P.)



Picrorhiza kurrooa Study Site at
Tino, L&S (H.P)

Quality planting material of Atish (*Aconitum heterophyllum*) and Chora (*Angelica glauca*) were multiplied in different nurseries at HFRI. Out of the 3.6 lakh seedlings, around 2.70 lakh distributed to various end users for cultivation and further multiplication. The Institute and its network partners carried out extensive survey throughout North-Western Himalayas (Himachal Pradesh and Uttarakhand) to carryout population assessment and identification of superior genetic stock of *Picrorhiza kurrooa* Royle ex Benth and *Valeriana jatamansi* Jones.



Atish Stock at Shillaru Nursery

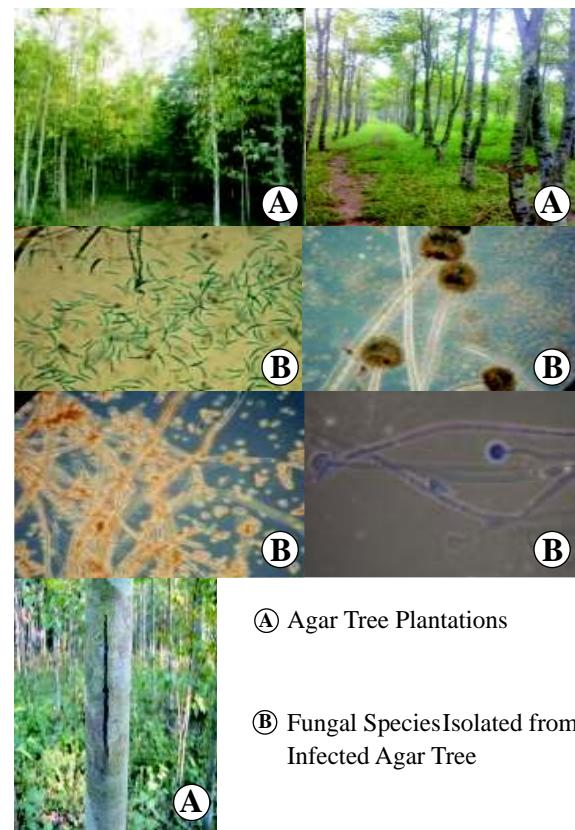


Training Programme at Brundhar, Manali (H.P.)

Fatty oils from seeds of tree species *Givotiarottleriformis* Griff., *Madhuca insignis* (Radlk.) H.J.Lam, *Shorea tumbuggaia* Roxb, *Poeciloneuron indicum* Bedd, *Hopea parviflora* Bedd, *Mesua ferrea* L. and *Balanites roxburghii* Planch have been extracted. This is still in progress.

Aspects on propagation, agro-forestry models, protection, processing and utilization of major bamboo species, *Bambusa bambos*, *B. nutans*, *B. balcooa*, *B. pallida*, *B. tulda*, *Dendrocalamus asper*, *D. brandisii*, *D. hamiltonii*, *D. stocksii*, *D. strictus*, and *Guadua angustifolia* are in progress.

Identified the associated fungi and studied the impact of climate and soil factors in agarwood formation for standardization of artificial technique to promote agarwood in *Aquilaria malaccensis* in six districts (Jorhat, Sibsagar, Golaghat, Nagaon, Tezpur and Rural Kamrup) of Assam.



Ⓐ Agar Tree Plantations

Ⓑ Fungal Species Isolated from
Infected Agar Tree



Effect of fertilizer application on growth and yield of ten years old *Salvadora persica* on arid salt affected soil, has been studied and zinc application has been observed to enhance the fruit yield. Performance trial and agritrial of guggal are in progress.

Exploration and documentation of indigenous knowledge of phyto resources among Mishing tribe of Assam was done. Documentation

of 110 wild edible plants used by people of Kinnaur district of Himachal Pradesh has been done.

A total of 300 samples of NTFPs and medicinal herbs were collected from different markets and a database is being maintained showing the details of the markets from where the NTFPs were sold in Jharkhand state.

SUCCESS STORY

Cultivation protocols for three important medicinal and aromatic plants such as tulsi (*Ocimum sanctum*), shatavar (*Asparagus racemosus*) and sarpagandha (*Rauvolfia serpentina*) have been developed at FRI.

- Tulsi cultivation fertilized with organic compost (FYM) and Vermicomposts (V) mixture (@ 12.5t/ha & 6.25 t/ha, respectively, gave the highest herbage tulsi dry yield of 564 kg/acre. Techniques for harvesting of tulsi leaves for use in ayurvedic and as herbal tea can be done four times during its growing season.
- High yield of shatavar to the tune of 3000 kgs dry roots per acre can be achieved in 20 months by fertilizing the plantation site with organic compost FYM and vermicomposts @ 12.5 + 12.5t/ha.
- High yield of sarpagandha upto 372 kg dry root per acre from plants raised through root cuttings can be obtained in 20 months by applying FYM and Vermicomposts @ 12.5 and 6.25 mt/ha.
- Mulchings using leaf litters are effective in controlling weeds and also in conserving moisture. The technique developed is very useful to the small and marginal farmers in raising their income from small land holdings.

