FIELD FORESTER

VOICES FROM THE FIELD

VOLUME 1 • ISSUE 12 OCTOBER 2016

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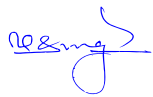
From the Chief Editor's Desk

Field Forester is a documentation of success stories and initiatives in forestry sector of India. It also encompasses issues and challenges facing forests and wildlife of the country and ways and means to address these issues. The October 2016 issue of Field Forester rightly covers various aspects in this direction. The topics covered in the present issue largely focuses on people centric forestry supplemented by articles on wildlife management, Agroforestry and shola forest ecosystem restoration works. The issue highlights the importance of taking forestry to people as in the case of Tree Growers' Society in Tamil Nadu , Agroforestry in Haryana and Importance of the multi-purpose tree Grewia optiva in the livelihood security of sub-Himalayan villages. Articles on Promoting Eco-tourism and Tribal Development through Vanasree Eco-shop reveals how forests can be channelized for improving livelihoods and nature interpretation by ensuring the objectives of Conservation. Articles on Management of Wild Elephants in Chattisgrah and Odisha, wildlife management in Pench Tiger Reserve and Eco-restoration of Shola Forests in Munnar of Kerala set examples of scientific approach in managing the forests and wildlife based on Ecosystem Approach.

The scope of Field Forester has now been widened as articles from Field Officers posted in various parts of the country have also been included in addition to the case studies undertaken by Officer Trainees of the State Forest Service. Thus Field Forester has been enriched with thoughtful writings and documentations that come straight from the field. I thank all the Officers and Officer Trainees for contributing their experiences and initiatives to this issue of Field Forester.



(R.P. Singh, IFS)

Forest Products

Improving timber productivity in eastern Maharashtra

Teak plantations done in the Tropical Dry Deciduous Forests of Eastern Maharashtra by the Forest Development Corporation of Maharashtra Ltd have proved to be a great success

Subhash KB &
Pramod Kumar Dhakad

The planting of genetically superior teak (*Tectona grandis*) in the hot and dry Southern Tropical Dry Deciduous Forests of Eastern Maharashtra by adopting stump planting, after the removal of miscellaneous overwood and retaining economically important tree as reserves, is carried out by the Forest Development Corporation of Maharashtra Ltd (FDCML) extensively. The method adopted helps in improving the timber productivity of forests while safeguarding the Non-Timber Forest Produces sources for the local tribes. The year-round forestry operations also create huge employment opportunities for the tribes and local people and in meeting the firewood needs of the people.

Study Area

The study area is the Central Chanda Forest Project Division in Ballarshah. The total area of the Division is 31,182.257 ha and has four Ranges—Zaran, Kanhargaon, Tohogaon and Dhaba.

central chanda Forest Project division

Terrain, Climate & Soil

The terrain of this area is mostly plain to gently undulating. Small patches towards north-east and west side are hilly and streams passing through the tract drain into the Wardha River.

Most of the tract is covered by sandstone and clay and remaining

Indian Forest Service (IFS) DIG R&T, MOEF & CC, New Delhi

forest area to the east is occupied by igneous rocks such as garbo, pyroxene and gneiss.

The soil to the west of Dhaba is sandy loam, deep and fertile, supporting high quality mixed forest while that to the north-east of Dhaba is clayey loam and supports medium quality dry teak bearing forests.

The climate of the area is characterised by a hot summer and general dryness throughout the year, except during the south-west monsoon season. Average annual rainfall varies from 1200 to 1400 mm. Maximum rainfall is received in the months of July and August. Occasional showers are received in winter from the north-east monsoon. The temperature rises rapidly after February till May, which is the hottest month of the year. The mean maximum temperature during May is 43^{0}C and the mean minimum temperature during December is 12.2^{0}C. In severe hot conditions, temperature rises up to 46^{0}C and occasionally even up to 48^{0}C.

Forests & Vegetation

The area supports Southern Tropical Dry Teak Bearing forests (5A/C1) and Southern Tropical Dry Deciduous forests (5A/C3). In the mixed dry forests, important trees include *Terminalia tomentosa, Terminalia bellerica, Anogeissus latifolia, Lannea coromodalica, Maduca indica, Diospyros melonoxylon, Acacia catechue, Acacia lucophloea, Delbergia paniculata,* etc. Undergrowth of *Dendrocalamus strictus* in varying densities is also seen in these forests. Most of the teak bearing area belongs to Site Quality III.

Establishment of Teak Plantation

New teak plantations are raised under the Teak Plantation and Reboisement Working Circle, as per the approved working plan for the Division. Out of 31,182 ha area, 8,311 ha of the Division comes under this working circle. The areas included in this working circle are teak plantations-failed (4,969 ha) due to anthropogenic factors, areas previously regenerated with inferior species like *Prosopis* (974.634 ha), un-tackled areas of miscellaneous natural forests (1,975 ha) and teak plantations raised from 2002 rains onwards that require tending (392.6 ha).

Silvicultural system adopted

The silvicultural system is named as 'Conversion to uniform system with supplemental artificial regeneration of genetically superior stock from known source of teak'.The seeds are collected from Seed Production Areas maintained by the FDCML and are screened, graded and distributed by the Maharashtra Forest Seed Centre, Nagpur. Quality teak stumps are used for planting operations and root trainer seedlings are used for casualty replacement.

Activities carried out

(i) **Demarcation of Coupes:** The area to be worked is called 'coupe' and is selected in advance according to the working plan prescription. A strip of natural forest of 20-metre width along the boundary, called coupe line, is demarcated on both

sides with pillars and painted band on trees. If the coupe area is more than 20 ha, it is divided into sections of 10-20 ha with a convenient section line of 5-20 m width in between the sections. No felling is done in coupe line or section line except improvement felling. After the demarcation of the coupe, the Stock Map and the Treatment Map are prepared. Hundred per cent enumeration is done in grids of size 1 ha in the entire area for preparing the Treatment Map.

(ii) **Marking areas to be excluded from felling:** All areas having more than 25 degree slope and strip of forest, 20 m wide along both sides of main water courses, are to be excluded from regeneration operations. Grids of Site Quality IV or having more than 0.5 ha of heavily eroded and exposed rocky areas, patches of poorly stocked forests and heavy waterlogged and blank areas are unfit for teak plantations and are excluded from the operations.

(iii) **Determination of areas fit for removal of overwood:** In other areas inside the coupe, the average crop girth in each grid is calculated using the enumeration data. If the grid has average crop girth equal to or more than critical crop girth for the site quality concerned, the area is selected for the removal of overwood and demarcated in the field.

(iv) **Marking of trees to be reserved:** All young to middle aged fruit-bearing trees up to 20 trees/ha with priority 30-90 cm girth class and young to middle aged trees of *semal*, *khair*, rosewood and other superior miscellaneous species up to 20 trees/ha with priority to 30-60 cm girth class are to be retained uniformly, spread over the area for future crop. All *kullu*, *mahua*, *chinch* and mango trees, irrespective of age, are also to be retained as reserves.

(v) **Overwood removal:** All the unmarked trees, poles, advanced growth, etc., in the area suitable for overwood removal are felled and timber, poles and firewood removed. In the areas excluded from felling and grid areas unsuitable for teak planting, and in coupe line and section lines containing existing forest, improvement felling is carried out to remove dead, fallen and hollow trees. Crooked and unsound advance growth of teak is also cut back. These operations are completed by March.

(vi) **Fire protection measures:** All along the inner edge of coupe line or the section line, a strip of 5-metre width shall be left at the time of planting for maintaining it as fire line.

(vii) **Planting operations:** Just before the commencement of monsoon, all shrubs and weeds are cut down and slashed. These are heaped

away from the retained trees and burnt. Aligning and staking is done at an espacement of 2m×2m and, on the commencement of monsoon, teak stumps are planted in crowbar holes. Sprouting is expected within a week.

(viii) **Post-planting operations:** In July, circular weeding is carried out around the plants, followed by strip weeding across the slope in August. Another strip weeding, perpendicular to the previous, is also carried out. In the next monsoon, in June, casuality replacement with root trainer seedlings is carried out followed by two strip weedings in July and September. By the third year, the success of the plantation can be visualised. Intensive fire protection and cattle protection should be given to the plantation area as it is prone to fire and cattle grazing.

Result and Discussion

The establishment of teak plantations under reserve trees after the removal of overwood is highly successful as the natural regeneration of economically important trees also ensured maintaining a good healthy mixture in crop. During the working plan period, 3,279.367 ha of teak plantation was raised successfully in the Division.

Maintenance of strips of natural vegetation in the coupe lines, section lines and along streams, and retaining middle aged trees uniformly over the plantation area as reserve, ensure regeneration against any mishaps due to severe droughts or frequent forest fires in the area.

Forest Products

Raising teak forest on degraded land

A successful scientific approach has been taken to felling and marketing of teak in Bramhapuri Forest Project Division

Anand Kumar & Balram Sharma

The Forest Development Board was established by the Government of Maharashtra in 1969 for converting large blocks of low value mixed forests into valuable stands. Considering its experience and the recommendations of the National Commission on Agriculture regarding raising of manmade forests, the Forest Development Corporation of Maharashtra (FDCM) Limited was incorporated under the Companies Act, 1956, on February 16, 1974, as a wholly owned government company of Maharashtra State. Its main objectives are to develop land in the State for forest resources by raising thereon plantations of economically important species as well as maintaining, conserving, protecting and preserving plants, crops, trees raised or come up naturally along with the existing fauna. Its business of managing forests is of commercial nature unlike that of the Forest Department.

Bramhapuri Forest Project Division (BFPD), under the North Chandrapur Region, was established on December 15, 1987, for reforestation of degraded reserved forest taken over from Bramhapuri Forest Division of North Chanda Circle of the Forest Department. The plantation, under NABARD, EGS and Waste Land Development Programme (WLDP) and Maharashtra Forestry Project (MFP), was taken up in 1995. The forest area was transferred to FDCM for scientific management purposes in the BFPD. A new area of 9,880.730 ha in Wadsa and Gadchiroli Forest Division, spread over 24 compartments, were taken over by BFPD in 2014, making the total area of this Project Division 30,132.741 ha of Reserved Forests in 69 compartments. Forest areas of this Division are found in compact and scattered patches. The forest of the track dealt with belongs to Sub-group 5A – Southern Tropical Dry Deciduous Forests – as per the revised classification of forest types of India by Champion and Seth.

The area consists of mainly metamorphic rocks with patches of laterite. Vindhyan sandstone occurs in some parts. East of Wainganga, the rock formation is of granite and gneiss. Chandrapur is the hottest district in Maharashtra having dry weather for major parts of the year. The mean maximum temperature reaches up to 46^0C and maximum recorded is 47.8^0 C. Hot blazing wind starts from April beginning up till the commencement

Officer Trainees 2015-17 Batch, CASFOS, Coimbatore

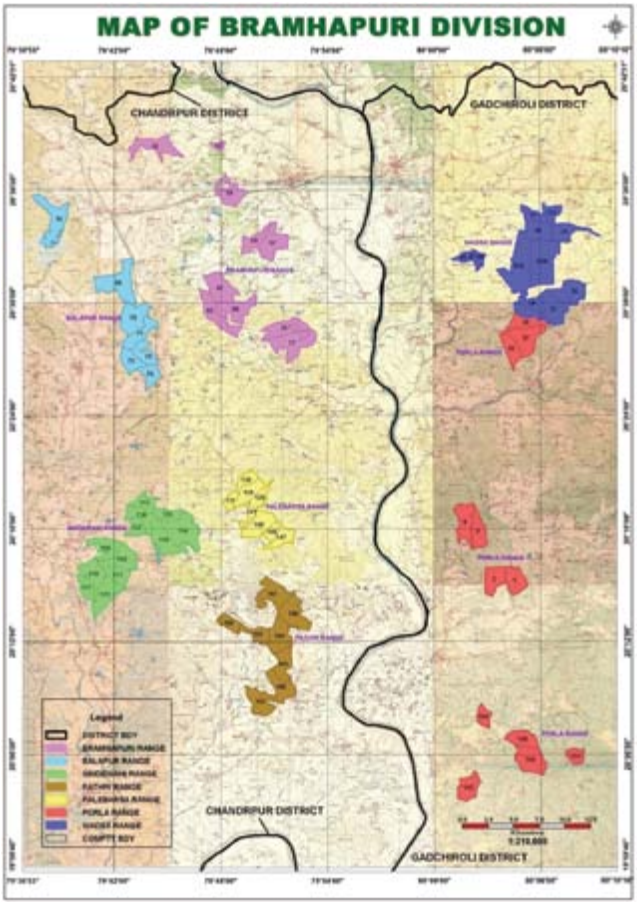
of monsoon. Occasional shower brings down the summer temperature. The rainy season is sultry. The rainfall varies from 770 mm to 2229 mm. The average annual rainfall is 1425 mm. The quality of teak forests varies from III to IV. The density of forests varies from 0.4 to 0.9; the crop consists mostly of middle aged trees with scattered matured and over matured trees. The matured/ over matured trees are branchy and malformed, exhibiting ill effects of instant fire and adverse effect of past maltreatment. The natural regeneration of teak is sporadic and not satisfactory and, at most of places, the degradation is compounded by a virtual absence of regeneration of this valuable species. The natural regeneration of other miscellaneous species, like *ain, bija, dhawada,* etc., is present in forest areas.

Scientific Management of Teak

Well established plantations having more than 50 per cent survivals and growth are treated as productive areas. Here, various tending operations are prescribed with an objective to enhance the standing volume and value of the regenerated areas. Areas having survival less than 50 per cent and where growth is stagnated because of certain edaphic factors are treated as failure and are proposed for appropriate treatment under different working circles. Assessment of the areas compartment wise has been carried out and history sheet is prepared for each of the compartment. Earlier efforts to regenerate areas have been listed. Area assessment has been carried out on the basis of revised Stock Map and ocular estimation of past plantations is recorded.

The area to be worked, called çoupe', is demarcated in advance of its working. All along the periphery of the coupe to be worked, a strip of natural forest of 20 m width, called coupe line, is demarcated by giving two coal tar bands and a red paint band in between on selected trees at suitable intervals. Coupe due for working is divided into suitable sections. The average size of a section is about 15 ha. A strip of existing forest of minimum 5 m width is demarcated, giving one band with red paint at the breast height and a cross mark above it on selected trees at suitable intervals on both edges of the strip separating two sections, called sections lines. While laying and demarcating section lines, wherever possible, groups of young pole crops of seed origin of teak, *semal, khair*, rosewood and other superior miscellaneous species are included in the section lines to avoid their sacrifice while removing the overwood.

After demarcating the whole area of the coupe, Stock Maps for the entire coupe are prepared in the 1:15000 scale, using conventional signs and depicting crown density, site quality, preponderance of species and existence or otherwise of bamboo. Compartment and section boundaries are distinctly shown in the Stock Map. After the preparation of Stock Map, section-wise Treatment Maps of the entire area are prepared on 1:5000 scale. The entire area of the coupe is divided into grids of size not bigger than 100 mx100 m. (1 ha) after taking the baseline, as far as possible, through the centre



of the section. For the purpose of determination of areas fit for removal of overwood, first, average crop girth (OB) of the forest in the remaining area is determined for each grid separately according to the formulae {Crop girth = 2 x square root of (π x B/N), Crop girth in cm = 250 x square root of (B/N)}, where 'B' represents average basal area per ha and 'N' represents average number of trees per ha in the crop excluding advance growth. The average Crop Girth so computed is compared with the Critical Crop Girth (CCG). No grid is selected for the purpose of removal of over wood if its average Crop Girth (O.B.) is less than the Critical Crop Girths.

In grids shown on the treatment map found fit inter alia as determined after applying the above test, marking for felling the entire crop is done. All young to middle aged fruit bearing trees up to 20 trees/ha and 20 trees/ ha of *semal, khair*, rosewood and other superior miscellaneous species are

retained. In addition, no marking for felling is done in all areas of coupe line and section lines containing existing forests where it is on the sides of water course of well defined *nalahs*. However, at other places, improvement felling, including removal of dead and hollow trees and those which are likely to fall, is done. Crooked and unsound advance growth of teak is cut back. No marking for felling is done in heavy water logged areas that are unfit for teak plantation. All along the inner edge of the section line a strip of 5-metre width is left at the time of planting for maintaining it as fire line.

All the exploitation works are done departmentally—by FDCM Ltd—by engaging local labourers. Transport of timber and firewood is done through haulage contractor. The rates are paid to the labourers as per the daily wages rate fixed by the Maharashtra government and the rates for exploitation works sanctioned by the General Manager of the North Chandrapur Region.

Ballarshah on the Central Railway is an all-India market for teak and non-teak timber, where timber is sold in large quantity. Some of the marginal timber is also disposed of by FDCM Ltd at local depots. Chandrapur is an important centre for storage and export of charcoal. Due to intensification of working of FDCM, timber depots are opened in and near the forest and periodical sales are held. Balapur, Pathari and Sindewahi are the main depots of this Division. Purchasers from various districts and even outside State, such as AP, attend the sale at Ballarshah depot.

Conclusion

BFPD under FDCM has been formed for development and management of forest into higher economic value. Its objective is to develop modern nurseries for production of genetically superior planting stock. Such a high quality planting stock is made available to forestry sectors. It will turn key projects in the urban forestry sector in a professional manner and will also encourage to take up commercial plantations on private lands. Eco-tourism, bamboo marketing on wholesale basis, production and marketing of high quality compost, non-timber forest produce like medicinal plant and *in-situ* and *ex-situ* conservation are among its other important goals.

Acknowledgements

We wish to place on record our sincere thanks and profound gratitude to DFE, Dehradun, and CASFOS, Coimbatore, for providing us an opportunity to visit Bramhapuri Forest Project Division (Maharashtra) for this case study from July 15-29, 2016. We also express our thanks to all the forest officers, staff and all the resource and expert persons at Forest Development Corporation of Maharashtra Limited for giving help and valuable information about their field. We express our gratitude to Dr T S Ashok Kumar, IFS, Principal, CASFOS, Coimbatore, for his valuable guidance and support for this case study.

Peo PLe ANd Forest s

Promoting ecotourism

Management of ecotourism activities by JFM committees in Mahabaleshwar and Sinhagarh can help reduce human pressure on the fragile environment

Prashant Garg & Pankaj Kasana

Ecotourism is one of the fastest expanding tourism markets and is widely accepted as responsible tourism focused on the livelihood of local people. It has received much attention in developing countries like India. As an agent of change, ecotourism has been linked to sustainable development strategies and initiatives in many places. Operating in its ideal form, ecotourism provides the tourist with a quality experience of nature, generates funds and support for conservation efforts, has minimal environmental impact and provides socio-economic benefits to local host communities.

This requires a shift in attitudes, from regulation and control to empowerment, from patronage to partnership, and from linear government-led structures to alliances with diverse stakeholders. It can be achieved by a well-articulated partnership policy that cascades into a viable business plan with clear mission statements and strict monitoring and evaluation criteria. While ecotourism projects need to be financially independent to remain sustainable without grants and subsidies, the primary pillars of community involvement and enhancement of the environment are paramount in measuring the success.

Need of JFM Committee

There was a rapid degeneration of historic values in Sinhagarh Fort and scenic points of Mahabaleshwar due to inadequate conservation efforts and severe weather conditions. Historic structures, such as buttresses, fortification wall, historic doorway, moats etc., were in a state of dilapidation. There was a lack of directional and informative signage and basic amenities, including toilets and drinking water. The absence of a public mode of transport to the fort and well-defined boundaries resulted in inadequate safety and security of the approach road. Open-ended and harmful impact of unorganised tourism and lack of proper drainage and garbage disposal were among the basic reasons.

By inviting people's participation, Joint Forestry Management (JFM) was started in 2006 in Mahableshwar and its adjoining areas like Kshetramahabaleshwar, Bekwali, Avkali, Pratapgarh and Gureghar with the following objectives:

- Plastic eradication
- Forest development

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- Ecotourism, women empowerment
- Employment generation
- Soil and moisture conservation, etc.

Tourism Development Works

Plastic Eradication Campaigns are run from time to time. The Forest Guest House in Mahabaleshwar is managed and maintained by a JFM committee and thus helpful in reduction of government expenditure. Many other works, like plantation, barbed wire fencing, safety railing, cement benches, colour band on trees, installation of dustbins, etc., are also being implemented through JFM.

