COMPLETED EXTERNALLY AIDED PROJECTS

Project 1: Identification of species and ethno-botanical survey. [ID no. 088/ TFRI/2005/Bio-3(CGMFD) (6)]

Findings: Nine PPAs of 5 divisions were quantitatively and qualitatively analyzed as per resource survey methodology. About 50 sample plots of 0.1 ha with stratified systematic sampling design were laid out in 1000 ha area of each PPA. Four subplots of 5 x 5 m size were laid out inside the main plot. Each one of them was marked at a distance of 11.2 m from the centre of the plot on all four sides. Study of important medicinal plants and MFP species on each plot was done. Five subplots of 2 x 2m were laid out inside the main sample plot for the study of regeneration.

Phytosociological (qualitative and quantitative values for structure and composition) studies were undertaken in all the nine people protected area of 0.1 ha each site. All individuals of > 10 cm CBH (Circumference at breast height at 1.37 m) were enumerated. Data were recorded in all fifty sample plots of each 9 PPA.

The vegetation data were quantitatively analysed for density, frequency and basal area. The relative values of frequency, density and dominance were also determined. These quantities were summed up for getting Importance Value Index (IVI) of individual species. On the basis of IVI, dominant, co-dominant and main associated species are recognized in different sites. The composition of forest and regeneration status along with other growth parameters such as girth was also enumerated.

Enumeration of vegetation in the Makadi range indicated the presence of 2347 trees of over 10 cm cbh/gbh in 0.1 ha sample plot. It is represented by 29 families, 49 genera and 62 species. Plant community was recognized accordingly as *Shorea - Terminalia* community. A density of 469.4 trees /ha was found. *Shorea robusta* was found dominant with 110.6 trees/ ha followed by *Terminalia tomentosa, Buchanania lanzan* and other species. Basal area of trees ranges from 7.769 m^2/ha to 0.02m^2/ha. Total 62 tree species were enumerated. Forty one species of medicinal plants were recorded in Makadi PPA.

Antagarh PPA indicated the presence of 3671 trees of over 10 cm cbh/gbh in 0.1 ha sample plot. It is represented by 24 families, 37 genera and 62 species. On the basis of density the species *Cleistenthus collinus* secured the highest value (146.4 trees/ha) followed by *Shorea robusta.* Plant community was recognized accordingly as *Cleistenthus - Shorea* community. Total basal area 11.44 m^2/ha was observed. Total 43 tree species were enumerated. 37 species of important medicinal plants were inventorized.

In Dugli PPA of Dhamtari area 41 tree, 10 shrub, 26 herb, 14 climber and 2 grass species have been observed. 41 tree species belongs to 19 families and 37 genera. Plant community was recognized as *Shorea – Terminalia* community. Total 41 tree species were enumerated. Density under Dugli PPA was 501.8 trees/ha and basal area 7.01 m^2/ha was observed. Total 39 species of important medicinal plants were listed out.

Enumeration of vegetation in the PPA Sankra range indicated the presence of 3142 trees. It is represented by 25 families, 47 genera and 53 species. Plant community was recognized as *Shorea- Cleistenthus* community. A density of 628.4 trees /ha was found *Cleistenthus collinus* was found as dominant species with 115.4 trees/ ha. Basal area of trees ranged from 3.75 to 0.002m^2/ha. The highest basal area was shown by *Shorea robusta*. Total 53 tree species and 26 important medicinal plants were recorded.

The vegetation in the Karpawan PPA indicated the presence of 2445 trees. It was represented by 27 families 51 genera and 60 species. Plant community was recognized as *Shorea- Terminalia* community. The total density was 489 trees /ha. *Shorea robusta* was found as dominant with 110 trees/ ha. The highest basal area was shown by *Shorea robusta*. Total 60 tree species were quantitatively enumerated and 77 species listed as important medicinal plants.

Enumeration of vegetation in the Machkot PPA indicated the presence of 2232 trees. It is represented by 27, families 46 genera and 56 species. Plant community was recognized as *Shorea- Pterocarpus* community. Total density was 469.4 trees /ha. *Shorea robusta* was found dominant with 99.2 trees/ ha. Overall total basal area covered by the trees was 13.42 m^2/ha. 54 tree and 77 medicinal plants species were recorded.