2.6.3. Sustainable Harvesting and Management.

Non-destructive harvesting technique of medicinal plant namely *Bergenia ligulata*, *Picrorhiza kurrooa*, *Valeriana wallichii* and *Rheum australe* have been developed. Field trials for in-situ resource enhancement of *Microstylis wallichii* carried out in 3 natural forest areas of Uttarakhand state. The productivity studies are in progress.

Sustainable harvesting of medicinal plants viz. *Andrographis paniculata*, *Asparagus*

recemosus, *Chlorophytum borivillianum* and Chironji fruits, *Buchnania lanza* was studied. Harvesting of 80% *A. paniculata*, 60% *A. recemosus* and *C. borivillianum* was proved sustainable without affecting the regeneration. Regeneration of *B. lanza* was found unaffected even on the harvest of 90% fruits.

Experiments have been initiated to standardize the various means of sustainable harvesting methods such as strip harvesting, alternate harvesting and opposite harvesting of barks from tree trunk, branch, twig, leaves,



flowers, roots, etc. of *Bauhinia variegata*, *Holorrhena antidysentrica*, *Oroxylum indicum*, *Saraca asoka* and *Terminalia arjuna*.

Development of clump management practices for economically important bamboo species for enhanced production of quality culms and edible shoots.

Seed handling of important NTFPs of Tamil Nadu and Kerala states, seed handling of medicinal plants and post harvest techniques of *Jatropha curcas* were disseminated through posters, pamphlets and trainings.

Two pamphlets and a booklet in simple Hindi on cultivation of Atish and Chora for the benefit of end users were published and distributed among beneficiaries.

2.6.4. Chemistry of NWFPs, Value Addition and Utilisation

Active principle/ chemical analysis was undertaken for up to 12 months after storage under different storage conditions following both Ayurvedic and Modern analytical methods for medicinal plants namely *Asparagus racemosus*, *Rauvolfia serpentina*, *Withania somnifera*, *Aconitum heterophyllum* and *Picrorhiza kurrooa*.

Extraction of aromatic oil and its component are being studied from *Thymus serpyllum* at 3 stages of growth like before flowering, just at the time of flower initiation and during full bloom state. Initial result indicated that Oil percent is not much varied in wild and cultivated plant but the percentage of thymol & other compounds were highly increased in cultivated form compared with samples from wild.

Researches on Bioactivity of crude powder made from leaves, ripen and unripen fruit of *Aegle marmelos* on test organism has been undertaken at IFGTB, Coimbatore.

Fruits of *Garcinia indica* were collected from Subramanya and Puttur of Karnataka. Testing of two distinct fractions along with the crude extract for anti-diabetic property in mice by Streptozotocin induced model for Type-I and Type-II diabetes is in progress.



Garcinia indica Fruits



Processing and Drying of Fruits

L-DOPA contents in seeds of *Mucuna pruriens* Linn. from different areas of Andhra Pradesh, Karnataka, Kerala and Tamil Nadu were estimated. It was observed that white seeds yielded less (3.12% w/w) compared to black mottled seeds (4.5% w/w).



Seeds of *Mucuna pruriens* Linn. from Different Areas



Physical and chemical properties of polysaccharides in the tubers of *Curcuma augustifolia*, *C. pseudomontana*, *Dioscorea bulbifera* and *D. hispida* and seeds and aerial parts of *Hyptis suaveolens* were studied.

Nutritive value of bamboo shoots was also investigated. Boiling shoots of *Bambusa tulda* and

Dendrocalamus strictus in 1% NaCl solution in water for 15 minutes, *D. asper* in 5% NaCl for 10 minutes and *B. bamboos* in 5% NaCl for 15 minutes proved best for removal of anti-nutrients. Different products like bari, pickles, papad, petha, sauce and cruches were made from the shoots.