There are 26 nature trails of in Mahabaleshwar. These trails were used by British for walking and are being developed by JFM committee.

Landscape development is being done on similar lines as of the fort, including provision of lookout points, pathways, plantation of flowering trees, etc.

Economic Upliftment of Local Communities

JFM committee also provides employment to local people. It has installed an RO plant and water ATM machine to provide safe drinking water to villagers and tourists. For clean fuel and to avoid pressure on forests for fuel wood, LPG is provided to villagers.

Fringe villagers are involved in various forestry operations as VFC members and received support for their employment generation. The Forest Department gave emphasis on the scientific management of forest resources and developed management plan after proper survey and taking into consideration socio-economic aspects. The planning process also involved local people. Village-level micro plans were formulated through the participatory method of rural appraisal so that appropriate socio-economic development of these villages can be taken up in a phased manner. The Forest Department focused on community development through various eco-friendly income-generation support activities for VFC members.

These socio-economic activities of the Forest Department have helped in reduction of dependency on forest resources for livelihood and, as a result, pressure on forest resources has gradually reduced. It is evident that the government gave emphasis on the overall community development of the people around the forest as they are an integral part of the forest ecosystem and their livelihood needs have to be addressed in order to ensure long-term conservation of resources.

Other Major Contribution

JFM committee is helping injured animals by providing them veterinary help. Signages of dos and don'ts are displayed at conspicuous places. CCTV cameras are installed at the entry gate and ticket counters for better surveillance.

Also, increasing use of bottled water nowadays has created hazard of plastic waste. To cope up with this problem, the committee has installed a plastic bottle crushing machine.

Threats of Ecotourism

The number of tourist arrivals in

Mahabaleshwar has almost reached the carrying capacity and any increase would be unsustainable. A necessity has been felt to develop satellite locations to shift or divert the tourist flow. Trampling of endangered species and disturbing the balance of breeding habits by tourist may cause loss of biodiversity. Development of transport routes, clearance of natural vegetation for hotels and facilities will further put pressure on the ecosystem. Further, plastic garbage is hindering the natural flow of water.

Suggestions

For making tourism and conservation sustainable, there is a need for assessment of the present situation and planning for future. Some suggestions are as follows:

- Carrying capacity of day tourists and their night stay options should be assessed and controlled. This can be regulated by providing limited entry passes.
- Guides and caretakers should be educated to tackle international tourists.
- Accommodation and other facilities need to be upgraded for promoting international tourists.
- Wildlife sightings can be increased by habitat development.
- An interpretation centre and nature trails may be planned in near future.
- Marketing of local handicraft should be insured.
- Increase in facilities like post office having telephone facility, primary health centre with medicines, bus services and more teachers and educational institutions can help in development.
- Studies on habitat and water hole utilisation should be planned.
- Limiting unproductive cattle and immunisation of cattle should also be planned to reduce grazing pressure.
- Villages are still largely dependent on the forest for meeting their basic requirements of fuel wood. Hence, providing alternatives like 'gobar gas plants' is an urgent requirement.
- Local people can provide accommodation, story tellers and guides.
- The mountain range of Sahyadri offers plenty of opportunity for trekking, hiking and rock climbing and these could be promoted.
- Activities like bird watching may be developed through JFMC.
- Telescopes should be installed for better view at tourism points.
- Various campaigns should be organised in the vicinity of ecological important sites.
- More dustbins should be installed to avoid the menace of plastic.

Forest MANAGeMeNt

Rejuvenating Tirumala hill forest

Afforestation, constant monitoring and fire control has led to natural regeneration in the area

Chandrapal Singh Chouhan & Sunil Gupta

The Tirumala hills lie above Tirupati town which is situated in Chittore district of Andhra Pradesh. The Tirumala hills are part of the Seshachalam range which is part of the Eastern Ghats of India. The hills are at average 853 metres above mean sea level. The hills comprise seven peaks, representing the seven heads of Adishesha in mythology. The famous Tirupati Balaji temple, devoted to Lord Vishnu, lies on the seventh peak–Venkatadri. This is second richest temple in the world after Vatican City. The Tirumala enclosure covers about 26.78 sq. km. The temple is visited by more than 65,000 pilgrims daily and the number of devotees goes up to five lakh people during Brahmotasav. The temple is believed to have been constructed in 300.A.D. In 1932, the temple was handed over to the Tirumala Tirupati Devasthanam by the TTD Act of 1932.

Climatic conditions and Topography

The south-westerly monsoon starts in the later half of June and is fully active in July and August and tapers off in September. The north-easterly monsoon is active in October and November. The Tirumala hills receive a higher rainfall than the surrounding plains. The diurnal variation of temperature is high in summer when compared with winter. On account of the elevation, the summer is not severe. It is mildly hot to pleasant. The winter is also mild chilly and there is no frost. The summer season is from March to June, the rainy season from June to December and winter from November to February.

The water supply is from the following sources: Papavinasanam reservoir, Murthynayani Cheruvu, Akasaganga water fall and Gogarbam tank. The underground potential is yet to be tapped fully in the area.

The average annual temperature is as follows: Minimum from 31 degree celsius to 44 degrees in Tirupati while for Tirumala, it is 25 to 35 degree celsius.

Afforestatation

The forest prevalent here is southern tropical dry deciduous forest bearing red sanders. However, the area had become degraded forest and scrub jungle due to heavy biotic pressure and frequent fire. So to revegetate the area, a bio-aesthetic plan was prepared by the Forest Department during 1975-76 to be implemented by Tirumala Tirupati

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Devasthanam. Subsequently, a fully fledged Forest Department was created in 1980 in TTD. The following projects were undertaken to cater to the needs of reforestation:

1. Bio-aesthetic plan (1980-1996)
2. Haritha project (2000-2004): Financial Expenditure was Rs. 7 crore (both Plan1 & 2)
3. Action plan (2015-2020): Approximate Expenditure was Rs. 50 crore for five years.

Bio-aesthetic Plan

Objectives

1) To protect the existing crop in the area from further degradation and degeneration and to prevent further denudation.
2) To preserve, protect and conserve whatever soil is there in the area.
3) To conserve sub soil moisture and raise the water table in order to increase the infiltration of water into the springs, Theerthams and wells.
4) To prevent the silting up and to prolong the life of tanks and water reservoirs like Gogarbham, Alwartheerthum tank, etc.
5) To create a bio-aesthetic environment in Tirumala Hills as well as on the hill slopes and plains near Tirupati town.
7) To plant avenue trees all along the pilgrim routes leading to Tirupati and Tirumala.
8) To raise medicinal plants, aromatic grasses and plants, etc., as an understorey crop to utilise the space fruitfully.

Plan components

1. Plantation in 27 vanam
2. Avenue plantation
3. Township plantation
4. Institutional plantation
5. Colony plantations
6. Barren hills afforestation
7. Ghat Road beautification

Plantation in 27 vanam: Pits were filled with good imported red earth, wherever necessary. Depending on the requirement of the species, plants were watered to boost growth @ 45 waterings per year. While refilling soil, Phorate (25gm), Dithane M (45 gm), Single Super Phosphate (100gm), Neem cake (30gm), Ammonium sulphate (25gm) was properly mixed. Also, saucer pit or Thanwla of 1 meter dia was dug to harvest rainwater.

The species planted were: *Psidium guajava, Mangifera indica, Tamarindus indica, Artocarpus heterophyllus, Punica granatum, Annona squamosa, Azadirachta indica,* Bamboos, *Pinus carabea, Pterocarpus santalinus, Acacia auriculiformis* and *Grevillia robusata*.

Maintenance of plantations is done for up to five years. After one month of planting, replacement is done up to 25 per cent in the planting year itself. During subsequent years, the first weeding was carried out in June and the second during December/January. Moreover, DAP/Urea dose was given at the time of watering. After the third year, pruning was also done as per standard procedures.

Avenue Plantation: The roads radiating from Tirupati town, the

Ghat roads to Tirumala and pedestrian paths to Tirumala were included in this scheme for planting shade, ornamental and fruit bearing trees on either side of the road or path to a width of two or three planting rows. As many as 1,82,500 trees had been planted covering a length of 150 km. Avenue plants were also planted.

Technique: Pit size of 1M x 1M x 1M was dug and given a a basal dressing of 15 gm of BHC and 15 gm of Superphosphate. The pits were filled with 50 per cent FYM and 50 per cent imported red earth.

"Ball of earth with tall plants" is a TTD specialised technique, widely known as TTD technique among the foresters. The technique is as follows. The technique is that the Nursery starts duringJune-July. Trenches of size 10.0 x 0.60 x 0.60 metres (60 plants for each trench) are dug. These trenches are refilled with silt and dug out earth (2:1). Then poly bags of size 5" x 9" of species desired (6 months old) are transported to the trenches' site. The bag is removed and the plant is planted by scooping this well. Then watering the trench plants is done 10 times a month. Weeding is carried out in the trenches twice in a month. During the next planting season, the plants attain 3-4 metres height and will be ready for planting.

After, removal from the trenches these plants are kept under shade for 15 days and watering is done twice a day during this period. After 15 days the tall ball of earth plant will be ready for planting.

Barren Hill Area Afforestation: Staggered trenches were dug of 1 mt. in length, width of 0.45 m at the top and 0.30 m at the bottom and 0.30m depth with spacing of 2m along the contours, and 3m across the contours. A pit measuring 30 cm cube was dug in the centre of the trench. In addition, 0.5 cubic metre pits at the rate of 200 per ha were dug and tree poles were planted.

The species planted were: *Azadirachta indica, Tamarindus indica, Leucaena leucocephala, Ficus glamerata, Boswellia serrata* and *Pterocarpus santalinus*.

Town Plantation: The species planted were mainly *Azadirachta indica*, *Tamarindus indica*, *Ficus glumerata* and *Pterocarpus santalinus*.

There was space available in between choultries and along sides of the roads. Pits of size 1 M X 1 M X 1 M were dug. Wherever necessary only imported soil was used. 15% to 50% of the Pit (depending on the fertility of local soil) was filled with good farm yard manure.

Tall plants of various flowering; fruiting and ornamental species were planted. The species were *Michelia champaca*, *Tabebuia avellanedae*, *Tecoma argentea* and *Grewillia robusta*.

Ghat Road Beautification: The Ghat road beautification was envisaged in the Bio-aesthetic Plan. There are two Ghat roads to Tirumala where thousands of vehicles ply on a daily basis. The total length of 35 km was in shade, covered with ornamental and flowering trees. The following are the varieties of plants planted along the Ghat roads: *Ficus religiosa*, Bougainvilleas, *Nerium odorum, Thevetia peruviana* and many more shaded and flowering plants were planted. Wherever necessary, the uphill

slopes were stabilised by stone pitching and planting of Agave suckers.

Medicinal Plant Orchards: There is a lot of attachment for medicinal flora in the Tirumala hills. In a total of about 1,500 varieties, 50 per cent of plants have medicinal value. TTD has also brought out a book on medicinal plants available on Tirumala Hills.

Further, the TTD Forest Department has to cater to the needs of TTD Ayurvedic College and Sri Srinivasa Ayurveda Pharmacy. Therefore, a garden of about 200 species of medicinal plants was developed at Sri Srinivasa Ayurveda Pharmacy in Narasingapuram to cater to the raw material requirements of the pharmacy.

Soil and Moisture Conservation works: SMC works were taken up to arrest soil erosion and improve in-situ moisture conservation and as many as 232 random rubble check dams were constructed. Before the advent of the Bio-aesthetic Plan, the entire TTD Forest area was subjected to serious and intensive soil erosion, as there was hardly any vegetation in the area and rock, boulders, disintegrated rock was exposed everywhere with hardly any soil in between the boulders. But after the effect of the Bio-aesthetic forestry plan, soil erosion was arrested. There was leaf litter, especially by pine and acacia. The groundwork of constructions of 260 were built across streams.

Haritha Project

A special project called Haritha was prepared during the year 2000 with a financial outlay of Rs. 144 lakh to improve the forest both within the TTD enclosure and surrounding reserve forest covering an area of 29,500 hectares.

Objectives

The objectives of the Haritha project were:

- To conserve soil and moisture in the project area by adopting appropriate soil and moisture conservation techniques.
- To afforest all the available sites for planting in the project area.
- To protect the flora and fauna against the damage of fire and biotic interference
- To improve the sacred "Tirtham" which are perennial water springs enriched with groves of dense floristic wealth.

Types of works

(i) Digging of contours (sizes 3 x 0.5 x 0.3 metres) on hill slopes as well on degraded and barren hills slopes for soil and moisture conservation. The trenches broke the slopes at intervals and reduce the velocity of surface runoff. The water retained in those trenches helps in conserving moisture and providing favourable sites for seed dibbling and planting.

(ii) Gully plugging works

1. Construction of rock fill dams: The rock fill check dams were constructed with locally available stones and boulders along gullies or small streams from ridges to valley in all the catchments. These were designed to retard the flow of water. These also retained some quantity of sediments

and moisture, which helped in establishing vegetation.

2. Construction of masonry check dams: Masonry check dams were constructed along the fault of different types of rock formation to arrest water flow and also to impound the maximum quantity of rain water. Location for constructions of masonry check dam were identified by a team consisting of geologist, hydrologist, engineers and forest officers.
3. Construction of chain-link check dam: Wherever the velocity of water was more in the gullies, rock fill dams wrapped with mesh wire were constructed.
4. Digging of percolation ponds: The percolation pond is a multipurpose conservation structure which depending upon its locations and size, stores water for recharging ground water as well as supply drinking water to wild animals. This is constructed by excavating or digging out a depression, thus forming an excavated reservoir or by constructing an embankment in the natural ravine to form an impounding type of a reservoir.

So far, 3884 rock fill check dam, 89 masonry check dams, 136 chain-link check dams, 85 percolation ponds, apart from contour trenches and peripheral trenches, have been constructed.

In addition to the soil and moisture conservation works, under Haritha projects, 65 lakh plants were planted. The species included *Azadirachta indica*, *Syzygium*, *Embilica officianlis*, *Terminalia*, *Arjuna*, *Dendrocalamus*, *Ficus bengalensis*, *Ficus religiosa*, *Ficus glomerata*, etc. Plants were prepared in different sized polybags. The planting techniques followed were trench cum pit method, pitting method, and ball of earth method. In order to conserve moisture, trenches were dug and *Stylosanthes hamata* grass seed was broadcast on the mounds of the trenches to improve soil fertility and to serve as fodder to wild animals. It also acts as a soil binder.

Fire control and monitoring

Frequent annual fires in the area had resulted in degradation of forest. Under the Haritha Project, 30 km of fire control barriers were constructed and 150 km of fire lines were formed. These fire lines and fire control barriers helped to prevent spread of fire from one area to another. In addition, an effective communication system was established for immediate movement of staff to fire-affected areas to control fire. The TTD has established central control rooms with wireless network both at Tirupati and Tirumala and 10 watch towers have been erected at elevated places to view fire incidents. At these places, personnel with walki-talkie sets are positioned around the clock. As soon as the information is received about fire, the fire protection party stationed at the control room, which consists of 25 to 30 personnel, will immediately rush to the spot and control the fire by using local techniques.

Present Action Plan

The whole area has been divided into 27 grids according to enumeration done by

species composition and crown density differentiation. Different treatment has been prescribed for different grids. The area has been classified into 4 categories viz.,

1. Red Sanders (RS) bearing areas
2. Non RS area with miscellaneous species population
3. RS bearing areas planted with *Acacia auriculoformis*
4. Areas afforested with *Acacia auriculoformis*

Protection from fire involves:

- detection by fire detectors stationed at 10 watch towers.
- rushing of dedicated anti fire fighting squads of staff and labourers
- Regular maintenance of fire lines
- Protection against smuggling and harvesting of mature crop of *Acacia auriculiformis* and Eucalyptus hybrid and replanting by endemic and indigenous valuable species like Red sanders, Rosewood and sandal.
- Removing dead, dying and diseased trees

Achievement and Conclusions

The projects taken up to reforest the area have attained their goals nicely. A sea change has occurred in the composition and density of forest. As per the ground water department reports, considerable additional ground water recharge has been observed. This is all due to the above plantation and SMC works. Moreover, as per the Andhra Pradesh State Remote Sensing Application Centre (APSRAC), there is an increase of 5.23 per cent in dense forest, 49.74 per cent in moderate forest and 91.66 per cent in water bodies. There is a decrease of 61.89 per cent and 8.06 per cent in sparse forest and barren, stony area, respectively.

The impact of these planting works and soil and moisture conservation works was also studied by the AP-SRAC, Hyderabad, and described as encouraging. As a result of integrated fire management, fire occurrence have come down steeply over the last decade--from 51 incidents to just 3 incidents during 2015. Also, the extent of affected areas has been reduced to a minimum of 18 hectare from a maximum of 162 hectare during the period when there were no fire lines, fire control barriers and other prevention activities.

The constant monitoring and fire control has seen an improvement in the natural regeneration in this area. The regeneration of species like *Anogeissus latifolia*, *Chloroxylin swietenia*, *Shorea talura*, *Shorea tumbuggia*, *Pterocarpus santalinus*, *Santalum album* has improved considerably. Many prizes have been given in recognition of above achievements, including the Indira Priyadarshini Vrikshmitra Puruskar in 1990, the Accolade of Excellence in 1996 by Colombo University, and Indira Gandhi Paryaran Puruskar in 2004. Dedication and concerted efforts are needed continuously to keep the greenery and biodiversity in its pristine form. The achievements obtained in these projects were mainly due to the hard work and sincerity of officers, combined with the full support of the TTD management in matters of finance and otherwise.

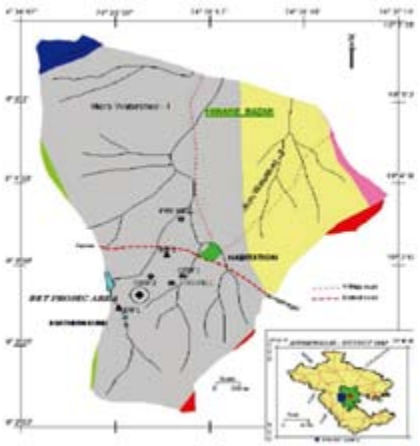
Peo PLe ANd Forest s

Case Study on Soil Moisture Conservation in Hiware Bazar

Villagers' efforts at forest conservation, watershed development and the ban on hunting has led the forest department to initiate a Joint Forest Management scheme

Sanjay Kumar Gupta &
Vikram Singh Shekhawat

Hiware Bazar is a small village lying in the western part of drought prone district of Ahmednagar in Maharashtra. The village by following a well devised plan for watershed management and soil moisture conservation has transformed itself from a very poor village to a prosperous one today. This case study discusses the soil moisture conservation measures applied in the village. Spread over 977 Ha of land in the Sahayadri Foothills, Hiware Bazar Gram Panchayat has population of 1300 comprising of 305 families. The village receives only 300-400 mm of rainfall a year. Due to its location in the drought-prone region, the rain fall is recorded is as low as 150-200 mm once in every three years on an average.



Map o f Hiware Bazar

Total Geographical Area	976.84 Ha.
Cultivatable Land	795.23 Ha
Forest Land	070.03 Ha.
Pasture Land	006.75 Ha.
Irrigated Land	750.00 Ha.
No. of functioning wells	348
Slope of the watershed	3 to 25 %

Degradation and Impact

In earlier times, Hiware Bazar was an important and prosperous trading center because of its location. It marked the end of Shivaji's territory and the beginning of the Nizam's area. Food and water was available in plenty for the people and livestock. Hiware Bazaar's downfall began in the early 1970s. Negligence, over grazing and illicit cutting for fuel wood led to degradation of forest land. Very soon villagers found themselves trapped in a vicious cycle of

recurring droughts and severe scarcity of water for agriculture and drinking. With reduction in agriculture production and availability of water, migration to the cities started. Distillation of illicit alcohol and its sale became a source of income and alcoholism and crime were rampant. Over 90 percent of families lived below the poverty line. The village lacked basic facilities like education, health, veterinary services, roads and drinking water. Literacy was as low as 30 per cent at one time and no government teachers or other employees were willing to serve in this village. The social structure was so badly affected that the eligible youth would not get brides from outside the village. This was for two reasons: first, that the woman would have a hard life due to scarcity of water and, second, it was feared that alcoholism and crime rampant in the village would affect the future of the family. This village reached its worst condition in late 1980s.