The vegetation in the Guriya PPA indicated the presence of 2181 trees. It is represented by 28 families, 50 genera and 55 species. Plant community was recognized as *Shorea- Pterocarpus* community. Total density was 436.2 trees /ha and *Shorea robusta* was found dominant with 131 trees/ ha. The total basal area of trees in the area was 25.1 m^2/ha. Total 55 tree and 59 medicinal plant species recorded.

Vegetation in the Ataria PPA of Lamni range indicated the presence of 3236 trees. It is represented by 21 families, 38 genera and 42 species. Plant community was recognized as *Shorea- Terminalia* community. Total density was 647 trees /ha. It indicated high density and highly protected area. *Shorea robusta* was found as dominant with 181.6 trees/ ha. The total basal area of trees in the area was 11.87 m^2/ha. *Shorea robusta* showed the highest basal area. 42 tree species were enumerated and 41species of medicinal plants recorded.

The vegetation in the Keonchi PPA, indicated the presence of 1172 trees. It is represented by 20 families, 33 genera and 37 species. Plant community was recognized accordingly as *Shorea- Terminalia* community. Total density was 468.4 trees /ha and *Shorea robusta* was found as dominant species. The total basal area of trees in the area was 34.23 m^2/ha. Total 37 tree species were enumerated and 72 species of medicinal plants were recorded.

In all, 1114 species of flora (tree, shrub, herbs, grasses and climbers) in all PPAs including species observed in low intensity and under threat were also listed.

Project 2: Screening of indigenous species of *Trichogramma* Westwood and *Trichogrammatoidea* Girault (Hymenoptera: Trichogrammatidae) from central India and their utilization against important forest insect pests. [077/TFRI/2005 / Ento-(1) 9].

Findings: Of the 2590 specimens collected from Madhya Pradesh,Chhatisgarh, Maharastra and Orissa, 37 species of *Trichogramma viz. T. achaeae*, *T. agriae, T. breviciliata, T. latipennis, T. kankerensis*, *T. chilotraeae, T. flandersi, T. fasciatum, T. hesperidis, T. higai, T. plasseyensis, T. raoi, T. sembeli, T. semblidis, T. pallidiventris, T. vargasi, T. thalense, T. sericini, T. julianoi, T. bezdenkovii, T. parkeri, T. brevicapillum, T. nomlaki, T. tshumakovae, T. fuentesi, T. ingricum, T. savalense, T. margianum, T. rossicum, T. ostriniae, T. artonae, T. clotho, T. lachesis, T. lenae, T. pretiosum, T. poliae, T. stampai* ,and 04 species of *Trichogrammatoidea* viz. *Trichogrammatoidea bactrae, T. fumata, T. armigera & T. ruficorpa* were recoded for the first time from central India.

Ten species of genus *Trichogramma* and two species of Trichogrammatoidea are proposed as the species new to science. Complete host-range has been prepared, after consulting the world literature for all available species of *Trichogramma* & *Trichogrammatoidea*. Live culture of 4 indigenous species viz., *Trichogramma raoi, T. plasseyensis, T. latipennis & T. breviciliata* are being maintained.

Project 3: Standardization of sustainable harvesting practices of Arjuna (*Terminalia arjuna)* Bark. [ID.No. 078/TFRI/2005/NWFP-1(MPFED) (12)]

Findings: Presently the bark of Arjuna is being extracted through unscientific and destructive harvesting practices. This is the first study on development of sustainable harvesting practices of Arjun bark. *T. arjuna* has the ability to withstand bark removal as long as the vascular cambium is not destroyed.

The study revealed that the regeneration of bark in young trees was faster in comparison to old trees. The bark was regenerated in two years. The medium aged trees gave better quality of bark in terms of their major active ingredients. The best time to harvest bark was found between March and April. The study recommends that for sustainable harvest, only ¼ or $1_{/3}$ of the mature bark of total girth of the tree should be stripped by removing only outer and middle bark leaving the inner bark for regeneration from opposite quarters of the trunk. Thus sustainable bark harvesting can be done after every two years by removing opposing quarters of trunk bark rather than girdling the trees.