SUCCESS STORY

Products from Hadjor, *Cissus quadrangularis*

Cissus quadrangularis (Hadjor) plant samples were collected from Chhindwara, Bhopal, Jabalpur (Madhya Pradesh), Nagarjuna Botanical Garden, Akola, Nagpur (Maharashtra), Janjgir, Raigarh (Chhattisgarh) and NRCAF, Jhansi, and established in nursery beds of the Centre and are being maintained. Fresh stem samples were collected on monthly basis and analysed for total phytosterols, ascorbic acid, macroelements and trace elements content. Macroelements viz. calcium, magnesium, potassium were analyzed and trace elements viz. zinc, copper, manganese, iron and selenium content were estimated on AAS. All the parameters have a synergistic effect on bone fracture healing, bone related problems and general weakness. Analysis of active constituents viz. total phytosterols and ascorbic acid in *C. quadrangularis* fresh stem samples collected from various places were also done simultaneously. The sample collected from Chhindwara was found to be the best in total phytosterols content followed by Akola. The sample collected from Piparia was best followed by Raigarh in terms of its ascorbic acid content. The best harvesting time based on its active chemical constituents was found to be December to March. Survey was conducted in some places of Chhattisgarh and Madhya Pradesh viz. Rajnandgaon, Khairagarh, Kapsi, Tamia and Betul district and collected information from the tribals and traditional herbal healers regarding their knowledge on best harvesting time of *C. quadrangularis*.

Stems (peel and core) *C. quadrangularis* were analyzed separately for moisture, yield, ash, phytosterols, ascorbic acid and phenols. Maximum amount of active constituents was found in peel as compared to pulp. Dehydration studies of stem were carried out from Department of Food Technology, Nagpur University, Nagpur which included solar drying, shade drying, oven drying and radio frequency drying treatments. Radio frequency drying method was found to be the best followed by shade drying in retaining maximum amount of active constituent. From economic point of view, shade drying could be recommended for large scale drying of the herb. Technology was developed for formulation of nutraceutical food products. Six nutraceutical food products viz. biscuits, cookies, jelly, squash, chutney and pickle were developed as per FPO (Food Products Order) & Prevention of Food Adulteration Act (PFAA) specifications in collaboration with Dept. of Food Technology, Nagpur. All the products were tested for consumer acceptance level by conducting the chemical and sensory evaluation of the finished products. The research results were disseminated to the user groups through training programmes. Brochures were published in English and Hindi.



Nutraceutical Food Products (squash, jelly, biscuits, cookies, chutney and pickle)
Developed of *Cissus quadrangularis* Stem.



An organometallic complex has been prepared by complexing Cu^{++} and Cr^{+++} ions with plant leaf extractives of *Prosopis juliflora* and *Cleistanthus collinus* as organic ligands. This complex is being evaluated as a wood preservative by measuring the anti-fungal, anti-termite and anti-insect activity. Initial results indicated strong inhibition of fungi by the extractive. Studies on anti-termite, anti-insect activity of the complex are in progress.

Tubers of *Asparagus racemosus* were sown in nursery beds and 70% sprouting was recorded at a depth of 2.5 to 5 cms. The data showed that size of the tuber grown in stress condition are comparatively bigger than the irrigated one. Chemical analysis of tubers for saponin indicated large variation at all the selected sites.

Studies on phyto-proteins from selected plants of North-East region for the production of protein concentrates with greater food value were undertaken.

Chemical constituents imparting durability to wood and pest resistance to leaves of Eucalypt hybrids were identified. Heritability and other genetic parameters for wood and foliage constituents and their genetic correlation were also established.

Quantitative variation of bioactive ursolic acid in foliage of different physiological stages was studied using HPTLC.

Chemical constituents from ethnobotanically important medicinal plants—*Pavetta indica* and *Scindapsus officinalis* were isolated and characterized.

Extraction of the seed kernel was done with solvents of elutropic series viz. petroleum ether, chloroform and methanol. Fractionation of the methanol extract was done in ethyl acetate and butanol fractions. A process is being optimized to

prepare hederagenin from seed kernel extract. The extracts prepared were tested against 8 forest fungi namely, *Alternaria* sp., *Colletotrichum gloesporioides*, *Phoma* sp., *Phomopsis dalbergiae*, *Fusarium oxysporum*, *Ganoderma lucidum*, *Rhizoctonia solani* and *Trichoderma pilluliferum* at different concentrations i.e. 0.5, 1.0, 1.5 and 2.0 per cent.

Carboxymethyl Cellulose (CMC) was prepared from -cellulose isolated from *Lantana camara*. Reaction conditions were optimized for grafting of alpha cellulose with acrylamide.

Petroleum ether, Chloroform and methanol extracts of *Malaxis acuminata* pseudobulbs, *Drymaria cordata* (whole plant) and *Mussaenda glabra* (bark) were prepared. Fractionation of the methanol extract was done in ethyl acetate and butanol fractions. Column chromatography of the petroleum ether extracts of *Drymaria cordata* (1:1) resulted in isolation of a pure compound. It was found to be -sitosterol. Two more compounds were isolated from the above extract.

Fruits of *Diospyros peregrina* were fractionated to obtain 4 fractions i.e. chelator soluble pectic fraction, carbonate soluble pectic fraction, alkali soluble hemicellulosic fraction and cellulosic residue fraction and their chemical investigations were carried out. Variations in chelator soluble pectin fraction, carbonate soluble pectin fraction, alkali soluble hemicellulose and cellulosic residue with fruit ripening is in progress.