Visionary and Vision

In 1990, Shri Popat Rao Pawar, after completing his M.Com in Pune, was persuaded to return to his village. He was elected *sarpanch* unanimously. Under his leadership the village drew up a plan based on priorities set by villagers themselves –top on the list of priorities was safe drinking water, irrigation, employment, education and health. In 1994 the 'ideal village project' of State government was implemented in the village and it was declared as an 'Adarsh Gaon' where the following *panchsutras* were followed. These included; ban on free grazing, ban on cutting trees, ban on liquor, family planning and voluntary labour.

Watershed Based Planning

A watershed is defined as a geographic area that drains to a common point. The speed of runoff and percolation are mainly dependent upon the slope and land use. Destruction of forests and green cover leads to rapid flow of rain water causing soil erosion and leaving little time for water to percolate into the soil. As a result, soon after the rains, the watershed turns dry again. Watershed development refers to a set of measures that help retain water within a watershed. These include soil and water conservation, afforestation, grasslands development and protection of biomass. Conservation measures are applied on the basis of top to bottom approach. Development and preservation of non-arable lands is central to watershed development not just for its indirect benefits of raising the water table but also for its direct benefits like fuel and fodder.

In 1993, the Forest Department formed a Village Forest Management Committee to regenerate the completely degraded 70 ha of village forest and the catchments of the village wells. With the help of voluntary labour, the Panchayat built 40,000 R.mt. contour trenches around the hills to conserve rainwater and recharge groundwater. Residents took up massive plantation and forest regeneration activities. Immediately after the monsoon, many wells in the village collected enough water to increase the irrigation area from 20 ha to 70 ha in 1993. Under the

leader ship of Shri Popat Rao Pawar the villagers visited Ralegan Siddhi which was a huge success story of watershed based development. Hiware Bazaar applied for the *Adarsh Gaon Yojana (AGY)* or Ideal Village Scheme of the state government and was selected. For the implementation of AGY, the village prepared a five-year plan having a financial outlay of 60 lakhs, with water conservation as the most important feature. The Yashwant Krishi Gram and the Watershed Development Trust were instituted to implement the development works under AGY.

The implementation of the Employment Guarantee Scheme (EGS) also played a very important role for the transformation of Hiware Bazaar. The village prepared another five-year plan from 1995-2000 specifically targeting ecological regeneration, which became the basis for implementing EGS. Integrated planning was ensured for better coordination among the various departments. The implementation and the decision making process is democratic and participatory in nature. The funds for the regeneration plans in Hiware Bazaar were received from the EGS scheme. In total the state government spent Rs. 42 lakhs under the Employment Guarantee Scheme. Thus, in order to regenerate degraded village forests and catchments and to restore watershed ecosystems, the village was divided into three micro-watersheds – the first with an area of 612.14 hectares, the second with an area of 123.4 hectares and the third with an area of 241.3 hectares.

Engineering Measures - Soil Moisture Conservation

- Deep Continuous Contour Trenches *(CCT's)*

This is one of the most important measures for soil moisture conservation. Deep continuous trenches were dug having size 1m x 1m. Deep CCT's were excavated on forest land as well as private hillocks. These trenches played a major role in arresting surface runoff and improving the soil moisture regime. Trees and grasses were planted on the mound of the trenches.

- Loose Boulder Check Dams (LBCD's)

Loose boulder check dams are small semi permanent check dams constructed across a drainage line to lower the speed of surface runoff and arrest soil erosion. In Hiware Bazar all the drainage lines have been treated by con-

structing LBCD's of various sizes as per the site requirement. A total of 3035 cu. m. of LBCD's have been constructed so far.

- Earthen Dams

Fifty-two earthen dams were constructed where the slope was not very steep. These bunds played an important role in arresting surface runoff and improved the soil moiture regime. Trees and grasses were planted on the mound of the dams.

- Cement Check Dams

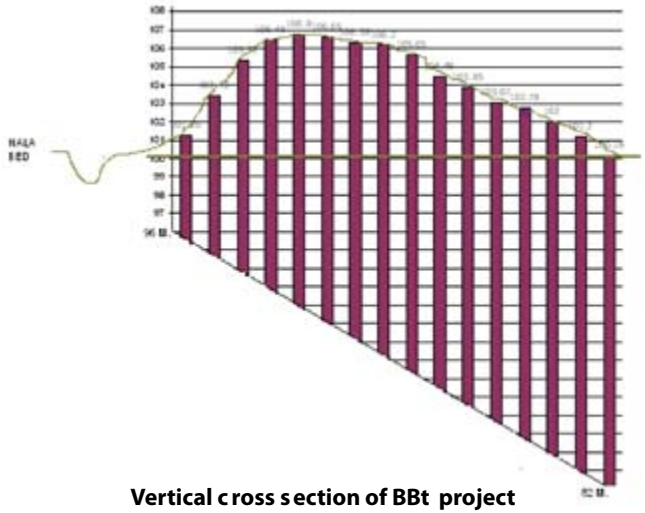
Ten check dams were constructed in order to improve ground water storage facility. These are masonry 'bhandharas' constructed across the stream. These help in arresting the post-monsoon flow is obstructed and store water. This stored water is then used for a variety of purposes.

- Percolation Tanks

Two percolation tanks were constructed having capacity of 100 crre liiters in the low slope areas to ensure percolation of water in order to enhance the water table.

- Bore well Blast Technique for aquifer Improvement

In 2006-07 the village decided to increase groundwater and storage by implementing 'Borewell Blast Technique' (BBT), a new technique developed by Groundwater Survey and Development Agency, Maharashtra. A geophysical study carried out in the village indicated that the area above the 'gaothan' was favorable for BBT to interconnect the upper and lower fractures to improve the groundwater storage aquifer system in the area. Nearly 103 bore wells ranging in depth of 5-18 metres were drilled by maintaining hydrostatic gradient in 1,620 sq m of land. These bore wells were charged by ammonium nitrate based explosives and blasted to create artificial fractures and cracks in the hard massive basalt formation. Blasting was done in two phases – 48



Vertical cross section of BBt project

borewells were drilled on July 13, 2007, the remaining 55 borewells on July 20, 2007. It was observed that the hard rock shattered and fractures created showed interconnectivity, sound of moving water was heard from the bore hole and the water level in the observation well increased to small extent. After the first phase of blasting, impact on water level was not seen to a large extent, but after the second phase of blasting, water level was seen to rise and after 40 days the water level rose by 12 m and the drinking water hand pumps became free flowing.

Blasting in the bore wells

- Farm Ponds

Three farm ponds were dug in the agriculture fields of the farmers for improving availability of water for irrigation and other subsidiary purposes.

- Open Wells

Since the digging of bore wells for irrigation purpose is banned by the 'gram sabha' in Hiware Bazar, open wells are the main source of irrigation water. There are as many as 348 functioning open wells in the the agriculture fields. Owing to the hard rock in

the substrata these wells are constructed using blasting technique and cost around Rs. 2 lakh.

- Bore wells

There are no private bore wells in Hiware Bazar owing to the ban on digging of borewells for irrigation. There are 19 community borewells in Hiware bazar which are exclusively used for drinking water purpose.

Non Engineering Measures

- Plantations

Plantation work in Hiware Bazar started in 1993 with the formation of the Village Forest Management Committee. Nearly 1.5 lakh saplings have been planted by the forest department in the 70 hectare forest land of the village. Apart from this, 9 lakh saplings have been planted on the private hillocks, agriculture fields, roadsides and community land by the villagers.

- Change in cropping pattern

The villagers collectively took a decision not to grow crops which require more water for irrigation such as sugarcane and banana. Instead of these crops, farmers are now growing vegetable, millets, wheat, maize, oil seeds and gram. Floriculture is also practiced by some farmers.

- Drip irrigation

Drip irrigation is a very efficient method of irrigation as it requires only 40 percent water as compared to traditional method for any given crop. Approximately 200 ha land in Hiware Bazar is now irrigated through by this method.

- Ban on Open Grazing

Open grazing is extremely harmful for any forest land or grassland and has detrimental effects on the watershed. It leads to degradation of the land and increases soil erosion. There is a total ban on open grazing in Hiware Bazar. Stall feeding is being practiced by all the farmers for their cattle. Any villager can cut the grass from forest land after depositing a nominal amount of Rs 100 per sickle per season.

- Ban on bore wells

There is a total ban on digging of bore wells by any individual for irrigation purpose. Water for irrigation is taken from dug wells.

Water Budgeting

Accounting of input and output of the water in a project area on the annual basis is referred to as water budget. Since 2002, Hiware Bazar has been doing an annual budgeting of water assisted by the Ahmednagar districts' groundwater department. Every year the village measures the total amount of water available in the village, estimates the uses and then prescribes the agricultural cropping to be taken up. All this is done through *Gram Sabha* whose decisions are binding. The cropping pattern has undergone a change in favour of cash crops with high productivity. Food security is no longer an issue for the village. Through the water budgeting, the village has been able to identify its average water availability. It is estimated that with 400 mm of rainfall the village will have sufficient water throughout the year. Because the village has an average shortfall of 50 to 80 million liters, the *Gram Sabha* has banned drilling of bore wells for irrigation. The audit process begins with the monitoring of the groundwater level of the six observation wells identified in the village, along with the amount of total rainfall received measured by the village's rain gauges. The sum of rainfall and groundwater is the total water available to the village after monsoons. The *Gram Sabha* thus budgets water for the village and decides from the total water available the amount of water that can be used and for what purpose. Here, water for drinking purposes (of humans and animals) and for other daily uses gets top priority. After budgeting for drinking water, 70 per cent is set aside for irrigation. The remaining 30 per cent is kept for future use by allowing it to percolate and recharge groundwater. Taking this broad framework for water use, a yearly audit is carried out to assess water availability and adjust use accordingly.

WAter Bud Get YeAr 2015-16

Total Rainfall	255 mm
Available Water	249 Cr. Lt
Classific tion Of Available Water	
Runoff	0
Evaporation Loss	87.18 Cr. Lt
Surface Water Storage	12.45 Cr. Lt
Ground water Recharge	24.91 Cr. Lt.
Soil Moisture	74.73 Cr. Lt.
Additional Ground water	49.82 Cr. Lt
Actual Available Water for Use	161.91 Cr. Lt.
r equirement	
Drinking	4.27 Cr. Lt.
Agriculture	149.41 Cr. Lt.
Other Needs	3.24 Cr. Lt.
Total Requirement	156.92 Cr. Lt.

Impact

As the water table got recharged, water reappeared in open wells and seasonal ponds. The constant assured water has helped farmers to change their cropping patterns to grow crops that are more nutritious and lucrative. Not only do the villagers now grow enough to last them the entire year but are also able to generate substantial income by selling farm produce, particularly

vegetables. They have also managed to increase their profit margins by establishing direct producer-consumer links and doing away with the middlemen. Now the produce from the village sells at good price in the local market, as the village assures quality to the consumers. Additionally, the farming is largely organic, since the villagers find it cheaper and more productive to use cow dung (which is now available in plenty because of stall-feeding) and locally produced vermi-compost. The increased fodder available has improved the yield of milk from livestock. Milk production has reached 2,200 litres per day, as compared to a mere 150 litres per day in the mid-90s. Fodder in the forest now is enough to meet all the village needs and those of the surrounding villages. Once the cutting season is declared, anyone can take one head load per day till fodder remains available on payment of Rs 100 for the entire season. Payment is made to the *gram sabha*. Given the enthusiasm of the villagers, their efforts at forest conservation, watershed development and the ban on hunting, the forest department has initiated its Joint Forest Management scheme and the forests of the village have been handed over to the village for management. This has also helped them bring in some resources for water harvesting structures and tree plantation. The development indicators of the village are amazing. The number of wells has increased from 97 in 1999 to 348. More than 750 ha of land have been brought under irrigation as against 120 ha in 1999. The number of families living below the poverty line has reduced from 198 in 1999 to nil. There has been a considerable decline in alcoholism and the crime rate. Migration has declined sharply due to the cultivation of more than one crop per year. The spirit of cooperation and success of the programme has increased the self-confidence of the villagers. Villagers claim that the number of wild animals has increased since the ban on hunting. As recognition of their efforts, Hiware Bazaar received the Gram Abhyan Puraskar 1995-96, the Adarsh Gaon Award in 1997, the National Productivity Award in 1998-99 and the Maharastra Vanashree Puraskar in early 2000.

Conclusion

Water management is in the core of the success of Hiware Bazar. Right Vision, great leadership, understanding and willingness to work as an extended family to bring about the change and proper implementation of government schemes through the past two decades transformed a very poor village into a village of millionaires. More or less homogeneous social structure, small population, relatively small area and suitable topography for carrying out soil moisture conservation measures have also played a very important role. Hiware Bazar model can be implemented in other villages after giving due consideration to the above stated factors.

References

Artificial recharge to ground water in Hiware Bazar http:/www.cse.iitb.ac.in

Local Governance and Environment Investments in Hiware Bazar, India Supriya Singh

WILd LIFe MANAGeMeNt

Management of Migrant Wild Elephants in Bilaspur Circle, Chhattisgarh

The time-bound Gajraj Project was introduced by the government to develop elephant habitat and to reduce man-elephant conflict

Sandeep Kumar &
Dr. Sunil Kumar Gaur

The Forest Department in Chhattisgarh is engaged in planning, implementation, monitoring and evaluation of forestry, and environmental programmes in the State. It is the sole custodian of rich forest resource of the State. The principal activities undertaken by the Department consist of conservation of flora, fauna, sustainable management of forest and wildlife, rehabilitation of degraded forests, natural regeneration of forests and management of forest products in the framework of current policy and legislative environment. The State has its own forest policy. The organisational structure of the Department covers different wings at the Headquarter, 8 field circles and 45 territorial, wildlife and other functional divisions.

Biodiversity

The State of Chhattisgarh by virtue of its location in the Deccan bio-geographical area, houses an important part of that rich and unique biological diversity. What is more conspicuous is that the State is significantly rich in endemism with respect to many plants having medicinal importance. The forests of the State fall under two major forest types, i.e., Tropical Moist Deciduous forest and the Tropical Dry Deciduous forest. The State is endowed with about 22 varied forest sub-types.

Sal (*Shorea robusta*) and Teak (*Tectona grandis*) are the two major tree species in the State. Other notable overwood species are Bija (*Pterocarpus marsupium*), Saja (*Terminalia tomentosa*), Dhawra (*Anogeissus latifolia*), Mahua (*Madhuca indica*), Tendu (*Diospyros melanoxylon*), etc. Amla (*Embilica officinalis*), Karra (*Cleistanthus collinus*) and bamboo (*Dendrocalamus strictus*) constitute a significant chunk of middle canopy of the state forests. From the management point of view, there are four types of forests in the state of Chhattisgarh, viz. Teak, Sal, Miscellaneous and Bamboo forests.

Biogeographically, the State falls in Deccan bio-region comprising representative fauna of central India like the tiger (*Panthera tigris*), leopard (*Panthera pardus*), gaur (*Bos gaurus*), sambhar (*Cervus unicolor*), chital (*Axis axis*), nilgai (*Boselaphus tragocamelus*) and wild

boar (*Sus scrofa*). The state is a proud possessor of rare wildlife like the wild buffalo (*Bubalus bubalis*) and hill myna (*Gracula religiosa*) which have been declared as rare and endangered. Apart from the species diversity, the State is also endowed with rich genetic diversity. The variation in the genetic composition of individuals within or among floristic and faunal species is large.

Recorded Forest Area

The recorded forest area in the state is 59,772 km^2 which is 44.21 per cent of its geographical area. Reserved, Protected and Unclassified Forests constitute 43.13 per cent, 40.21 per cent and 16.65 per cent of total forest area, respectively.

History of Migrant Wild Elephants in Chhattisgarh

The elephant population in Chhattisgarh has grown since the pachyderms started visiting the State's forests in the late 1980s due to rampant deforestation in Odisha, Andhra Pradesh and Jharkhand. This has resulted in an increase in human-elephant conflict – human deaths have increased to an average of 25 a year and around 14 elephants have died due to electrocution in Chhattisgarh between 2005 and 2013.

The following divisions were selected for the case study

1. Dharmjaygarh Division, Chhattisgarh.
2. Raigarh Division, Chhattisgarh.
3. Bargarh Division, Odisha.
4. Sundargarh Division, Odisha.

Dharamjaygarh Division

This division falls in Raigarh District. There are six Ranges – Chhal, Dharamjaygarh, Boro, Bakaruma, Lailunga, Kapu in the division. Most affected ranges are – Chhal and Dharamjaygarh. Koylar and Semipali villages are frequently visited by elephants. During interaction with the villagers it was revealed that earlier the elephants were scared of torch light, high mask light, solar fencing and sounds but had now got used to them. They suggested the following measures;

- Elephants can be scared away with the help of chilli smoke.
- Subsidy should be given for farm solar fencing to individuals.

The villagers now have accepted the presence of elephants in their surroundings. Some of them believe that if the elephants move in the field, it would result in a good crop.

In Kurekela village (Chhal Range), a dam was under construction at Chini Naala boundary of Dharamjaygarh and Raigarh Division to provide water for drinking and bathing for elephants in the summer season.

Raigarh Division

This division falls in Raigarh District. There are five ranges in the division named Tamnar, Gharghoda, Raigarh, Kharsia and Sarangarh. Three ranges Tamnar, Gharghoda and Raigarh are highly affected. In Jhingol and Padkipahari village (Tamnar Range), pits of size (1.5 m x 75 cm x 90 cm) made by the Forest Department are not effective for keeping the elephant movement under check. In Bhangursia village (Raigarh Range), the boundary wall of a plot was destroyed by elephants.

Dhengur Nala is source of water for elephants. The nala is the boundary between Chhattisgarh and Odisha. During interaction with villagers, it

emerged that elephants can identify persons and behave accordingly. If someone irritated them, the elephants would recognise and would attack the person whenever they got a chance, otherwise they do not attack.

Rani Darra Nala too is the source of water for elephants. The road from Bhangursia to Odisha is closed after 6 pm when elephant herds dwell there. The villagers also suggested since the pad on the elephant's foot is soft tissue, small spiked stones should be fixed around the village, so elephants would not enter the village.

Elephants were not seen in this range before 2011. Currently two elephants are present in this range. In Tedhinala village (Sarangarh Range), the primary school building was broken by wild elephant due to smell of mid-day meal, the main gate of kitchen and the kitchen window too were broken. In Shashpani Village (Sarangarh Range) in outskirts of Mangarkuda, the two wild elephants damaged the house around 3 am when the residents (Jodhi Ram and his wife) were sleeping. One of the elephants broke the wall where bags containing paddy and *chironji* were stored. The elephants did not break the wall which was near the bedroom of the family.

Bargarh Division (Odisha)

Nine female elephants were present in Bargarh. These were residing in buffer zone of Heera Kund Sanctuary. Two male elephants which were present in Sarangarh were seen in Bargarh Division during 29 June – 2 July 2016 in the Bhatali Range of the Division and from 2 July they were in Sarangarh Range. Forest officials tried to merge these 2 male elephants with the herd of 9 female elephants, but they were rejected by the herd.

Sundargarh Division (Odisha)

Past records show that elephants never reside permanently in the division. Movement of elephants is usually seen during crop harvesting season. Elephants migrate from neighbouring Bamara Wildlife Division to Sundargarh Division in September and remain there up to January.

Existing Elephant Movement Paths in Sundargarh Division

i. Bamara Wildlife Division to Jharsuguda Division to Sundargarh Range through (Jamtalia RF, Amtalia RF, Deuli RF, Bijlikhaman RF, Satparlia RF, Deuli RF) and return back to Bamara Wildlife Division.

ii. Bamara Wildlife Division to Jharsuguda Division through (Jamtalia RF, Satparlia RF, Jogijugiani RF, Runga RF, Kurei RF, Sapukundal RF, Sirimunda RF, Kusumura RF, Tildega RF, Athakosia RF, Sikajore RF) and return to Bamara Wildlife Division (sometimes the elephants cross the State border and enter Chhattisgarh State).

iii. Chhattisgarh State ⇔ Dhanubans RF, Garjanpahad RF, Jamkani RF, Koilungs RF and Sikajore RF.