Project 4: Standardization of non-destructive harvesting practices of Aonla (*Phyllanthus emblica*), *Baheda* (*Terminalia bellerica*) and *Baividang* (*Embelia ribes*) fruits. [097/TFRI/2005/NWFP-8 (CGMFD) (20)]

Findings: The study revealed that harvesting time plays very important role in maintaining the sustainability because only mature fruits produce viable seeds. The fruits if harvested at right maturity in Aonla (December-January), Baheda (January-February) and Baividang (November-December), they produce viable seeds. Even small quantities of fruits (5-10%) were found sufficient for regeneration. The study also suggests that anthropogenic pressures other than harvest could be responsible for difference in regeneration between protected and unprotected areas, which are managed under similar harvest intensities. Grazing and fire is the major causes for poor regeneration. In protected areas, 10-20 % Aonla fruits were found sufficient for regeneration. However, in unprotected areas less regeneration was observed even if 20% fruits were left for regeneration. In Baividang, 5-10 % fruits were found enough for proper

regeneration in protected areas of Dhamtari district in good fruiting year if harvested in December. In Baheda, even 5-10 % fruits were found suitable for its regeneration in protected areas if harvested in the month of January. In Baheda, the seed dispersal is very poor. For proper dispersal and to maintain sustainability, mature seeds should be dispersed in the forest area. These practices may be helpful for the sustainable management of these important medicinal plants.

Project 5: Standardization of non-destructive harvesting practices of Arjun (*Terminalia arjuna)* and Maida (*Litsea glutinosa*) bark. [096/ TFRI/ 2005/ NWFP-8 (CGMFD) (19)

Findings: The study revealed that the regeneration of bark in young trees was faster in comparison to older trees. In Arjuna, the bark was regenerated in two years whereas in Maida it took only one year. In Arjuna, the quality of trunk bark was superior in comparison to the bark of other plant parts, whereas no significant difference was found in Maida. In Arjuna, the bark thickness at breast height varied from 8.12 to 20.96 mm and was found to be irrespective of the age/girth of tree. The tannin content in Arjuna bark ranged from 6.89 to 11.83 gm per 100 gm. Mature Maida trees had thick bark with less mucilage content in comparison to younger trees. The study also showed that the stage of bark recovery (regrowth) varied from tree to tree. Arjun showed remarkable bark regrowth in moist sites. The medium aged trees gave better quality of bark. The best time to harvest bark was found between December and March. The study recommends that for sustainable harvest, only ¼ or $1/3$ of the mature bark of total girth of the tree should be stripped by removing only outer and middle bark leaving the inner bark for regeneration from opposite quarters of the trunk. The length of blaze/strip can be upto 1.20 meter depending upon girth of the trees. A long strip of one quarter of the trunk may be removed with sharp thin edge tool designed for the harvest of bark.

Project-6 : Processing techniques of NWFPs of Chhattisgarh TBOs–*Madhuca latifolia, Shorea robusta,Schleichera oleosa, Pongamia pinnata* and *Buchanania lanzan*. [ID No. : 091/TFRI/2005/NWFP-3(CGMFD)(14)

Findings: Study conducted on processing of Tree Borne Oil seeds (TBOs) *i.e.*. Sal (*Shorea robusta*), Chironjee (*Buchanania lanzan),* Karanj (*Pongamia pinnata)*, Mahua *(Madhuca latifolia)* and Kusum (*Schleichera oleosa*) indicates that method of drying and storage in containers affect the quality of oil seeds severely. Different methods of drying i.e. shade, sun drying, hot air drying at 40, 60 and 80ºC were used to dry the tree borne oil seeds. Hot air drying at 60ºC proved better in comparison to sun drying /shade drying methods to maintain quality of seeds. At 80ºC, the moisture of the seeds decreases rapidly and affects the quality of seeds. Hot air drying at 60 °C for 8 hours was found to be most effective in minimizing moisture content to 7-9% without affecting oil quality and undesirable changes in lipids and its properties. The kernels obtained after processing of seeds should be dried properly before storing to avoid deterioration due to pests. This will ensure availability of good quality seed kernels for the extraction of oil with minimal deterioration.

Project 7: Quality assessment of NWFPs: *Asparagus racemosus, Buchanania lanzan*, *Andrographis paniculata*, *Phyllanthus emblica* and *Embelia ribes* from Chhattisgarh. [ID No.: 092/TFRI/2005/NWFP-4 (CGMFD) (15)

Findings: The maximum weight of fresh Aonla fruits was recorded as 6.89 gm, pulp weight 6.44gm and ascorbic acid was recorded as 197.2mg/100 gm fresh aonla in samples collected from Ambikapur. In Jabbara Nagan, the maximum fresh weight of Aonla was recorded 6.447 gm and the pulp weight was 6.53 gm and ascorbic acid 143.5 mg /100 gm of fresh weight. Ascorbic acid contents was found to be significantly higher in aonla samples collected from Kanker. Maximum weight of fresh fruit was recorded 5.77 gm, pulp weight 4.99 gm and ascorbic acid 326.3 mg/100gm of fresh fruit.