Water extract of roots of *Achyranthes bidentata* and two pure compounds isolated from *Achyranthes aspera* seeds exhibited 92% maturity of silkworm *Bombyx mori* L. in 18 hrs. While in case of control, only 69% maturity was observed in 28 hrs. Three formulations were developed namely ASM, ARW, ABRW and tested at Sericulture Research Station, Sahaspur on *Bombyx mori* L. at rearing house.



Generally spinning of silkworm of *Bombyx mori* L. takes 24 to 36 hrs. for completion. In our study, spinning completed in 15-18 hrs. Due to shortening of time period, consumption of mulberry leaf was less and uniform spinning was obtained. This will help at the time of scarcity of mulberry leaves. The above formulations will be useful to farmers in rearing of silk worm with very good cocoon quality. The main achievement of this project is reduction of spinning time period just half of normal time.

Significant yield of dyes were achieved from aerial parts of *Tagetes minuta* and fruit pericarp of *Terminalia chebula* under optimized conditions. Dyeing of textile samples (silk, wool and cotton) followed by mordanting and determination of colour coordinates have indicated good colourfastness properties of dyed fabrics using the dye isolated from both the plants.

Ten dye plant species were identified, collected/procured and processed for extraction of dye. Dyeing trials on human hair with the extracted dyes were also carried out.

Baccraurea sapida (common name—Leteku) & *Aporusa dioica* (common name—Tamsir) and *Biscofia javanica* (common name—Urium) were identified for making dye. Plant material was collected & processed for extraction of dye. The plant material was extracted for material to liquor ratio & time for isolation of dye from two species has been optimized. Herbarium maintained & identified from BSI, Shillong.

2.6.5 Biofuels and Bioenergy

Multilocational trials of 9 superior accessions of *Jatropha curcas* were raised at TFRI, Jabalpur in 2008 and 19 accessions in 2009. On the basis of growth attributes, two accessions HAP-41 and HAP-44 (Garhwal, Uttarakhand) were recorded to give higher number of branches without pruning.

A national multilocation trial comprising of 36 accessions of *Jatropha* were established at TFRI, Jabalpur. Accession TFRI-2 performed better with respect to growth, number and size of fruits. Raised performance trial from 24 elite accessions, native trials from 160 accessions and spacing and pollarding trials of *Jatropha curcas*. Clonal trials and seedling seed orchard of *Jatropha curcas* were established. Progeny trials of 30 CPTs of *J. curcas* selected from Rajasthan and Gujarat were also established.



Jatropha Plants after Pruning



Jatropha Fruiting

Demonstration - cum - experimental plantations of *Jatropha curcas* was established on 23 has. of area in Himachal Pradesh. Experimental trial with 10 superior accessions of *Jatropha curcas* has been established in Himachal Pradesh.



Rooted Cuttings Trial at Solag (Bilaspur)



Half-sib Trial at Jawalaji (Kangra)



Maximum reducing sugars was obtained 40.2 g/l (66.65 %) in *Lantana camara* and 33.9 g/l (56.20%) in case of pine needles.

Interesting results were obtained first under current study when lignocellulosic hydrolyzate obtained after hydrolysis was further heated under optimized conditions. After heating there was an increase in Total Reducing Sugars (TRS) content.

Pre-extraction of lignocellulosic biomass (*Lantana camara* and Pine needle) with different solvents resulted reduction in phenolic content (a measure of toxicity) after hydrolysis. *Lantana camara* after pre-extraction with solvent methanol reduced the phenolic content by 18.9% and Pine needle after extraction with solvent alcohol-benzene resulted reduction in phenolic content by 65.92% after hydrolysis.

Fermentation efficiency was increased by using different medium instead of conventional medium. Fermentation efficiency was increased from 77.27% to 80.72% in case of *Lantana camara* and from 78.93% to 79.75% case of Pine needle.

National trial comprising of 5 accessions and zonal trial of 17 accessions were established

at institute campus in the year 2005 and 2006. TNMP-14 and RAK-5 are performing better in national trial whereas IGAU-1 and IGAU-2, JNKVV-29 and JNKVV-15 in zonal trial. A progeny trial comprising of 20 progenies was established at Balaghat, Kushmeli Chhindwara, Sikharpur, Chhindwara and Lalpur Satna were found most promising genotype among other progenies. The fruiting was observed in IGAU-3 accession of zonal trial.

Different type of wood wastes were collected from sawmills and its physical properties were studied. Calorific value, proximate and elemental analysis of collected wood waste were also analysed. Wood chips, bamboo chips and saw dust were oven dried for biomass gasification.



Gasifier



Producer Gas