Gajraj Project by Chhattisgarh Government

The Gajraj Project was introduced to develop elephant habitat and to reduce man-elephant conflict. This project is Division based and a time bound project. The duration of Project is five years (2014-15 to 2018-19). Under this project, nine different types of activities will be carried out. These include; solar fencing, construction of ponds, stop-dam construction, pasture development, fixing high mask solar lights, compensation to villagers, awareness programmes, a Hathi Sahayata Kendra, toll free number for assistance and other works. The main office of the Hathi Sahayata Kendra is at Raigarh. It is manned by six personnel and they are available 24x7 for events involving conflicts with wild animals in the villages.

Compensation given by Odisha Government

In the event of death Rs. 3 lakh is given by the Odisha government as compensation. There were no fatalities reported in Bargarh Division in Odisha. The table below shows the death and

Proposed expenditure (5 Years) in the two divisions under Gajraj Project (In crores)

Forest division	2014-15	2015-16	2016-17	2017-18	2018-19	total
Dharmjaygarh	2.71	2.71	2.67	2.59	2.59	13.27
Raigarh	2.69	2.69	2.67	2.59	2.59	13.23

compensation given by chhattisgarh Government

#.	description	Amount of compensation
1	On Death	Rs. 400,000 (within 15 days (Rs. 25,000 on the spot))
2	Permanent Disability	Rs. 200,000
3	Injury	Rs. 59,100
4	Death of domestic animal	Rs. 30,000
5	Damage to Animal Shed/House : 1	Rs. 1,500
6	Damage to Irrigated Crops	Rs. 13,500 / ha (Minimum Rs. 1000)
7	Damage to Non-irrigated Crops	Rs. 6,800 / ha (Minimum Rs. 1000)
8	Pucca House broken on normal land	Rs. 95,000 / house
9	Kucha House broken on hilly land	Rs. 1,01,000 / house
10	Pucca House broken 15%	Rs. 5,200 / house
11	Kucha House broken 15%	Rs. 3,200 / house
12	Hut broken	Rs. 4,100 / hut

Human deaths and incidents of crop damage

Year	Dharamjaygarh division, Bilaspur circle				Raigarh division, Bilaspur circle			
	Human Death	Com. (Lakh)	Crop Damage Attempts	Com. (Lakh)	Human Death	Com. (Lakh)	Crop Damage	Com. (Lakh)
2013-14	2	4	319	49.29	3	6	703	15.88
2014-15	6	12	1502	39.70	2	4	705	13.67
2015-16	8	30	1915	73.67	4	10	1127	29.81

Year	Sundargarh division, Odisha		
	Human Death	House Damage	Crop Damage (Ha)
2010-11	2	254	252.59
2011-12	7	139	282.18
2012-13	10	220	268.38
2013-14	2	130	240.56
2014-15	6	255	310.00

damage data for Sundergarh Division, Odisha

Feed Base of Elephants

Elephants feed on the following trees – *Ficus bengalensis*, *Ficus religiosa*, *Ficus glomerata*, *Careya arborea*, Kekat (*Garuga pinnata*), Char (*Buchanania lanzan*), Chhind (*Phoenix acaulis*), Mahuwa (*Madhuca indica*), Pakar (*Ficus infectoria*), Jackfruit, Mango, Banana, Bamboo, Bija (*Pterocarpus marsupium*), Saja (*Terminalia tomentosa*). Along with these they also forage on the following crops - paddy, groundnut, sugarcane, wheat, pigeon pea, maize and Green gram.

To prevent incidents of elephants entering villages to feed on crops and potential flashpoints of conflict the following have been suggested;

- Elephants fodder trees should be planted in the deep forest.
- Villagers should avoid the forest path from 5 pm to 6 am during elephant movement.
- Encroachments should be removed from elephant habitat and corridor.
- Mining activities should be stopped in elephant habitat.
- Sufficient water bodies be developed/constructed in forest area.
- Haathi Sahayata Kendra should be strengthened.
- Awareness progamme should be scaled up.
- Solar fencing should be provided to farmers at subsidised rate.
- Inter-state communication of forest departments should be well coordinated. For effective management of

wild migrant elephants, Chattishgarh, Odisha and Jharkhand should work together.

- Compensation for death should increase. Compensation on death is deposited in the account of head of family, mostly male. The compensation should be deposited both to male and female heads of the family.
- Raigarh can be developed as an elephant habitat. Tamnar, Ghargoda, Chhal, Dharmjaigarh and Kapu ranges can be developed as an elephant corridor.

ecosystem approach

Innovative ideas help in better management

Many new ideas have been implemented in Pench National Park apart from other activities, which have gone a long way in improving the management of the Tiger Reserve

Ashish Vyas & Yadvendra Singh

The Pench National Park is also known as 'Mowgli Land' because this is where Rudyard Kipling created *The Jungle Book*. The Pench National Park came into being when the Government of Maharashtra declared its intention to constitute this area of 257.26 sq km vide gazette notification No. PGS 1375/121758-F I, dated November 22, 1975. Later, Pench National Park was declared as the 25th Tiger Reserve of India vide the Government of India letter F No. 1-1/96-PT, dated February 18, 1999, and the Government of Maharashtra Resolution No. WLP-1095/CR-110/F-1, dated February 23, 1999. There is one village, Fulzari, in the Critical Tiger Habitat. The core area of the Pench Tiger Reserve comprises of Pench National Park and total area of buffer zone is 483.96 sq km (buffer zone includes area of the Mansinghdeo Wildlife Sanctuary).

Pench Tiger Reserve is named after Pench River which meanders through the National Park, dividing it into two ranges—East Pench Range and West Pench Range. Important carnivores in its faunal wealth are Tiger, Leopard, Wild Dog, Jackal, Hyena, Jungle Cat, etc. The herbivores include Sambar, Nilgai, Gaur, Chital, Barking Deer, Chausinga, Wild boar, Bear, etc. The forests of the Park are a major catchment for the Totladoh reservoir.

Habitat Enrichment

Water Management: Construction of borewells at appropriate, identified places along with a solar pump are being undertaken to provide drinking water to wild animals in periods of scarcity, especially in summer. As a innovative idea, Kolhapuri style gate at pipe culvert has also been implemented (Fig. 1(f)). Apart from that, series of *bandharas*, such as the earthen *bandharas*, brushwood *bandharas*, inverted puddle dams, cement plugs, trenches, small forest tanks, etc., have also been constituted by taking the *nallahs*, streams and natural depressions as the natural units of treatment. The gully plugs, contour trenches, *nallah* bunds, check dams, Gabion and other suitable SMC structures in the water scarcity areas have been constructed.

Officer Trainees, SFS Batch 2015-17, CASFOS Coimbatore

Fig.1: **Water conservation structures and s Mc works**

(a) Water Hole

(b) *Nallah* Rejuvenation

(c) Solar pump-operated borewell connected to waterhole

(f) Pipe culvert with gates (Kolahpuri style)

Meadow Development Works: Meadow development works have been carried out at suitable sites to make adequate fodder available for the ungulate populations. This is an innovative idea within the PTR. Meadow development to utilise the land below high tension electric line was observed (Fig. 2(a)). Apart from this, blank spaces (e.g. under high tension electric lines, etc.) have been ploughed and planted with local varieties of grasses by sowing seeds or by tussock plantings. Before the seeding of various weed species to check their spread in the PTR areas, control measures have been undertaken.

Protection and Intelligence Gathering

Special Tiger Protection Force (STPF): A Special Tiger Protection Force, comprising of one ACF, three Range Forest Officers, 81 Forest Guards and 27 Forest Watchers selected from the local tribal population, has been constituted and they have been provided with a vehicle and wireless equipment. This force patrols the vulnerable areas. STPF is a special force, built on the line of India Reserve Battalion.

Illegal fishing activity in Meghdoot dam is a major threat to the core area of Tiger Reserve. STPF has also been given the task of controlling illegal fishing. So far, in last three years, no poaching of

Fig. 2: **Meadow development at Ptr**

(a) Meadow development under high tension electric line

(b) *Lantana* eradication

Fig.3: **protection measures in Ptr**

(a) STPF

(b) Boats for STPF

(c) Protection huts & barriers

(d) Watch towers

animals for skin and trophies has taken place in Pench Tiger Reserve. But there are strong reports of Bahelia groups becoming active in Central India. Bahelia groups are known for poaching tigers for skin and bones.

Monitoring System for Tigers Intensive Protection and Ecological Status (M-STrIPES): The system consists of two components:

- Field based protocols for patrolling, law enforcement, recording wildlife crimes and ecological monitoring,
- A customised software for storage, retrieval, analysis and reporting.

Law enforcement and ecological monitoring are being done currently, but the information generated is ad-hoc and rarely available in a format for informed decision making. The M-STrIPES' addresses this issue and is a tool for adaptive management. It enables managers to assess intensity and spatial coverage of patrols in a GIS-based tool. The system performs statistical computations of occupancy, precision, sample size and assesses trends over desired time and spatial scales for tigers, other carnivores, prey populations, human impacts, illegal activities and law enforcement investments. M-STrIPES produces easily interpretable reports and maps that are useful for management and for taking appropriate policy decisions.

The salient features of M-STrIPES are:

- Software developed by WII and NTCA
- Funding in Pench Tiger Reserve given by WCT and Foundation
- Each forest official up to the rank of Field Director has to do foot patrolling, which is traced by

Fig.4: **Map generated by M-st rIPes software (Pipariya beat, east Pench range, Ptr)**

M-STrIPES software. For example, each forest guard has to walk 45 kms within a week.

- One form and one GPS are given to the forest guard. Form is to write down the observations and GPS helps to trace the path on which foot patrolling has been done.
- It generates reports to provide quantitative information for management effectiveness assessment and decision making.
- It provides user-friendly field protocols (training and material, data quality control), data storage and report generating tool system features.
- It captures detailed information on population status and trends, animal mortality, illegal activity, human pressures, patrol effort, habitat status for monitoring and guiding management.
- It provides a comprehensive GIS and statistical tool for processing and reporting information needed for conservation and management purposes.

Conclusion

As mentioned above, many innovative ideas have been implemented in the Pench Tiger Reserve along with other activities like research, monitoring, ecotourism, livelihood initiatives through village micro-plans, tiger census, etc., for better management of the Tiger Reserve. Apart from these activities, Tiger Conservation Foundation for PTR has been established—as per provision of the Wildlife Protection Act, Section 38 V, in the year 2010—within the State to facilitate and support their management for the conservation of tiger and bio-diversity and to take initiatives in eco-development by involvement of people in such development process. Many innovative ideas have already been implemented and some are in the pipeline.

Peo PLe ANd Forest s

Functioning of Tree Grower Societies in Tamil Nadu

The present study will help to improve functioning and create a platform for tree growers to share knowledge on tree growing practices and marketing trends on trees and their products

V Irulandi[1], TT Renganathan[2] & M Ramasubramanian[3]

Farmers' Interest Groups, Farmers' Clubs, Farmers' Commodity Groups, Farmers' Associations, Farmers' Societies are some of the nomenclatures assigned for the congregation of farmers. A recent addition to this list is Farmer Producer Companies through making suitable amendments in the Companies Act. Primarily, the mobilisation of farmers will help in marketing the produce, getting inputs for a reasonable price, credit in a hassle free manner and ultimately improve their economic status. Realising the benefits of group-based approaches, 'tree grower farmer associations' have been mobilised by different service providers.

Tree Growers Societies (TGS) are characteristically umbrella organisations and their prime objective is to represent the interest of private tree growers to the Forest Department and other line departments at the state and district level and to influence politically to achieve their objectives. These associations are beneficial for buying expensive equipment for forestry works especially planting equipments to be shared among members, reducing the fixed cost burden and inputs of individual tree growers.

Higher market price for wood products could be achieved through joint marketing and through bulk order. The expenditure for raising seedlings needed for tree growing on private lands could be lowered for small and marginal farmers. Farmers in their individual capacity may not be able to influence policy makers and cope with market fluctuations whereas members of TGS together can organise for collective action in the field of private forestry and provide to its members, forward and backward linkages that are inevitably needed for tree cultivation.

Tree Grower Societies in Tamil Nadu

In Tamil Nadu, a well-established Forestry Extension network system has been developed and programmes are being implemented through Forestry Extension Centres (FEC) created in all

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32 districts. Currently, these centres are engaged in activities such as production and supplying of quality seedlings, organising training to farmers, publicity and awareness creation activities, formation of demonstration plots on the farmer's land and taking up tree cultivation programme on the farmer's land.

One important activity of FECs is to facilitate the functioning of Tree Growers Societies (TGS) to augment the potentials of farmland for the cultivation of tree crops. Twenty seven TGS were formed in various districts about a decade back.

Despite the fact that TGS are being promoted with greater enthusiasm by the Forestry Extension wing, the diffusion of the concept among the members has not been as desired. Most of the TGS in different districts were defunct and very few are functioning with lesser activities. Though, the benefits accrued out of such farmers' societies elsewhere were found to be abundant, it was necessary to analyse the reasons or factors responsible for the defunct nature as well as the poor functioning of TGS and to find out strategies for strengthening the activities of TGS in Tamil Nadu. Keeping this in mind, a study was contemplated with the following objectives:

1. To analyse the functioning of Tree Growers Societies in Tamil Nadu. and
2. To predict the willingness of tree growers to become members of Tree Growers Societies.

Theoretical Orientation

Perusal of studies of Singh and Ballabh (1982), Shankar Narayanan (1991), Saxena (1987), Gupta (1989), and Shah and Ballabh (1986) revealed that a co-operative organisation should perform procurement, storage, processing, and marketing in the most cost effective manner, if it is to successfully compete with private traders engaged in similar activities. Judging the quality of wood and determining its price is a difficult task for the personnel of TGS and it requires a lot of hands-on experience and skill. TGS personnel will need to beg, borrow and steal expertise in this area from private traders engaged in the timber business.

Case studies conducted by Gupta (1989), Mishra *et al.* (1982), Raju and Sarabhai (1992), Saxena (1987), Singh and Bhattacharjee (1991), identified the following issues and options for healthy functioning of Tree Growers Societies. There were hassles in securing revenue wastelands on lease, choice of tree species, harvesting and transport of trees grown on private lands, equitable distribution of benefits, financial viability, integration of procurement, storage, processing and marketing activities

According to Ballabh and Kramer (1992), for the success of Tree Grower Cooperative Societies (TGCS), two things are of paramount importance: (a) exclusive property right of TGCS to the land on a long-term lease of at least 30 years and its enforcement to restrain non-rights holders from using the resource; and (b) ability of the TGCS to coordinate and regulate the use of

the resource by its members to avoid "free-riding"

Singh and Balooni (1994) in their working paper indicated that Tree Grower Cooperative Societies (TGCS) hold high promise as an instrument of promoting farm forestry in India on a sustainable basis. They can disseminate technical information to potential tree growers and train them, supply quality saplings and fertilisers and pesticides, provide or help secure institutional credit and arrange for marketing of farm forestry produce at remunerative prices more cost effectively than any other organisation.

Rakesh and Rajesh (1999) proposed a natural resource accounting system which can be used with the conventional financial accounts of village level Tree Growers Cooperative Societies operating under the umbrella of a National Tree Growers' Cooperative Federation.

Christian and Annemarie (2012) highlighted that the small holder's market access improves not only as a result of Small Holder Marketing Cooperatives (SMC), networking and negotiation with key actors in the public and private sector but also due to improved interrelationship among SMCs and other type of farmers' organisations. Peer-to-peer relationship with other SMCs are critical for mutual learning, collaboration and collective action.

Methodology

This study was undertaken in Tamil Nadu state of India. A total of 245 farmers were selected from the eight districts, representing the five agro-climatic zones of Tamil Nadu that have higher potential for tree growing activities. The respondents were selected using Snowball sampling wherein word of mouth of potential tree growers and opinion of forestry extension officials were taken into consideration.

All the selected respondents were asked about the functioning of Tree Growers Societies (TGS) in their respective districts. Out of 245 respondents, 84 were found to be members of TGS and were considered for further data collection regarding the functioning of the societies.

A well structured pre-tested interview schedule was constructed to pursue the objectives of the study, which included four components: awareness about TGS, perception about benefits of participation in TGS, constraints in functioning of TGS and suggestions to overcome the constraints in functioning of TGS. The items for the study of TGS to be included in the interview schedule were finalised through discussion with the office bearers and members of Tree Growers Societies and prospective tree growers in different agro-climatic zones of Tamil Nadu.

The awareness of tree growers about TGS was studied using five items, namely awareness of existence of TGS, member in TGS, payment of membership fee, satisfaction with functioning, attendance during meetings of TGS. All these items were scored with the help of Yes or No questions wherein '2' score was given for 'yes' response and '1' score was assigned for 'no' response. Similarly, the perception about the benefits of participation in TGS, constraints

prevailed in the functioning of TGSs and suggestions to improve the functioning of TGS were studied using 'yes' or 'no' responses, and was given a score of '2' and '1', respectively.

Analysis of data

The above said four components of the study were analysed using simple percentage analysis. The second objective of the study was pursued using binary logistic regression. The response of the respondents, namely willing to join TGS or unwilling to join TGS was coded '1' and '0' and the predictors of the willingness was studied through binary logistic regression using the following procedure

Binary logistic regression (which will be referred to simply as logistic regression) is regression applied to a dichotomous dependent variable, where the dependent variable is not the raw data values, but instead is the odds of the event of interest occurring. The general equation for logistic regression is:

$$\text{In (Odds)} = \alpha + \beta 1X1 + \beta 1X2 + \ldots\ldots\ldots\ldots \beta kXk$$

Where the terms on the rights are the standard terms for the independent variables and the intercept in a regression in a regression equation. However, on the left hand side is the natural log of the odds, and the quantity In (Odds) is called a logit. It can vary in principle from minus to plus infinity, thus removing the problem of predicting outside the bounds of the dependent variables. The odds are related to the probability by:

Odds = Prob / 1-Prob

Note that this is a linear relationship with the independent variables in logistic regression, but it is linear in the log odds and not in the original probabilities. Since we are interested in the probability of an event, i.e., the higher code in a dichotomous variable, the logistic equation can be transformed into an equation in the probability. It then has this form:

$$\text{Prob (event)} = \frac{e\alpha + B1X1 + B2X2 + \ldots.. + BkXK}{1 + e\alpha + B1X1 + B2X2 + \ldots.. + BkXK}$$

This equation cannot be estimated with the least-squares method; instead, the parameters of the model are estimated using a maximum likelihood technique. We derive coefficients that make our observed values most "likely" for the given set of independent variables.

Results and Discussion

In line with the methodology set forth, the data was collected and the results tabulated. This section deals with the results and discussion of the study.

Awareness and participation in TGS

The primary thing that needs to be understood is the level of awareness of tree growers about the functioning of TGS, since any action starts with awareness. Hence, in this study, the awareness of tree growers about the functioning of TGS and their participation were assessed and the results are presented in

Table 1. **distribution of respondents according to their Awareness about t Gs Functioning**

(Multiple response) (n = 245)

s.No.	Awareness about functioning of t Gs	Yes		No	
		No	%	No	%
1	Awareness about existence of TGS	97	39.59	148	60.41
2	Member in TGS	84	34.29	161	65.71

Table 2. **distribution of respondents according to their participation and involvement in t Gs activities**

(Multiple response) (n = 84)

s.No.	Awareness about functioning of t Gs	Yes		No	
		No	%	No	%
1	Payment of membership fee	55	65.48	29	34.52
2	Members attending the meeting regularly	75	89.29	9	10.71
3	Satisfaction with functioning	57	67.86	27	32.14

the Tables 1 and 2.

A perusal of Table 1 revealed that almost two-thirds (60.41 per cent) of the respondents did not know about the existence of TGS in their villages. One-third (34.29 per cent) of the respondents had enrolled themselves as TGS members. These members were also part of the few TGS which were functioning with limited activities.