The fruit weight of Chironjee ranged from 0.552 to 0.802 gm with maximum fruit weight in Kapu, Dharumjaigarh samples. Samples collected from Kudur, Kawardha showed maximum kernel weight (1.20 gm) and oil (62.57%).

Out of 20 localities surveyed for the quality of Chironjee, the maximum fruit weight of 0.802 gm was recorded from Kapu and Dharmngaigarh samples. The maximum oil percentgage 62.57% was observed from the samples collected from Kudur and Kawardha.

Roots of Satawer (*A.racemosus)* were collected from 22 localities of Chhattisgarh during the month of April-May. Maximum average root length of 25.35cm and dia 1.02 cm and saponin percentage of 2.5 % was observed in the samples of Dondi (Durg), which are significantly higher than other localities.

Kalmegh samples were collected from 19 localities. Andrographolide contents were observed to vary from 0.27 to 0.49%. Maximum andrographolide content was found in the samples collected from Jagdalpur (0.49%).

Physical and chemical parameters of fruits of *Emblia ribes* were studied in samples collected from 5 localities of Chhattisgarh. The moisture % and embelin contents were estimated. Embelin concentration was ranged from 1.98-2.94%. Maximum concentration of 2.94% was estimated in the sample collected from Jabbara, Dhamtari.

Project 8: Non destructive harvesting practices for selective MFPs species– *Buchanania lanzan* (Chironjee). [ID No.: 093/TFRI/2005/NWFP-5 (CGMFD) (16)

Findings: Surveyed and selected nine different Chironjee growing areas of Chhattisgarh state.The fruits were harvested on the basis of occular/ visual observations and number of branches per tree. Fruits were collected non destructively either by hand or with the help of long bamboo sticks. Sometimes beaten slowly to help fallen the fruits

Annual recruitment of young seedlings varied from site to site. Harvesting 90% fruits at Kota, Bilaspur resulted 7.90, 9.04 and 8.20% seedling recruitment in I^{st}, II^{nd} and III^{rd} years, respectively. In non-harvested control sites, it was 5.80, 9.69 and 9.69% respectively. It indicates that the population is increasing both in controlled as well as in different levels of harvesting.

Project 9 : Sustainable yield assessment/harvesting of Non Wood Forest Produce (NWFP) in People's Protected Areas (PPAs) of Chhattisgarh. [098/TFRI/2005/Silvi-3 (CGMFD -10)]

Findings: Sample plots of *Andrographic paniculata* (Kalmegh), *Aspargus racemosus* (Satawar) *Celastrus paniculata* (Malkangani) and Ae*agle mrmelos* (Bel) were laid out in three agro-climatic zones (Bastar, Raipur and Bilaspur) of Chhattisgarh.

Sustainability for *Andrographic paniculata* with maximum productivity was found to be at 80% harvesting level. As such 80% of entire plants of *Andrographic paniculata* may be harvested. Sustainability for *Aspargus racemosus* with maximum productivity was found to be at 60% harvesting level. Eight month old plants of *Aspargus racemosus* should only be harvested.

Sustainability for *Celastrus paniculata* with maximum productivity was found to be at 80% harvesting level. Similarly, sustainability for *Aeagle mrmelos* (Bel) with maximum productivity was found to be at 80% harvesting level. Regeneration through root suckers was found better than through seeds. Regeneration through root suckers by hoeing 10-15 cm. deep is advisable around the trees.

Socio-economic status and living standard of people in JFM areas have been found to be better due to implementation of the scheme by way of employment and enhancement of production of medicinal plants.

Project 10: Nursery technologies for mass multiplication of superior seedlings of Vaividang, Sarpgandha, Chironjee, Arjun, Aonla, Bel in Chhattisgarh. [099/TFRI/2005/Silvi-4 (CGMFD -11)]

Findings: Nursery technologies for mass multiplication of superior seedlings of *Embelia ribes* (Vaividang), *Rauvolfia serpentina* (Sarpgandha), *Buchanania lanzan* (Chironjee), *Terminalia arjuna* (Arjun), *Emblica officinalis* (Aonla), Ae*agle marmelos* (Bel) in Chhattisgarh were standardized.