It is evident from Table 2, that only 65.48 per cent of members had paid the membership fee. It is conspicuous from the table that there existed a gap between being a member in TGS and paying the membership fee. Since the members could not realise any tangible benefits from the society, they were hesitant to pay the membership fee. Further, the societies were poorly patronised by Forestry Extension personnel. Had the benefits of being a member of the society been explained to the farmers by the Forestry Extension personnel, the participation of members in terms of payment of membership fee could have been enhanced which would have facilitated sustenance of society activities.

Out of 84 members, majority of them (89.29 per cent) reported that they attended the meeting regularly. Nearly two-thirds (67.86 per cent) of the respondents were satisfied with the functioning of the society.

The point to ponder here is that the officials of Forestry Extension wing of Forest Department had invested lot of time in creating TGS in 27 districts of Tamil Nadu. However, observation in

Table 3. **distribution of respondents according to their perceptions about functioning of t Gs**

(Multiple Response) (n = 84)

s.No.	Benefit	Yes		No	
		No.	%	No.	%
1	Got to know fellow tree growers	61	72.61	23	27.39
2	Chance to interact with fellow tree growers	66	78.57	18	21.43
3	Improved my expressiveness and developed self confiden e	72	85.71	12	14.29
4	Understanding the collective approach	69	82.14	15	17.86
5	To know about technical information on tree growing	74	88.09	10	11.91
6	Got to know market information	77	91.66	7	8.34
7	Avoidance of middle men	70	83.33	14	16.67

the field does not confirm the same. Most TGS members conveyed to the investigator that the facilitation of officials of the Forestry Extension wing is not forthcoming and they failed to sustain the initial efforts. Forestry Extension officials, therefore, need to be trained in mobilising the farmers, understanding the group dynamics, and facilitating members in renewing the registration of the society.

Perceptions about benefits of participation in TGS

The perceived opinion of TGS members about the benefits of participation is important to assess its sustainability. The relevant data is presented in Table 3.

An important benefit that whopping majority of members (91.66 per cent) indicated was access to market information. This would result in avoidance of middlemen which is again reported by majority of (83.33 per cent) members as a benefit. From this finding, it is evident that the expectation of members to get reliable, timely market information such as demand, supply, price of timber and other forest produce has been steadily increasing. Hence, Forestry Extension system needs to invigorate itself to improve its information system to provide needed market details to TGS members.

Majority (88.09 per cent) of TGS members endorsed the benefit of getting to know technical information about tree growing by being a member of society. Further, the membership in the society has improved their expressiveness and developed self confidence as reported by a majority of members (85.71 per cent). The TGS gave an opportunity to the members to meet and

Table 4. **distribution of respondents according to perceived constraints in functioning of t Gs**

(Multiple Responses) (n = 84)

s.No.	constraints prevail	Yes		No	
		No.	%	No.	%
1	Dominated by few persons	48	57.14	36	42.86
2	Lack of fund to run the society	70	83.33	14	16.67
3	Lack of infrastructure facility	76	90.48	8	9.52
4	Inadequate knowledge to handle society matters	58	69.04	26	30.96
5	Time constraint	55	65.48	29	34.52

interact with Forestry Extension officials which improved their self-confidence and allowed them get technical information about tree growing. Further, the meetings organised by TGS helped the members to express and exchange their ideas.

The indirect consequence or benefit of being a member of TGS is that understanding the collective approach which has been reported by nearly four-fifths of the respondents (82.14 per cent). The group extension concept is fast emerging like Farmers' Interest Groups (FIGs), Commodity Groups, Farmer Producer Companies (FPCs) in agriculture and farmers are increasingly realising the benefits of working in groups.

Approximately, three-fourths of TGS members reported that they got to know fellow tree growers (78.57 per cent) and they had chances to interact with fellow tree growers (72.61 per cent), respectively.

The prime aim of mobilising farmers' groups is to provide a platform wherein farmers with diverse backgrounds share their experiences which can be more location specific, farmer friendly than technologies delivered through the formal extension system.

Constraints in the functioning of TGS

The constraints in functioning of TGS have been documented and presented in Table 4. The prime constraint expressed by vast majority of members (90.48 per cent) was the lack of infrastructure facilities such as office space, furniture, computer accessories with internet facility and a staff which are essential to hold meetings and governing day to day activities for the effective functioning. The next constraint expressed by a majority of members (83.33 per cent) was the lack of funds to run the society.

Another constraint reported by nearly two-thirds (69.04 per cent) of members was inadequate knowledge to handle the society matters. This is

Table 5. **distribution of respondents according to suggestions to improve the functioning of t Gs**

(Multiple responses) (n = 84)

s. No.	suggestions	Yes		No	
		No.	%	No.	%
1.	Provision of funds and creating Infrastructure facilities	84	100.00	-	-
2.	Creation of awareness about the existence of the society	75	89.28	9	10.72
3.	Periodicity of meeting must be ensured	68	80.95	16	19.05
4.	Democratically elected office bearers	45	53.57	39	46.43
5.	Renewal of registration and auditing	31	36.90	53	63.10
6.	Providing market information	78	92.86	6	7.14
7.	Involving members in raising nursery and vermicompost production	17	20.24	67	79.76

a crucial point to be borne in mind by the officials of Forestry Extension wing and they have to seriously think of imparting knowledge about working and mandatory activities of the society, renewal of society and maintenance of records and accounts.

Time constraint has been reported by nearly two-thirds of (65.48 per cent) members of the society. Although, the members are eager to take part in the meetings organised by the societies, due to various timely agricultural works, the members could not find time to take part in these meetings. The society must fix a particular date in a month for the periodical meeting, which will enable the members to attend the meeting by adjusting their other works.

Nearly half (57.14 per cent) the members cited domination by few persons as one of the constraints. Any group is bound to have such individuals who need to be tackled diplomatically by other members and office bearers. Training on group dynamics for office bearers as well as members proved to be an effective solution for such problems.

Suggestions to improve functioning of TGS

Suggestions to improve functioning of TGS was sought from the society members. The results are given in Table 5.

Provision of funds and creation of infrastructure facilities was the suggestion endorsed by all members (100 per cent) of TGS who were interviewed. For any institution to thrive and sustain its functions, funds and infrastructure are very vital. The members and office bearers might have felt the onus while conducting the meetings/functions/melas during which they needed to

arrange facilities like meeting hall, furniture, public address system and refreshment. Hence they have prioritised this suggestion among others.

Providing market information to TGS members by the Forestry Extension wing was suggested overwhelmingly (92.86 per cent) by a majority of the members. At the end of the day, good market price for the produce would be the ultimate expectation of any farmer toiling in the field. In the absence of proper market information system, the middlemen took a lion's share of profit by exploiting the ignorance of the farmers. Many studies suggest that the price spread for tree produce could be restricted through effective market regulatory mechanism which will provide proper market intelligence. This is the reason why members felt that suitable mechanisms should be devised for providing market information.

The next important suggestion expressed by a majority (89.28 per cent) of the members of TGS was the creation of awareness about the existence and benefits of society. As discussed, awareness among tree growers about the existence of TGS is very low. This suggestion should be taken care of by the Forestry Extension system through intensive campaigns and meticulous publicity.

Majority of respondents (80.95 per cent) felt that ensuring regular conduct of society meeting as one of the suggestion. Though the Forestry Extension wing has formulated a system to have periodical meeting through TGS, it is not being conducted regularly due to paucity of funds for arranging transport and refreshment. The members were also did not evince interest in attending the meetings due to the assumption that they will not be getting enough, relevant technical information on tree growing and allied activities from the meetings. This suggestion indicated a policy decision to be taken for allotment of corpus fund, infrastructure and provision of updated technological information through appropriate experts in the relevant fields.

Nearly half (53.57 per cent) the members felt that the office bearers for TGS must be chosen in a democratic way to avoid dominance by a few members. This is true with many organisations and hence this should be streamlined by adopting an acceptable method.

Renewal of registration and auditing the accounts is a statutory provision as stipulated in the Societies Registration Act. Many TGS did not follow the procedure of renewal of registration which has affected functioning. Hence a few members (36.9 per cent) suggested that this statutory provision be adhered to scrupulously.

About one-fifth of the members (20.24 per cent) suggested that they should be involved in nursery raising and vermicomposting pertaining to some Government schemes, so that they will get to know about the techniques of nursery raising and vermicomposting. A suitable policy decision is to be taken to consider this suggestion.

Willingness of tree growers to become TGS members

Another dimension of the study is to assess the willingness of tree growers

Table 6. **Model summary of logistic coeffici ts**

step	-2 Log likelihood	cox and snell r square	Nagelkerke r square
1	64.209	0.410	0.602

Table 7. **classifi ation table to check the predictive ability of the Logistic model**

Observed		Predicted		
		Willingness to become member of the tree grower society		Percentage correct
		Unwilling	Willing	
Willingness to become member of Tree Growers Society	Unwilling	5	22	81.50
	Willing	7	70	90.90
Overall percentage				88.50

to become TGS members which might have been influenced by several factors. Since the dependent variable willingness to become member of TGS is dichotomous and was scored '1' and '0' for willing and unwilling responses, respectively, the appropriate model would be logistic regression which will predict the willingness of tree growers, given their profile and other influencing factors. The results of logistic regression are given in Table 6.

Table 6 presents two important estimates, namely Cox and Snell R^2 and Negelkerke R^2. It is evident that both R^2 value indicated moderate variance in the dependent variable (Willingness to become member of TGS) due to selected independent variables. Among the two measures, Negelkerke R^2 is to be preferred, since it achieves maximum value of 1. In this case, it could be interpreted that 60 per cent of variance in willingness to become member of the societies is predicted by selected independent variables.

Another measure interpreted from logistic regression is classification. Table 7 gives the measure of how well the model performs in its ability to accurately classify cases into the two categories of the variables 'willing' and 'unwilling' to become a member in the TGS.

The cut value is 0.500. The overall predictive accuracy is 88.50 per cent. The model predicted 70/7 or 90.90 per cent of these cases were willing to become members of TGS. Table 8 presents the Logistic regression coefficients.

In logistic regression, the original model is in terms of the log of the odds ratio or logit. In logistic model, 'B' coefficients is the effect of 1 unit change is independent variables on the log odds. The Exp (B) column presents the exponentiated value of B.

In the present analysis, two variables

Table 8. **Logistic regression coeffici ts**

Predictors	B	s.e.	Wald	df	sig.	exp(B)
Area under tree cultivation	0.070	0.051	1.923	1	0.166	1.073
Decision making pattern	-0.088	0.096	0.833	1	0.361	0.916
Information seeking behaviour	0.725	0.421	2.961	1	0.055	2.065*
Innovativeness	1.578	0.537	8.640	1	0.003	4.847**
Income from tree crops	0.000	0.000	0.061	1	0.804	1.000
Marketing orientation	0.125	0.182	0.472	1	0.492	1.133
Access to forestry production technologies	0.039	0.027	2.129	1	0.145	1.040
Perception towards Forestry Extension activities	2.867	1.288	4.956	1	0.026	17.58**
Adoption of tree growing practices	0.078	0.088	0.788	1	0.375	1.081

namely 'Innovativeness' and 'Perception towards Forestry Extension activities' were found to be significant at 1 per cent level of probability. Another variable namely 'Information seeking behavior' was significant at 5 per cent level of probability.

It could be interpreted that, if a tree grower had high perception towards Forestry Extension activities, the odds of his willingness to become member of TGS would increase by a factor of 17.58 units. In other words, the willingness of a tree grower to become a TGS member improves by 17 times if he had high perception towards Forestry Extension activities. If an individual perceives high about a phenomena/activity, he tends to move towards that phenomena or activity. The perception towards Forestry Extension activity carried out by Forestry Extension wing will, therefore, act as a catalyst to have a opinion about forestry. Further, the societies are mobilised by the Forestry Extension wing and the benefits of being a member of the society has been reinforced in most of the meetings of the wing.

Similarly, if a tree grower is innovative, the odds of his willingness to become a member of the society would increase by a factor of 4.84 units. In other words, the willingness of a tree grower to become a TGS member improves 4 times if he is innovative. Obviously, any farmer who wishes to practice agriculture innovatively, he tends to look for innovative practices. The Forestry Extension wing, which is promoting TGS, is also known for transferring innovative tree growing practices. Hence, innovative tree growers might have formed a opinion to join the societies anticipating the benefits of being a member.

Yet another variable 'Information seeking behaviour' was also found to be significant which implies that the odds of a tree grower to become a TGS member would increase by a factor of 2.06 units and hence, the likelihood increased two times if he had higher information seeking behavior. It has already been discussed in adoption of tree growing practices that information seeking behaviour was significant. There is no doubt that if a tree grower is seeking information from various sources, including the Forestry Extension wing, his orientation towards this institution will grow and ultimately there exists a possibility of him or her becoming a member of the TGS.

In a nutshell, tree growers who are innovative, seeking information about tree growing activities and who had higher perception towards Forestry Extension activities possessed a higher chance of becoming a member of the TGS. This reveals the active role to be played by the Forestry Extension wing to conduct regular meetings, campaigns, demonstrations in the villages which will indirectly help tree growers to join as TGS members.

Conclusion and suggestions from the study

Twenty seven Tree Growers Societies have been formed in Tamil Nadu with the guidance of the Forestry Extension wing. During the study, the researcher had found that renewal of registration has not been done in many TGS; many societies were not functioning while some were functioning with limited activities. The following suggestions are made for the revival and successful functioning of these TGS.

- The study indicated that many respondents were not aware about the existence of the TGS while some were aware of its existence but did not actively participate or pay membership fees because they did not realise any tangible benefits. The Forestry Extension wing must take tangible action to organise a participatory workshop for two days by gathering Executive Committee members (EC) of all the 27 TGS, inviting few successfully functioning TGS members of other states and some successful tree growing farmers. They will be requested to share their experiences and deficiencies in TGS functioning and identify appropriate solutions to remove the deficiencies and also find ways and means for the successful functioning of the TGS.
- There is a need to organise training programmes exclusively for the Executive Committee members to familiarise them with strategic planning, accounting, financial management, capacity building and other tasks needed to run the TGS successfully.
- A corpus fund of at least Rs 10 lakh may be provided to each TGS from the State fund to undertake initial activities such as organising workshop, procuring few tools and implements, to meet office expenses, etc. Thereafter, the TGS has to sustain itself by mobilising funds from various sources.
- The Executive Committee must play a proactive role in enrolling more

members and collection of membership fees. In addition, they must also organise periodic meetings by inviting successful tree growers, financial institutions, wood based industries, and members from successfully functioning TGS to share their experiences and also induce enthusiasm among the members for better participation in the TGS and tree growing activities.

- The study also revealed that respondents are poor access to market information. Therefore, TGS can act as a service provider with respect to providing market information, prevailing demand and supply status of tree products, value addition to tree products, promotion of income generation activities such as nursery raising, vermicompost production, renting tools and equipment and any other activities bringing income to the TGS.
- The Forestry Extension wing must play a proactive role in providing market information, tree products demand and supply status and overall smooth functioning of TGS.
- It was found from the study that EC members are not being elected in a democratic way and this is true with many TGS. Hence the Forestry Extension wing must play an leading role to streamline the processes in selection of EC members by adopting acceptable methods.
- TGS branches may be formed at Taluk level which will be useful to reach to reach a larger number of farmers and enroll more members.

References

Ballabh, V and RA Kramer. 1992. "Property Rights, Transaction Costs and Co-operatives in Management of Common Pool Natural Resources: A Survey of Indian Experience". Paper presented at the Workshop on Cooperatives in Natural Resources Management, December 7-11, Institute of Rural Management, Anand.

Christian Gouet and Annemarie Van Paassen. 2012. Small Holders Marketing Cooperatives and Smallholders Market Access: Lessons learned from the actors involved. *Journal of Agricultural Education and Extension*, 18 (4), 369-385.

Gupta, Tirath. 1989. Protection of Social Forestry Plantation in Madhya Pradesh and Uttar Pradesh-Some Issues for Wasteland Management. *Management and Labour Studies*, 4 (2), 10-32 and 77-86.

Mishra, SN, LM Prasad and Kushal Sharma. 1982. Tribal Voting Behaviour: A Study of Bihar Tribes. New Delhi: Concept Pub. Co.

Raju, G and KV Sarabhai. 1992. Institution Building for Afforestation of Wastelands. Paper presented at the Workshop on Cooperatives in Natural Resources Management, December 7-11, Institute of Rural Management, Anand.

Rakesh Saxena and Rajesh Agrawal. 1999. Natural Resource Accounting by Tree Growers Co-operatives: Framework and Case Study. *Vikalpa*, 24 (3).

Saxena, NC 1987. Commons, Trees and the Poor in Uttar Pradesh Hills. ODI, Social Forestry Network Publication, pp. 43.

Shah, Tushaar and V Ballabh. 1986. Ownership/Use Rights and Community Involvement in Wastelands Development: Experience from Gujarat. Paper presented on the workshop on Fodder Production - An Alternative for Marginal and Wastelands Development, May 15-16, NDDB, Anand.

Shankar Narayanan. 1991. Participatory Regeneration of Forests on Common Lands Through Village Level People's Institutions: The Experience of Aga Khan Rural Support Programme (India) in the Tribal Areas of Bharuch. Paper presented at the

Training Workshop on People's Participation in Natural Resources Management, November 25-30, Institute of Rural Management, Anand.

Singh, Katar and Ballabh, Vishwa. 1982. Co-operatives in Natural Resources Management: Experiences, Issues and Agenda for Future Research (Theme Paper). Paper presented at the Workshop on Cooperatives in Natural Resources Management, December 7-11, Institute of Rural Management, Anand.

Singh, Katar and S Bhattacharjee. 1991. Economics of Eucalyptus Plantation on Degraded lands: A case Study in Nepura Village, West Bengal. Paper presented at the Workshop on Socio-economic aspects of tree growing by farmers in South Asia. March 11-15, Institute of Rural Management, Anand.

Singh, Kattar and Balooni Kulbhushan. 1994. Role of Tree Growers' Cooperatives in Promoting Farm Forestry in India. Working Paper 58. Institute of Rural Management, Anand.

Zoo MANAGeMeNt

Successful breeding of endangered species

Kanan Pendari Zoo in Bilaspur has become renowned for its successful breeding programme in less than a deacde

Dr. Amit Chouhan & Vijay

Kanan Pendari Zoological Garden located in Bilaspur district of Chhattisgarh State, was established on 3rd August, 2005. It is spread over 114.6 hectares and has 65 enclosures. The zoo was started with 242 wild animals which have subsequently increased to 550 animals of 65 species at present.

The zoo is equipped with a veterinary hospital, quarantine cells, a rescue center, slaughter house and meat processing unit, post-mortem unit and well designed animal transporting cages. The slaughter house and meat processing unit is maintained in zoo premises to feed carnivores. Live animals like goat and chicken are brought to this slaughter house and fresh meat is prepared. For herbivores, *Cheetal Ahaar* mixed with *Parakatiya* forms a significant part of diet along with different seasonal grasses. *Cheetal Ahaar* contains maize, rice, pulses, gram, by-products of groundnut and mustard oil extract which provide protein (20%), fibre (15%), oil content (5%) and the rest are minerals and vitamins. This combination of *Cheetal Ahaar* mixed with *Parakatiya* is preferred by herbivores and has also resulted in drastic improvement in health and behaviour as well as enhanced breeding ability of these animals.

The survival rate of newly born animals is excellent due to special care given to them after their birth at the Veterinary Section. Video cameras are fitted in the enclosures of these animals and the recordings are closely observed by Zoo authorities and the veterinary doctor. This helps to diagnose and cure the animal if they behave extraordinarily.

In a little more than one decade, Kanan Pendari has become renowned for its successful breeding programme. Some of the stories of breeding programmes of carnivores at Kanan Pendari are given below.

Heterozygous Tiger

The successful breeding of white tiger Vijay (from Delhi Zoo) and Bengal tigress Cherry (Wild Origin from Maharaja Zoo, Nagpur) gave birth to first heterozygous female tiger Asha in October 2013. In the second breeding of Vijay and Cherry, three heterozygous cubs (1 male and 2 females) were born in April 2015 and are healthy at present.

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The heterozygous tigers have 25:75 gene ratio of their father and mother, respectively. The zoo authorities are searching for a male heterozygous tiger for breeding with female heterozygous tigress Asha to get improved gene ratio of 50:50 in next generation.

White Tiger

The first successful breeding of white tiger Vijay and white tigress Sidhhi at Kanan Pendari Zoo resulted in the birth of a male white tiger Aakash in May 2015. On the fifth day of its birth, Aakash's throat was accidentally pressed by its mother while feeding. Due to that, Aakash was unable to feed further from his mother. This consequently stopped the growth of Aakash. Dr PK Chandan, the veterinary doctor, decided to feed Aakash with cow milk but that caused diarrhoea. Aakash was then fed with goat milk, this was also not effective, as it did not contribute to the growth of the cub. Finally Aakash was fed with the milk of a Rottweiler bitch. Following this the cub was able to attain normal daily growth of 40 to 60 gm.

In the second breeding of Vijay and Sidhhi, two male and two female cubs were born on April 20, 2016. In an analysis of the video recording, the zoo authorities observed that out of the four cubs, one cub was unable to feed from its mother.

To save this cub, it was separated from the mother and intense care was provided by the veterinary doctor. This cub was also fed with milk from a Rottweiler bitch. At the time of the visit, this cub was three months old, healthy and had started on solid food.

dog feeding of carnivores

tigress cherry with 3 cubs

Lioness Varsha with 3 cubs

White tiger Aakash

Breeding details of Herbivores of 2014 and 2015 :

s.No.	Animal	description	cubs
1	Swamp Deer	Brought from Lucknow Zoo in December 2015. Two fawns born in July and August 2016.	2
2	Sangai Deer	Brought from Delhi Zoo in April 2013. Two fawns born in September and November 2015.	2
3	Hog Deer	Brought from Delhi Zoo in April 2013. Two fawns born in July and September 2015.	2
4	White Deer	Brought from Delhi Zoo in March 2015 and one fawn born.	1
5	Himalayan Tahr	Brought from Delhi Zoo in March 2015. One female kid born in September 2015.	1
6	Chinkara	One male brought from Gwalior Zoo in August 2015, the female already existed at zoo. One fawn born in August 2015.	1
7	Barking Deer	Brought from Raipur Zoo in December 2014. Two fawns born in August and October 2015.	2
8	Sambhar	Brought from Bhilai Zoo. One female fawn born in September 2015	1
9	Four Horned Antelope	Brought from Raipur Zoo in December 2014. Two calves born in January and two in February 2015.	4
10	Black Buck	Brought from Junagadh Zoo and eight calves born in 2015.	8
11	Nilgai	Brought from Raipur Zoo in December 2014. Two calves born in September 2015.	2
12	Honey Badger	Brought from Raipur Zoo in December 2014. One kit born in September 2015.	1
13	Spotted Deer	Eleven fawns born in 2015.	11

Lion

A pair of lions, Jamna and Sultan was rescued from Raj Mahal Circus and brought to Kanan Pendari Zoo in 2006. Till now, 17 cubs (9 M and 8 F) have been born due to breeding of this pair and the cross breeding of their cubs. Out of these, three pairs have been sent to Bhopal, Lucknow and Indore Zoo respectively and one female has been sent to Gwalior Zoo. Currently seven male and five female lions are kept at Kanan Pendari zoo.

Conclusion

A separate slaughter house and meat processing unit for carnivores and *Cheetal Ahaar* for herbivores provides

Fawn of Mouse deer

Spotted deer (Axis axis)

Chinkara

Sambhar (Cervus unicolor)

healthy, nutritious and hygienic food for the inmates in the zoo. By keeping a close watch on any abnormal activity through cameras in enclosures and feeding the carnivore cubs with milk from a female dog has drastically reduced the mortality rate of newly born cubs of tigers and lions. Thus nutritious food, intense care and healthy environment are the key factors which have enhanced the breeding ability of wild animals in the zoo.

References

This article is based on the field experience of the authors and personal interaction with Chief Conservator of Forest, Deputy Conservator of Forests, Sub Division Officer and Range officers concerned. The statistical information and the photographs have been provided by the Range officer Mr. T. R. Jaishwal, Kanan Pendari Zoo, Bilaspur, Chhattisgarh.

Forestr Y eXte Ns Io N

Current status of agroforestry in Haryana: Challenges and some solutions

Despite having just 3.5 per cent area under forests, Haryana has become a 'timber-surplus state' because of establishment of trees outside forests (TOF) due to the flourishing practice of agroforestry.

Jagdish Chander

The term 'agroforestry' may be new but its history is as old as the history of agriculture itself. In about 700 BC, man shifted from hunting and food gathering as a means of livelihood to cultivation of crops. He cleared the forests, created some patches for food production and started practising agriculture. Initially these cleared patches were in forests and agroforestry happened in a natural way. However, as the time passed, man learnt the relative importance of trees and agriculture crops; he retained trees which were more beneficial than the others for fodder, fuelwood, timber, fibre, medicine, etc. Agroforestry, therefore, became the way of life all over the world.

Agroforestry is practised all over the world with varying objectives of meeting needs of both wood and non-wood forest products for maximisation of returns by putting land to optimum use. It indirectly helps in forest conservation by reducing pressure on forests by meeting the requirement of fodder, fuelwood and timber from on-farm plantations. With particular reference to India, the huge gap between demand and supply of fuelwood, fodder, timber and deteriorating quality of biodiversity wealth necessitates the adoption of agroforestry and extension of forests outside forests as a viable alternative to these problems.

Agroforestry is particularly the requirement of forest deficient states like Haryana with forest area of just 3.5 per cent of the total geographical area as against 20 per cent envisaged in the National Forest Policy, 1988. There is hardly any scope to increase forest area in the state as Haryana is primarily an agrarian state with almost 80% of its land under cultivation. Forestry activities in the state are dispersed over the rugged Shivalik Hills in north, Aravalli hills in south, sand dunes in west and wastelands, saline-alkaline lands and waterlogged sites in the central part of the state. Until recently, the forest department distributes annually about 25 million seedlings to farmers free of cost. Agroforestry plantations raised by the farmers of Haryana are rated as one of the best in the country. It has been adopted by farmers as an income

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generation practice and used as a model of rural development, worthy of emulation in the rest of the country.

On-farm plantations meet 99 per cent wood requirement of the state, which has transformed Haryana from a forest deficit state to the most productive state in terms of timber production. Annually 2.5 million cubic metres of farm-grown wood is converted into plywood and other form of composite wood within the state. Today, Yamunanagar has become the national centre of plywood and veneer industry. The policy of not putting unnecessary restrictions on felling of trees from private land and their subsequent transit has enabled an environment which has encouraged a large number of farmers to grow trees. The endeavour has been to enable an environment that agroforestry and wood-based industries flourish and grow simultaneously. However, agroforestry in Haryana is facing challenges as well. Recently, some new pests have invaded the state and some existing ones have assumed the status of serious pests. Eucalyptus gall wasp *(Leptocybe invasa)* and little leaf disease have recently invaded Haryana and are threatening eucalyptus cultivation. *Cylindrocladium* leaf and twig blight disease is assuming serious proportions. Poplar defoliator *(Clostera cupreata)*, shoot borer *(Eucosma glaciata)*, and stem borer *(Apriona cineri)* are causing more serious damage to poplars than ever before.

Traditional Agroforestry

Traditional agroforestry is practised in all parts of the state. In traditional agroforestry, farmers just retain or encourage the naturally growing young seedlings to establish preferably on field bunds to meet the household needs of fuelwood, fodder and timber, and the produce is rarely sold. The Shivalik region of the state comprising of three districts namely Panchkula, Ambala and Yamunanagar, shares boundary with Himachal Pradesh and Uttarakhand. The altitude varies from 400m to about 1400m and annual rainfall is around 1100mm. Tree species like beul *(Grewia optiva)*, tun *(Toona ciliata)*, khair *(Acacia catechu)*, mulberry *(Morus alba)*, etc. are grown on the terraces of fields. In central Haryana, the main species are sissoo *(Dalbergia sissoo)* and kikar *(Acacia nilotica Syn. Vachellia nilotica)*, which grow on the bunds of the fields. Kikar meets all domestic requirements of the people in terms of fuelwood, agricultural implements, making of buffalo carts, doors and windows, but it is not a preferred species for agroforestry because it does not allow anything to grow under it due to intense shade and exudation of tannins.

In the western semi-arid and southern Haryana, jand/khejrhi *(Prosopis cineraria)* is the lifeline of the people of this region. Only in the western and southern parts of the state comprising of semi arid region, a few trees of jand and roherha or marwarh teak *(Tecomella undulata)* can be seen growing just in the middle of the fields. Jand acts as nurse crop and helps agricultural crop to flourish by providing much needed nutrients in the form of humus and fixing atmospheric nitrogen. As

the trees grown under the traditional agroforestry are of long rotation in nature, they are harvested to meet the bonafide domestic needs. Farmers sell the trees upon their maturity or at the time of urgent domestic needs but the money earned is too less to be termed commercial agroforestry.

Commercial Agroforestry

Commercial agroforestry is practised in the central and northern irrigated plains. The agroforestry interventions are so successful in this part of the state that it has made Haryana a national leader in agroforestry. It all started with the introduction of *Eucalyptus* in the early 1960s and poplar *(Populus deltoides)* in the late 1970s. Both of these species have their own merits and limitations and therefore, there is no competition between them. While poplar grows in a limited zone along the Yamuna comprising of districts Panchkula, Ambala, Yamunanagar, Kurukshetra, Kaithal, Karnal and to some extent Panipat; eucalyptus has wider adaptability. It grows in areas wherever the canal network is available. While eucalyptus needs little care; poplar needs well drained loamy soils and operations like ploughing, weeding, hoeing and pruning. However, if grown with the agriculture crop, it does not need extra care and extra input (Chauhan and Mahey, 2008).

Agroforestry with Eucalyptus

Eucalyptus offers a great choice for the absentee farmer who can't supervise his trees regularly. Contrary to the belief that it does not allow anything to grow under it, farmers in Haryana are growing a number of crops under it varying from wheat to vegetables and mustard. It can be grown as block plantation or on the bunds of the fields. Till about the mid 1990s, all eucalyptus planting material comprised of seed origin only. High yielding clones of eucalyptus were introduced in the mid 1990s for general cultivation in the state. Eucalyptus has now become part and parcel of the farming system of Haryana. The importance of its growing in Haryana can be judged from the fact that out of about 50 million seedlings being raised annually in the state, about 40 per cent share goes to eucalyptus alone. So, about 20 million seedlings of eucalyptus are raised annually in the state. However, only about 2 million plants of clonal origin eucalyptus are raised annually in departmental mist chambers. The department is expanding its activity and more mist chambers are being constructed to meet the requirement of improved clonal plants of eucalyptus in the western and the northern parts of the state to meet the farmers' demand.

Up and down trends in Eucalyptus: Although eucalyptus has brought prosperity to the state of Haryana in general and its farmers in particular, it has seen many ups and downs as well. Ever since its introduction in the state, it brought quick returns to the farmers. Soon it became a number game. Instead of planting it at recommended spacing, the farmers started planting it one metre apart to increase the number of plants in unit area with resultant reduced

growth. This was followed by severe drought in 1987. Farmers could not cultivate their fields, so they resorted to felling the trees growing on their fields, which led to a sudden glut in the market. Lack of planning on the part of industries using eucalyptus added to the worries. People stopped planting eucalyptus and on-farm planting got a big setback. Eucalyptus growers in the state needed government support for the sale of their produce and it is in this background that the Haryana Forest Development Corporation (HFDC) was established in 1990. HFDC offers support price to the farmers. The farmers are free to sell their produce anywhere in the state if they get prices over and above the rates of the HFDC, failing which the HFDC is bound to buy their produce. With this support provided by HFDC, eucalyptus planting has again picked up and at present, it is raised annually on about 20,000 hectares and generating trade worth Rs 100 crore annually.

For the last 10 years or so, eucalyptus prices have almost remained stable in the market. At present, eucalyptus wood is sold at an average rate of Rs 6,000 per cubic metre in Haryana. This is because of the diversified uses of its wood like making *ballis* (bamboo sized poles for construction purposes), veneers, carving and furniture besides pulp and paper making.

Problem of pests: One of the reasons why people took up eucalyptus culture on a large scale in the state is because it was a pest free species. However, this is no longer the case. Eucalytpus is being attacked by a number of pests, of which many are very serious. The following pests at present are threatening Eucalyptus cultivation in the state.

1. Invasion of gall wasp of Eucalyptus *(Leptocybe invasa)*: Eucalyptus which is considered almost pest-free species is no longer safe from the insect pests and diseases. A tiny wasp of Australian origin invaded Haryana in 2008 but at that time it was not considered a nuisance as the attack was not severe. Soon it established and from 2010 to 2012, it caused serious damage to plants in the nursery and young plantations up to two years. The pest causes damage to the midrib and soft tissues by formation of galls. As a result, some plants die while others become stunted and bushy. They never form clear bole. The attack during 2011-12 was so severe that the farmers started uprooting Eucalyptus from their fields.

Studies conducted in Haryana have revealed that no eucalyptus germplasm is resistant to the wasp. Clone number 288 and 130 have been found tolerant while number 10 and 279 are most susceptible (uprooted from the clonal multiplication area). No insecticide, anti-feedant or repellent could deter the pest from feeding on the tender shoots. Even colour and light traps did not attract the pest. A long-term strategy was chalked out to find suitable alternatives to eucalyptus. This mainly focused on diversification of species under agroforestry. *Corymbia* hybrids are free from the attack of wasp as tender shoots of *Corymbia* have sharp trichomes, which act as a physical barrier between the soft tissues of plant and the pest. However, not all *Corymbia*

hybrids fit into the agroforestry system. The hybrid between *C. torelliana* X *C. citriodora* has thick crown and is not suitable for agroforestry as it is going to cause shade effect on the crop. However, it is suitable for growing as pure crop especially for the absentee farmer who does not want to grow agricultural crops. On the other hand, *C. citriodora* X *C. torelliana* hybrids have thin crown and are suitable for agroforestry. However, studies conducted on its wood have revealed that it is more prone to cracks and warps. However, furniture has been made successfully from its wood and it is expected that it will find acceptability among the farmers. *Quadrastichus mendeli*, a natural enemy of the wasp, donated by the National Bureau of Agricultural Insect Resources, Bangalore. has been released. The gall wasp now is under check but the problem is not over. Local predators have also played a role in controlling the pest, i.e., preying mantis *(Mantis religiosa)*, syrphids, lady bird beetle *(Coccinella septum punctata)*, etc.

2. Little leaf disease: This disease was noticed first in 2010 in old eucalyptus trees growing in Bithmarha Forest Research Station in Hisar district. The disease is supposed to have invaded Haryana along with clonal eucalyptus material. During 2011, the disease affected almost all eucalyptus nurseries in the state. What has added to the worry is that the gall wasp and little leaf disease were co-existing on the same plant. Still more bad news is that clone number 288, which is tolerant to gall wasp, is equally susceptible to the little leaf disease. The disease is caused by *Phytoplasma Like Organisms* (PLOs) and is said to be transmitted by western flower thrips *(Franklinella occidentalis)* and eriophid mite. PLOs kill the plant by blocking the xylem and phloem channels and nutrient supply to the cells. At present, there is no control against the disease. However, the vector can be controlled by spraying any contact or systemic insecticide. The entire eucalyptus germplasm was screened for the disease, but unfortunately, no genotype showed any resistance/tolerance to the disease. However, there still exists a silver lining in the dark clouds. The *Corymbia* hybrids still provide some relief. All *Corymbia* species or their hybrids are not attacked by the disease because of the fact that the tiny mite (or any other agent), which transmits the PLOs, is not able to reach the soft tissues because of the trichomes. So, *Corymbias* provide relief to the twin problem of gall wasp and little leaf disease of eucalyptus.

3. *Cylindrocladium* leaf and twig blight: This is not a new disease of eucalyptus but is now causing more damage than ever before. This is a fungal disease and is characterised by drying of lower leaves which later affects the entire foliage. The severe attack on young plants results in their death. The disease attacks the plants under hot and humid conditions. So, it is particularly severe during June to September. It attacks plants of all ages and kills them by releasing toxins. It is particularly severe on nursery plants and young plants in the plantations. The clones seem to be affected more than the plants of seed origin. About 30 to 35 per

cent plants of clonal origin are being destroyed by this disease in the mist chambers. There is no control against the disease at present. All fungicides tested at variable dose in Haryana did not provide any relief from the disease.

4. *Cryphonectria* canker: This disease was noticed in the Shivalik belt of Haryana in 2011 and is now slowly spreading towards the central and the western parts of the state. A dark blood red thick fluid starts emerging from the stem. Later on big knots in the form of canker appear on the stem. The plants start drying from the top and this is followed by their death. Plants of all ages are being affected. The disease is not severe at present. However, suitable management practices need to be developed to use in times of severity of the problem**.**

5. Aphids: The aphids are seen on the young shoots in the months of March and April. The problem is not severe but certainly these plant lice reduce the vigour of plants.

Status of poplar culture

Poplar was introduced by WIMCO in 1976 for diversification of species under agroforestry and also as a substitute for eucalyptus as the controversy against the latter was at its peak at that time (Chandra, 1986). However, very soon it was realised that the poplar is not a competitor of eucalyptus but rather they are complementary to each other.

Number and diversity of poplar entire transplants (ETPs) grown in Haryana especially in Yamunanagar, is a barometer of poplar culture and trade in the country. In a recent survey, it was estimated that around 1.34 crore poplar ETPs have been grown in the state during 2011-12 (Dhiman and Jagdish, 2011). WIMCO and the Haryana State Forest Department were leading nursery growers in terms of ETP quantity and clonal diversity. Yamunanagar district was a major poplar nursery growing area in the state (767 acres) followed by Karnal (176 acres) and Panipat and Karnal district (100 acres each). The percentage of poplar ETPs grown varies from 60 per cent in Yamunanagar district followed by 13 per cent in Karnal, 9 per cent in Ambala, 7 per cent in Panipat, 7 per cent in Panchkula and the remaining in Sonepat, Kaithal and Rhotak districts.

Poplar nursery has become a profitable business and a number of private poplar nurseries have mushroomed around Yamunanagar and Kurukshetra districts. It is estimated that about two million plants of poplar are raised in private nurseries. In Yamunanagar district, maximum poplar nurseries are in Chhachhrauli Tehsil followed by Bilaspur, Jagadhri and Mustafabad tehsils. Some locations around Yamuna river especially Karnal and Panipat also grow poplar nurseries for their trade in adjoining locations in Uttar Pradesh. Each year during January to March, number of truck, tractors and even bullock carts can be seen carrying poplar saplings across the state borders from Haryana. Lakhs of them are stacked each year on road sides at numerous locations during January-February for attracting buyers. Unfortunately, such saplings do not perform well, yet nursery growers

try to sell them at whatever price they can negotiate with buyers, mostly casual planters.

There are around two dozen clones commercially grown in the country and around one dozen in the state of Haryana. Most poplar growers and its wood users know only one clone, i.e., G48. WIMCO has introduced 16 clones in the state of Haryana till date, clones especially WSL 22, WSL 32, WSL 39, Udai and WIMCO 110 have become popular among the farmers . The farmer's preference for clones has been changing over the time. Poplar culture in the state was started with IC and D121 clones in the 1970s, established with G48 and G3 clones and is now further expanding with new clones developed by WIMCO.

During 1990s, G3 constituted more than 90 per cent planting stock in Yamunanagar district and this clone was taken out of production from Haryana and most other locations due to leaf blight disease attack. G48 is also becoming susceptible to many diseases and is likely to have a short life. New clones are gaining acceptability due to adoptability and good productive. It is also interesting to note that D121 and IC clones are still being grown in many nurseries and these did not find any mention in the survey. On the other hand, WSL34 and SAI43 clones recorded in the survey are not standard clones and are being ignorantly mentioned by some of the nursery growers. It is believed that most nursery growers lack knowledge and identification of the clones and they name their ETPs invariably to any standard clone which finds market. No provision exists for the certification of these plants. These private nursery growers use side branches of the old trees to raise plants thereby inducing inferiority in the planting stock.

About five million poplar plants are raised/planted every year in Haryana and nearly 70,000 hectares are under poplar on rotation basis. The productivity per hectare is 30 cu.m/ha/yr. The farm grown wood is sold on diameter basis, i.e., over, under, sokhta and fuelwood. It is being sold at the average rate of about Rs 700 per quintal, which was as high as Rs 1,000 per quintal in Yamunanagar market.

Agroforestry with Poplar: Poplar Based Agroforestry (PBAF) model is most successful in the state. The need for growing poplar has been supported by industries as its wood has versatile uses. It has more than three dozen uses including making plywood, paper, match sticks, ice-cream spoons, artificial limbs, charcoal, fuelwood, fruit packing, etc. Because of its deciduous nature, it allows winter crops to grow throughout its rotation age. Wheat is the most preferred crop followed by sugarcane during the initial two years. Poplar-turmeric combination has been found to be the best in the later stage. In fact, poplar is so popular with farmers that it has become part and parcel of their farming system. Particularly in Yamunanagar district, poplar is seen everywhere in the fields, canal banks, industries, school and institutional land, homesteads and so on.

In the farming system, poplar is planted as bund plantation and also

in blocks. The recommended distance for planting is 3m apart in the case of bund planting and 5mx4m in the case of block planting. However, the farmers conduct new experiments on their own for spacing depending upon whether they want to give importance to the crop or to trees. They themselves have discovered the multitier system combining trees, horticulture and agriculture crop. It was being harvested after six to seven years after planting. But now the farmers are harvesting it after five years as well. With the induction of modern peeling machines by the industries in Yamunanagar town, which now use spindleless technology of peeling, the log is peeled to two mm width. Accordingly, the harvesting age is likely to be reduced to three years with enhanced number of plants on unit area. A farmer in Yamunanagar and its adjoining parts earns about Rs 70,000 per acre per year as net profit from poplar alone if planted at 5mx4m in block and about Rs 40,000 per acre per year if planted on bunds. Farmers have resorted to high density plantations with intention to remove alternate plants for paper industry after three years and remaining for plywood industry after five years.

Ups and downs in poplar: Poplar too has seen ups and downs in Haryana. After bringing prosperity to its growers, in 2001 its prices crashed to bottom low of Rs 90 a quintal, almost equal to rates of green fodder. There was almost no planting for two years. But that was a temporary phase. It again picked up and at present poplar wood (diameter more than 60cm) is being sold at Rs 1,000 per quintal.

During recent years, poplar pests have posed more problem than ever before. A number of pests have been reported to affect the plantations in Haryana, namely defoliators, stem borer, shoot borer.

1. Defoliators: Two species of moths, namely *Pygaeria fulgurita* and *Clostera cupreata*, cause defoliation in poplar. These are not new pests of poplar but have attained serious status in recent times. No poplar clone is tolerant to these defoliators and all clones are equally susceptible. These defoliators start feeding on the leaves in the month of April and continue feeding till the middle of October, sometimes causing complete defoliation if not controlled. The pest causes premature leaf fall adversely affecting the growth of the plants. The pest is being controlled by spraying phosphamidon and dimethoate @ 0.1 per cent concentration at fortnightly intervals during the period of attack between April to October.

2. Stem borer *(Apriona cineri)*: This too is not a new pest of poplar but has attained serious status recently. It affects plants in plantations and is more severe on older trees. The larvae and the adults of this pest damage the pith of the stem by cutting with sharp mandibles. The affected plants show the hole and the saw dust at the base of the affected tree. The pest is being controlled by putting kerosene oil in the hole and thereafter, covering the hole with clay or cotton.

3. Shoot borer *(Eucosma glaciata)*: This pest affects the young shoots making trees branchy. The pest is

being controlled by cutting the affected branches.

4. Bark borer *(Indarbela quadrinotata)*: This pest affects the bark only but it paves way for the fungi and insects to enter besides affecting the look of the logs. Though the pest is not serious and does not affect the quantity and quality of the wood, the affected logs fetch low price in the market. Hence, the pest needs to be controlled. The pest is being controlled by painting the bark with *chaubatia* paste.

5. Leaf blight *(Bipolaris maydis)*: This is a very big problem in poplar cultivation. However, it is ignored because unlike direct damage from insects, it is not visible. The disease starts appearing on the leaves in the form of small yellowish irregular spots. These spots later widen and turn black. The premature leaf fall takes place affecting growth adversely. The use of Propiconazole, $CuoCl_2$, Tridemefon, Dithane M-45 @ 2 ml per litre of water and Bordeaux mixture provide some control but no control method is hundred per cent effective.

6. Heart rot *(Earliella scabrosa)*: The disease affects the stem of poplar and starts appearing when the trees have attained their rotation age. The disease is caused by a fungus called *Earliella scabrous.* Clone number G-48 is most susceptible to this disease. This is one of the clones introduced in India long back and is still staying because of high productivity and knot free stem. It is also the first choice of the industries for veneer and plywood making due to the creamy white wood. Efforts are being made to replace this clone with some suitable clone but it still continues to be the first choice among farmers.

7. Damage by Neelgai: Neelgai or blue bull *(Boselaphus tragocamellus)* damages young plants in the nursery and in the plantation by removing the bark or sometimes by breaking the stem. The damage sometimes is very severe as almost hundred per cent plants are damaged. It is worth mentioning that neelgai is a protected animal under the Indian Wildlife Preservation Act, 1971 and can't be killed. The plants can be protected from this mammal by adopting the following control measures:

a. Maintain cleanliness by removing the weeds and heap of its pallets, so the animal herd is forced to change its place of resting and herding.
b. Raising live fence with *Euphorbia*, agave, *Opuntia, Caesalpinnia,* etc. along the boundary.
c. *Chhappa* binding (wrapping) with date palm leaves ensures hundred percent protection of plants. This is affordable and cost effective solution, the cost of *chhappa* binding comes to about one and half rupee per plant.
d. Small polythene bags filled with about half glass of water tied on the stem provide very effective control. These polybags produce some sound, which drives neelgai away from the fields. However, in case the wind is not blowing, they are not effective.
e. In nursery, the plants can be protected by erecting six feet high barbed wire fence. The barbed

wire can be concealed by planting flowering climbers or climbers like giloy *(Tinospora cordifolia)*, which have medicinal value as well.

8. Monkey: Rhesus macaque/ monkey *(Macaca mulatta)* damage the plants by breaking the stems of young plants while roaming or while trying to eat the larvae of the insects feeding on the leaves of poplar. Only barbed wire fence can keep them away. They are also protected animals under wildlife act and can't be killed without permission of chief wildlife warden of the respective states.

Status of sissoo/shisham culture

This is the No.1 timber species of Haryana. People have a craze for shisham *(Dalbergia sissoo)* and it is the dream of every citizen of Haryana to use shisham wood for his/her house. The Forest Department raises annually about 15 lakh plants of shisham. Half of these are distributed to farmers and another half are planted by the Forest Department. The farmers are ready to plant any number of shisham plants in their fields and there is always shortage of shisham seedlings in the state. However, this tree species has been virtually pushed to the level of nearly endangered. Annually, about 15,000 shisham trees are dying in the state. The process started about two and half decades ago and the misery is still continuing (Gill *et al*., 2006). Plants of all ages starting from year three are being affected by mass mortality problem. Various reasons like water logging, over application of nitrogenous fertilisers, damage to root hairs, etc. have been cited as the primary reasons. As a result, the plant becomes prone to fungi like *Fusarium solani* and *Ganoderma lucidum*, which finally end up killing the plants. However, the primary reason for the mortality of shisham still remains elusive. Shisham trees are also dying in the lower Shivaliks far away from the fields where the soils are well drained and nitrogenous fertilizers are applied sparingly. Recently, FRI Dehradun has come out with its clone FRI-DS-14, which is a blend of higher productivity, resistance to die-back and excellent bole form. This clone has been planted by FRI Dehradun at research station in Bithmarha in 2008 and is under observation.

Dieback disease in shisham is not a problem of Haryana alone. States like Punjab, UP, Uttarakhand, Bihar, etc. and even adjoining countries like Nepal, Pakistan and Bangladesh are facing similar situation (Anon., 2000). There is no control for this disease at present. For the purpose of management of this disease, as soon as the initial wilting symptoms start appearing on the foliage, the immediate removal of the trees is recommended. The roots are also extracted and the pits are treated with copper sulphate and lime. In young plantations, as a prophylactic control measure, deep harrowing is avoided and after the removal of weeds, copper sulphate plus lime treatment is done within one meter radius of the plant. The same chemicals mixed with water are painted on the stem.

Introduction of *Melia composita*

As part of the effort to finding suitable alternatives to eucalyptus, Burma Dek *(Melia composita)* was introduced in Haryana in 2003. During 10 years of its performance in Haryana, it has been observed that it comes up very well in areas where soil depth is good and the soil does not remain dry for a very long period. However, it does not tolerate salt above pH 8.5, also does not tolerate water logging and struggles in sandy areas. Though it is frost tolerant but hot wind (*loo*) kills the top leading shoot to deform the stem. Rhesus monkey *(Macaca mulatta)* and blue bull *(Boselaphus tragocamellus)* have been found to be serious pests during initial stages up to three years and they badly damage the plant by breaking the branches. If the plants are protected well, *Melia* is an excellent species for diversification of species for agroforestry and also as suitable alternative to eucalyptus (Chauhan *et al*., 2008) in the Indo-Gangetic region.

Some problems have been encountered in traditional agroforestry, thus posing a threat to the traditional species along with shaking the confidence of the farmers.

Drying a problem of jand: Jand or Khejri *(Prosopis cineria)* also called the "kalptaru of deserts" is in problem in Haryana as elsewhere (Singh *et al*., 2002). The tree is worshiped in the desert area for its benefits to the farmers of arid region. Usually higher crop yield is reported under its canopy due to micro-environmental amelioration and soil properties. In spite of the fact that the farmers and crops love jand, it is vanishing from Haryana and adjoining states due to heavy lopping leading to fungal attack, deep ploughing by tractors and desire for quick returns.

Ailanthus is new avenue tree: *Ailanthus excelsa* (Indian tree of heaven or mahrukh), a fast growing tree with low water requirements is another addition to the list of the farmers for on-farm planting. It is not a new introduction and is very common in the adjoining state of Rajasthan (arid region) to meet the domestic demands of fodder, fuel, timber, etc. The industrial utilisation of timber (plywood, paper, matchstick, pencil, etc.) has increased its demand in Haryana as well. It is a summer deciduous fast growing tree with shallow crown to accommodate inter-cultivated crops.

Timber market at Jagadhri-Yamunanagar: The symbol of acceptance of commercial agroforestry in Haryana and adjoining states is the symbiotic relationship between on-farm plantations and wood-based industries. This relationship has been strengthened by the policy decisions taken by the Haryana Forest Department for the progress of agroforestry. Furthermore, the farmers of Haryana have adopted this income generation system as an inseparable part of their agricultural land. The glut of eucalyptus in the market in 1988 due to severe drought resulted in virtually no plantation of eucalyptus being taken up by the farmers. This state of affairs continued till the early 1990s. However, of late, the use of eucalyptus as popular species in agroforestry plantation has bounced

back due to its varied uses and improved market conditions. Some of the factors responsible for this turnabout were:

- Opening up of new market avenues like use of eucalyptus in packing cases.
- Market intervention in the early 1990s by the Haryana Forest Development Corp. Ltd. This helped in stirring up competition in the market and giving a fillip to the depressed prices, which continued to rise thereafter.
- Revival of market for eucalyptus crates, increasing use of this wood in furniture and even construction activities.
- Wood-based industries have also played a key role in promoting poplars in agroforestry based timber market at Yamunanagar-Jagadhri, the most important and biggest timber markets in the north-western region.

The forest-based industries at Yamunanagar are paper mills, saw mills, hard board, plywood, straw board, sugar mills, packaging case units, furniture, etc. There are 1,048 wood-based industries in twin cities of Jagadhri and Yamunanagar of which 273 are plywood making units, 297 peeling units, 413 saw mill and 65 other units. Reason for the vibrant agroforestry and agroforestry based wood industries in Haryana is the fact that both the farmer- and industry-friendly atmosphere co-exist in the state. There are no timber transit rules in the state and the farmers of Haryana do not have to take any permission from the Forest Department for felling and transportation of species like eucalyptus, poplar and other on-farm grown species. As a result of this, wood is easily available for industries at their door steps as the agroforestry areas starts from the boundary of the twin towns in Haryana and adjoining states.

However, the *Arhati*/timber trader (middle men) and Mandi System still prevails but farmers and industries are happy with the system because it is a win-win situation for everybody. With the middlemen system, the farmers do not have to wait and get money for their produce immediately after the sale. The middle men have developed a system whereby they pay money to the farmers immediately but they may wait to get money from the industry. The hidden part of the story is that some portion of the wood is declared as "kaat" or rejected by the middle men. This wood is sold to the industry at fairly good price. The farmer is at some loss in this case but he does not mind. While industrialists gets this wood at little cheaper rate, the recovery of the wood is almost 90 per cent. The middlemen get a big share in this deal, which they do not have to share with the farmers.

An interesting fact as regards the supply of farm-based wood is that the Jagadhri-Yamunanagar timber market gets only about 20 per cent of its wood supply from Haryana and the rest 80 per cent comes from adjoining states of Uttarakhand, Uttar Pradesh, Punjab and Himachal Pradesh.

As regards the timber trade, about 2,000 wood trolleys are traded every day in Jagadhri and Yamunanagar towns. As many as 30 to 40 hectares of poplar are felled every day in Haryana.

Another 60 to 75 hectares of poplar are felled every day in adjoining areas of Yamunanagar in Punjab, UP, Uttarakhand and Himachal. An estimated 25,000 trees are felled every day in and around Jagadhri-Yamunanagar. Considering 250 felling days: 250x25,000=62,50,000 (Sixty two lakh and fifty thousand) trees of poplar alone are felled annually (Chander *et al.*, 2014).

The world community is nowadays talking about absorbing carbon dioxide from the atmosphere and storing that carbon dioxide in the form of inactive carbon or reducing the usage of dormant carbon. Fast growing species are the best for storing carbon on a long time scale. Species like poplar, eucalyptus and *Melia* are well suited for the purpose.

The energy from the trees is always considered the best option because this form of energy is carbon neutral. Leave the wood, the dendro-mass in the form of twigs, saw dust, roots, bark, peels/ off-cuts, batons, etc. is a very good source of eco- friendly energy. Chander *et al.* (2014) reported that approximately 15.62 million tonnes of dendro-mass is being produced annually from Jagadhri-Yamunanagar belt alone, which otherwise was going waste.

Conclusion

In view of the global shift in the objectives of forest management from timber production and revenue generation to ecosystem management and biodiversity conservation, forests have to be managed as the saviours of environment and green lungs of mother earth. The wood requirement has to be met from outside the forests, and timber trees have to be integrated with agriculture. The symbiotic relationship existing between farmer and industry-friendly atmosphere existing in Haryana state has given a boost to agroforestry interventions in the state and this model needs to be replicated elsewhere in the country.

Farmers in Haryana have taken agroforestry as the way of life and it has become part and parcel of their farming system. Farmers have been benefitted a lot financially from this intervention. Annually approximately 11 million mandays are generated from poplar alone (Chander, 2012). This includes raising nursery, planting, care, tending, felling, transportation, value addition, trade, etc. Wood worth Rs 5 crore is traded every day in Jagadhri-Yamunanagar alone and after value addition, products worth Rs 10 crore are sold every day from these twin towns, which produce about 70 per cent of the country's plywood. The successful commercial agroforestry has made Haryana a national leader in agroforestry and transformed a forest deficient state to a timber surplus state. The credit for this success goes mainly to eucalyptus and poplar. However, in view of the threats being posed by new pests which have made species like eucalyptus prone to pests, there is an urgent need to go in for diversification of species under agroforestry.

References

Anonymous. 2000. Proceedings of the sub-regional seminar on die-back of sissoo (*Dalbergia sissoo),*

Kathmandu, Nepal (25-28 April, 2000). GCP/ RAS/163/Net Field Document No. 17 (Eds. (Appanah, S., Allard, G. and Amatya S.M.). Forestry support programme for Asia and the Pacific (FORSPA) FAO Regional Office for Asia and the Pacific Region, Bangkok, Thailand, 65p.

Bangarwa, KS and Wuehlisch, GV. 2009. Using exotic poplar in northern India for higher returns in agroforestry. *Asia-Pacific Agroforestry News*, 35: 3-5.

Chandra, JP. 1986. Poplar, a cash crop for north Indian Farmers. *Ind. For.*, 112 (8): 698-710.

Chauhan, R, Chauhan, SK and Saralch, HS. 2008. *Melia Azedarach*. Bulletin, Dept. of Forestry and Natural Resources, PAU Ludhiana, 48p.

Chauhan, SK and Mahey, RK. 2008. Poplar cultivation (revised edition). PAU Ludhiana, 36p.

Chauhan, SK and Mangat, PS. 2006. Poplar based agroforestry is ideal for Punjab, India. *Asia-Pacific Agroforestry News*, 28: 7-8.

Chauhan, SK and Ritu. 2005. Towards agro-ecological health: diversifying traditional crop rotation through agroforestry in Punjab, India. *Asia-Pacific Agroforestry News*, 27: 3-4, 6.

Gill, SS, Chauhan, SK, Khajuria, HN and Chauhan, R. (eds.) 2006. Shisham and kikar mortality in India. Agrotech Publishing Academy, Udaipur, 320pp.

Singh, MP, Harsh, LN, Lodha, S and Bohra, MD. 2002. Mortality of Prosopis cineraria in the arid districts of Rajasthan. Mortality of shisham and kikar in India (eds. Gill, SS, Chauhan, SK, Khajuria, HN, Dhanda, RS and Chauhan, R), Department of Forestry and Natural Resources, PAU Ludhiana, 65-68pp.

Toky, OP. 2003. Poplar agroforestry systems in northwest India boost sustainable economy. *Asia-Pacific Agroforestry News*, 21: 17-18.

Saxena, V. 2004. Greening the Indian state of Haryana with trees. *Asia-Pacific Agroforestry News*, 23: 9-10.

Hara, SS. 2005. Agroforestry farm in northern India serves as a learning field laboratory. *Asia-Pacific Agroforestry News*, 27: 15-16.

Dhiman R.C. 2012 An innovative partnership arrangement for poplar based agroforestry systems in India. *Asia-Pacific Agroforestry News* 40: 4-6.

Dhiman RC and Chander, J. 2012. Expanding poplar culture and plywood industry. *Plyworld*, 27 (3): 28-29.

Annual Research Report, 2013: Research Circle, Haryana Forest Department, Forest Complex. Pinjore, District Panchkula.

Chander, J, Chauhan, S and Yadav, S. 2014. Twin cities (Yamunanagar and Jagadhri) : The dendro-energy bowl of Haryana. Paper presented in the national workshop on power generation from dendro-mass at Mettupalayam Forest College and Research Institute on March 22, 2014.

Chander, J. 2012. An overview of poplar culture in Haryana state of India. Paper presented in 24th Session of the International Poplar Commission (IPC), 29 October-2 November, 2012, in ICFRE Dehradun, India.

Forest Products

Bamboo management in Gondia Forest Division

The Forest Department aims at improving the productivity of bamboo, both for meeting local needs and demand in the surrounding areas

Dr. Sajjan Kumar & Ikbal Singh

Gondia Forest Division is situated between 20^0 39 ' and 21^0 38' North latitude and 79^0 50' and $80^0$41' East longitude and covers the entire Gondia District. The forest area under the plan is 1731.786 km^2 including 782.025 km^2 of the Reserved Forests, 712.70 km^2 of the Protected Forests and 71.10 km^2 of the unclassified forests, 0.25 km^2 of private land acquired under F.C. Act 1980 and 219.70 km^2 of Zudupi Jungle. These figures exclude the areas allotted to the Forest Development Corporation of Maharashtra Ltd.

table 1: distribution of the Forest Area in ranges of the Gondia division

Abstract of Area in Gondia Forest division										
S.N.	Name of Range	(r F, Nr F. It, Gose PF, Jh.J. & unclass Forest)						Unclassed Forest	Private land taken over as a Compensatory land under F.C.A. 1980	Total Area in ha.
		RF	NRF	PF	Cose PF	Grand Total (RF+NRF+ PF) 3+4+5+6	Jh.J.			
		Area in ha.	Area in ha.	Area in ha.	Area in ha.	Area in ha.	Area in ha.			
1	2	3	4	5	6	7	8	9	10	11
1	Tiroda	1194.632	1168.938	3345.387	97.000	5805,957	2147.500	0.000	0.000	7953.457
2	Gondia	0.000	1267.571	4175.196	803.100	6245,867	3338.820	0.000	0.000	9584.687
3	Goregaon	0.000	1947.033	6705.087	297.500	8949.620	1584.680	2319.499	2.610	12856.409
4	Amgaon	0.000	579.100	2718.594	320.000	3617.694	2520.860	127.592	0.000	6266.146
5	Salekasa	0.000	4206.770	5360.421	71.000	9638.191	4691.250	1069.603	8.140	15407.184
6	North Deori	0.000	3225.920	8040.656	408.360	11674.936	2103.040	1011.047	4.980	14794.003
7	South Deori	0.000	5085.400	6482.541	173.150	11741.091	378.740	0.000	9.420	12129.251
8	Chichgarh	0.000	12412.290	10196.367	56.850	22665.507	800.890	53.454	0.000	23519.851
9	Sadak Arjuni	2627.538	4487.324	8460.843	304.000	15879.705	1771.780	964.453	0.000	18615.938
10	Nawegjionbandh	6176.484	4435.423	4569.820	282.350	15464.077	1014.500	182.551	0.000	16661.128
11	Gothangaon	8694.920	2423.180	3694.401	58,000	14870.501	1228.740	1381.879	0.000	17481.120
12	Arjuni Mor	9468.170	3401.890	4525.662	124.300	17520.022	389.400	0.000	0.000	17909.422
Grand Total		28161.744	44640,839	68274,975	2995.610	144073.168	21970.200	7110.078	25.150	173178.596

xxxxx

Climate

The climate of Gondia District is generally hot and dry. Summer (middle of February to middle of June), monsoon (mid-June to October) and winter (November to Mid-February) are the three main seasons. The average annual rainfall is about 1200 mm.

Soils

The soils of the district are highly varied. The main types of soils encountered in the district are Black, Kankar, Sihar, Morand, Khardi and Bardi.

Drainage

The main rivers passing through the division are Kanhan, Chulbandh, Garvi and Bagh. These rivers are tributaries of the Wainganga river and are fed by many small ephemeral tributaries. Scarcity of drinking water during summer is a major problem in many villages.

Forests

The forests of the Gondia Division belong to the Subgroup 5A – Tropical Dry Deciduous Forests of Champion and Seth's classification. Edaphic factors, topography and past management cause local variations. Garari (*Cleistanthus collinus*) is the most common species in the middle storey in the forest. The forests are more or less leafless during the hot season and are rich in grasses.

General Characteristics of the Bamboo

Bamboo crop is both natural and planted in this region. The major species of bamboo available in the forest areas of Gondia Forest Division is *Dendrocalamus strictus*. Katang bamboo (*Bambusa arundinacea*) is found in small quantities in some stretches along the streams and rivers.

Special objectives of Bamboo Management

Bamboo has a significant place in the local economy. Local tribal and non-tribal families use bamboo for construction, fencing and for making a variety of implements. Bamboo has a great potential as an alternative to the timber and supports the livelihood of artisans called *Burads*. It has a significant value for interior decoration, furniture making and manufacture of other articles of domestic use. Hence, increasing the productivity of bamboo in the Division is very important for the development of local inhabitants of this region. The Forest Department aims at improving the productivity of bamboo, both for meeting local needs and demand in the surrounding areas.

Central Nursery, Murdauli, Goregaon Range (Gondia Division)

The Central Nursery at Murdauli was established in 1965 and has an area of 7.5 ha. The nursery is producing bamboo rhizomes and seedlings of trees like Teak, Behada, Surya, Bhirra, Karam, Sewan, Semal, Tiwas, Mahua, Kusum, Chichwa, Arjun, Haldu, Shisham, Tendu, Palash, Char, Amaltas, Bor and Lokhandi, etc.

Preparation of Bamboo Seedlings

Seeds are sown in a mother bed (size

40 ft x 1m x 1ft) after 20th May and germinate within a week after the first monsoon shower. The rhizomes are prepared in the month of Jan-Feb. These rhizomes are shifted in the beds, at least twice. After six months, single healthy rhizomes are transplanted into poly bags of 12.5 cm x 25 cm size containing media soil: manure: sand in the ratio 2:1:1. One year old rhizomes are planted in the sites.

Spacing in Plantations

Bamboo and some NTFP seedlings like Hirda and Mahua, are planted at six-meter spacing (6 m x 6 m) in 45 cm x 45 cm x 45 cm pits. Care is taken to avoid planting seedlings directly under the canopy of existing trees or established saplings.

Digging of Pits

Pits of size 45 cm x 45 cm x 45 cm are prescribed for bamboo and NTFP Species like Mahua and Hirda. The dug up soil is kept on the upper side of the slope, and allowed to weather from March to the first week of May. Pit refilling is completed before the onset of monsoon. Pits for planting of bamboo are half filled during the refilling using topsoil from the heap.

Bamboo Planting

Planting of bamboo is completed within a fortnight after the first monsoon shower. Preferably, two-year-old bamboo seedlings with well developed rhizomes are planted. If stone mulching is feasible in the area, the pits are refilled up to the ground.

First Year Operations

The first scrape weeding, casualty replacement and the second scrape weeding are carried out. Stone mulching is also carried out with the second weeding in bamboo plantations as a safeguard against damage by wild boar. The third weeding and soil working operations are not required in the bamboo plantation.

Second Year Operations

In the second year, casualty replacement is done in the planting season. The first weeding is carried out in the first week of August and the soil working and mulching are done in early October.

Third Year Operations

One weeding in the third year is done along with the soil mulching in September. Singling of coppice shoots, management of damaged and malformed saplings, climber cutting and shrub clearance are repeated as third year operations.

Bamboo Working Circle

Total bamboo bearing area measuring 34,253 ha in 149 compartments has been proposed to be worked under this working circle. Fourteen felling series with three years of cutting cycle have been proposed. The average coupe area is 815.57 ha. Each cutting series is divided into three coupes viz. A, B, C and one of the coupe from each cutting series is to be worked annually.

Blocks and Compartments

Distribution of Bamboo Range wise (Table 2)

Method of Harvesting

Demarcation: The coupe due for working is demarcated before the onset of monsoon, in the year in which they become due for harvesting, by erecting poles at suitable intervals. On the poles, compartment number, coupe number and name cutting series are written.

Estimation of Clumps: Most of the areas included in this working circle contain planted bamboos at 6 m x 6 m as well as naturally growing bamboo. The growth of bamboo differs from compartment to compartment and even in the same compartment. In natural bamboo growth, the clump size shows variation.

Bamboo Flowering: Flowering is either periodic (gregarious) or annual (sporadic). It is either gregarious, sporadic or both. Gregarious flowering

r ange Wise Bamboo Area d istribution

s.N.	r ange	No. of c ompartments	Area in ha.
1	Tiroda	3	338.83
2	Gondia	1	10.00
3	Goregaon	2	473.354
4	Amgaon	0	0.00
5	Salekasa	28	5432.159
6	North Deori	4	691.789
7	South Deori	11	2351.343
8	Chichgarh	33	7785.738
9	Sadak Arjuni	5	1150.203
10	Navegaonbandh	27	6283.152
11	Ghothangaon	30	8003.09
12	Arjuni Morgaon	5	1734.329
	Total	149	34253.987

is usually followed by the death of clumps, but in some cases of sporadic flowering, the clumps do not die after flowering.

Gregarious flowering: Period, extent and location of the flowering are recorded in the Divisional Notebook. Extraction of bamboo is deferred for one year in case of the gregarious flowering. The clumps are clear felled after seeds are mature and have been collected. Very often seeds after the gregarious flowering are subjected to fungus attack and if such incidence is noticed, the area is sprayed with a very light solution of fungicide like Bevestein.

Adverse effects on Bamboo Crop

Grazing: Grazing pressure is acute due to large number of cattle present in this tract. The forests adjoining the villages face severe grazing pressure due to concentrated grazing by cattle including large number of goat and sheep.

Forest Fires: Regular annual fires are a highly destructive factor for the flora and fauna of the tract. Almost all fire incidents are man-made. *Tendu* contractors often influence setting up of fires to obtain a profuse flush of *Tendu* leaves during the collection season. Local villagers set fire to clear undergrowth under *Mahua* and gum-yielding trees to facilitate convenient collection. Sometimes, villages also set forest fires to obtain good flush of grasses. Such fires if left unattended spread to the adjoining forest areas.

Illicit Felling: Illicit cutting of bamboo clumps for local and commercial consumption and for encroachment upon the forest land is another important factor adversely affecting the forests of the Division.

Encroachment: Encroachment upon

Bamboo Production 2015-16 Gondia Forest division, Maharastra

S. No.	Division Gondia	Range 06	Felling Series	Felling series Area (ha)	Estimated production		Actual production	
					Long Bamboo	Bamboo bundles	Long Bamboo	Bamboo bundles
1		Grand total	C	2642	1639768	33055	1796055	35428

forest land is considerably high and as per records, a total of 396.87 ha of Forest Land is under encroachment.

Depot (Van Aagar)

These forests in Gondia Division are rich in valuable timber like Teak, *Bija*, *Saja*, *Surya* and *Dhaora*. Dongargaon and Nawegaon are main timber depots of the division. Firewood is also sold in public auction at the permanent or the temporary depots at Deori, Chichgarh and Kohmara. Nawegaon is also a major bamboo depot. Bamboo are graded according to the length, girth and quality classes and sold in public auction at the timber depots. However, bamboo is also auctioned in temporary depots at Chichgad, and Salekasa. Gondia, Nawegaon, Lakhandur, Sakoli, Bhandara, Nagpur and Raipur are main timber markets in the region. The Navegaon Depot was established in 1965 and is spread over 10 acres

Distribution of Forest Produce under the *Nistar* System

There are only 669 Burad families in the Gondia Division. The Burads are dependent upon the Forest Department for supply of bamboo. The Forest Department has issued cards to each family of the Burad community and accordingly 1500 bamboo are supplied to them on concessional rates from the depots. Dry and green bamboo are removed as per silvicultural rules and distributed to the local farmers under *Nistar* system and the surplus bamboo are sold in open public auction.

Suggestions

- More bamboo culms should be allotted to Burad community and *kashtkars* on concessional rates.
- Modern methods of cutting bamboo culms should be used rather than the traditional method and intensive monitoring is needed during cutting operations by the department.
- Need to generate more employment for tribal people by giving them vocational training by the Forest Department, as in Kohmara, where a group of artisans is making baskets, mats and *dholis* from bamboo.
- There is a need to introduce new species of bamboo in this forest division.
- Special task force should be appointed to protect the bamboo clumps from fire, grazing and illicit cutting in the sensitive areas of Division.

References

The Working Plan of Gondia Forest Division (Nagpur Circle), Volume - I, 2013-14 to 2022-23

Forest Products

Grewia optiva – One Tree Many Benefits

The Grewia optiva based agro-silvi-pastoral system managed on traditional wisdom plays an important role in sustaining livelihoods in the Shivaliks and Western Himalayas.

Neena Devi

The Shivaliks and the sub-Himalayan tract in northern India and North-Western Himalayas in India is largely a mountainous landscape dotted by villages and hamlets interspersed with agricultural lands and forest ecosystems. Most of these rural hamlets are dependent on agriculture and animal husbandry for sustenance livelihood. The agricultural land holding is small to medium spread across the slopes in the form of terraces, and depends mostly on rain fed irrigation. Sustainability in the hills is achieved through a well organised utilisation of plant based natural resources like fodder and firewood.

Fodder and firewood is obtained from forests, village common lands and private lands including agricultural terraces. The demand for fodder and firewood too is high in these areas and hence traditionally, the people have adopted raising of certain Multi-Purpose Tree Species (MPTS) along the bunds and contours of agricultural terraces. Observations regarding fodder and firewood were made in one such village – Paplota – in Arki Tehsil of Solan in Himachal Pradesh during 2016. The tiny village of Paplota is situated in the Shiwaliks very close to the outer Himalayas. Paplota with a population of about 200 individuals can be predominantly described as agrarian in socio-economic terms as majority of the households are linked to agriculture and animal husbandry either for subsistence or for income. The cattle population of village is approximately 80-90, primarily consisting of cows and buffaloes.

Grewia optiva – One tree many benefits

Keeping in view the very agrarian nature of Paplota village, it is evident that requirement of fodder and firewood would be high. Every household on an average requires about 25-35 kg of green leaf fodder and around 20-30 kg of firewood on a daily basis. This may vary depending upon season and other activities of the household. This large requirement of fodder is met by lopping of trees on private lands, common lands and the forest areas. Much of the fodder is obtained from agricultural lands wherein a large number of trees have been raised traditionally by the land owners. The trees on farm lands consist of *Grewia optiva, Celtis australis, Bauhinia purpurea* and *Ficus palmata. Grewia*

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optiva is noteworthy as it emerges to be most preferred fodder species in addition to its other local uses. Locally known as "beul" *G. optiva* is a small to medium sized deciduous tree of the Shivaliks and Western Himalayas. It is also known, Bihul, Bhimal and Dhaman in different villages across the North-Western Himalayas and the Shivaliks. The Genus is named *Grewia* in honour of Nehemiah Grew – one of the founders of plant physiology. It is generally distributed in the sub-Himalayan regions in Pakistan, Nepal, India, usually between 500 and 2500 m.

Paplota village, over the past few years, has emerged as good milk producing village through a flourishing animal husbandry sector. The residents have benefited from schemes like the Doodh Ganga Pariyojana of the State Government in recent times. Such progress is possible only when the input factors required for livestock management are abundant in the village. The key input in dairy being fodder resource, beul takes the centre stage of all green fodder harvested by the villagers. Approximately, 70-75 per cent of the green fodder fed to livestock in Paplota consists of beul leaves. This exemplifies how one tree species can revolutionise milk production in a tiny mountain village. Personal accounts of women who are major stakeholders in dairy sector of the village revealed that feeding milch animals with leaves of beul not only increases milk yield but also augments recovery of butter and ghee substantially. Scientific studies have revealed that leaves of beul are very rich in crude protein (about 14 per cent of dry weight) and other nutrients like calcium and phosphorus in addition of being very low on unwanted tannins, thus substantiating the claims made by local women. Winter leaves and young flushes are preferred for collection as it contains more proteins than in the other seasons. Chopping leaves and feeding the cattle in mangers can reduce 30-40 per cent wastage of fodder.

Though, beul is primarily planted and managed for fodder, the twigs and branchlets are also used to extract fiber that has very good strength properties. After the leaves are fed to the cattle, the stems, twigs and branchlets are made into small bundles of 10-15 sticks and dried for 10-15 days. Thereafter, these bundles are kept immersed in stream water having swift flow for one to two months. These bundles are then beaten against rocks or hard surface to separate out the fibres. This fiber is used extensively for making ropes by the villagers, especially the elder generations, being more expert in rope making. These ropes are largely used for haltering the cattle, weaving rope beds and other general purposes. The sticks after separating out fibres are dull white to pale yellow in colour and are again tied in bundles to be used as torches or in *chulhas*. The bigger stems and branches are sometimes used as firewood too. As far are traditional cuisines of the village is concerned, the leaves of beul are also used as a base material for preparing a special *roti* made of coarse ground maize flour and ghee. The less spoken utility value of *G. optiva* is perhaps the protection offered by the trees to agricultural crops from

scorching sun and numbing frost. Since the trees are grown on the bunds and boundaries of terraced agricultural fields, the intricate root system provides anchorage and holds the vulnerable soil together on the steep slopes of the mountains. Considering the litter dynamics in the soil under *G. optiva* grown farm land, several studies support the fact that the species enables soil to replenish nutrients like available nitrogen, calcium and phosphorus and exchangeable potassium in addition to enriching the soil with organic matter much needed for plant growth. Thus, the presence of beul on farm lands is also beneficial for the growth of agricultural crops. This fact has long been recognised by the village people since ages as the tree has been favoured over any other tree species in the hills.

Most importantly, *G. optiva* is amenable to intensive lopping and even pollarding. The tree is also a very good coppice and frost hardy. However, the trees in the recent times are being subjected to intensive lopping. Instances of all the branches being lopped are very frequent in the hills. Repeated intensive lopping reduces the quantity of leaf fodder produced by the trees in subsequent years. Also, the lead branches become knotty and gall like formations have occurred over a period of time. In other cases, where the branches grow tall, in order to cut the leaves, entire lead branch is axed! Such ill management has resulted into slow but steady mortality of several trees in the village and elsewhere too. Traditionally, proper management of the tree involves retaining at least one-third of the leaf canopy at any given time and leaving the lead branches

Poorly lopped *G. optiva* tree

Woman of Paplota carrying beul leaves fodder for her cattle

untouched so that the tree does not die and produces new flushes year after year. Rotational lopping from the trees was also practised to ensure sustainable supply of nutritional fodder for the cattle of the villages.

Traditional Agroforestry System: Lessons learnt

As rows of *G. optiva* trees, lopped to various extent, are standing on contours and bunds of the terraced hill slopes in hundreds of villages like Paplota in the upper Shivaliks and Western Himalayas, there is no doubt that people have recognised the multiple benefits of beul, nutritious fodder being the primary benefit. The entire land use system of Paplota is nothing but an example of *Agri-Silvi-Pastoral* system wherein agricultural crops, beul trees and animal husbandry are integrated with each other. The soil nutrient is replenished by way of litter fall and addition of cow-dung based farm yard manure back to the same land unit. Thus the system has evolved into a nutrient self-reliant system involving active soil nutrient cycling. This agroforestry system has evolved and is being managed through traditional wisdom which needs to be not only preserved but also promoted and transferred to the new generation.

Lopped *G. optiva* tree

Peo PLe ANd Forest s

Vanasree Eco Shop aims at Tribal Development

The eco-shop has reduced unsustainable harveting of forest products but marketing initiatives need a fillip to make it a thriving venture

Vinod Kumar Ramanbhai Damor

Nestled in the Western Ghats, Chalakudy Forest Division is located in Thrissur District of Kerala. The Forest Division is home to a variety of Non-Timber Forest Products (NTFPs) and people who depend on these NTFPs for their livelihoods. An endeavour to include the native tribes and forest dependent people under the umbrella of sustainable forest management a Forest Development Agency (FDA) has been constituted. The FDA has been constituted under the chairmanship of the Conservator of Forests while the Divisional Forest Officer, Chalakudy, is its Chief Executive Officer. The FDA has an executive body, which comprises selected members of the Vana Samrakshana Samithies (VSS).

At present, the Chalakudy FDA comprises of 11 VSS and 5 Tribal VSS. These together have been mandated with the management of 4127.5 ha forest area in the Division. Various greening schemes like National Afforestation Project, National Medicinal Plants Board schemes, National Bamboo Mission schemes and Green India Mission projects are implemented through this FDA. A unique facility christened as 'Vanasree' has been established with financial assistance from National Medicinal Plant Board for collection, value addition through processing and sale of Non-Timber Forest Produce at Chalakudy. The different VSS functioning under the umbrella of 'Vanasree' system have been assigned specific functions. Five Tribal VSS are involved in collection of NTFPs, one fringe VSS does the process-ing and value addition and another fringe VSS carries out sales operations.

Vanasree Project

Unsustainable harvesting of NTFPs many of which are threatened, exploitation of tribals by middlemen and marketing problems are the major issues being faced by the NTFP sector. Vanasree is one attempt to plug these gaps with the main objectives as enlisted below:

- Achieve sustainable utilisation of NTFPs
- To prevent middlemen from garnering higher profit
- To provide fair price for the tribal collectors
- To achieve skill development in

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NTFPs – processing and value addition
- To ensure genuine and quality products to the consumer

There are five tribal VSS and two fringe VSS in Chalakudy Division under the project. The tribal VSS–Anapandam, Karikadavu, Elicode, Chakkipparambu and Thenittampara – are located inside forest areas and comprise of Kadar and Malayan Tribes. The fringe VSS are Chembamkandam and Randukai. The five Tribal VSS situated deep inside forest areas of the Division collect NTFP from forest area. The fringe VSS of Randukai is involved in processing and value addition. After processing, these products are sold by another fringe VSS of Chembamkandam through the Vanasree Eco-shop at Chalakudy. Vanasree products also have an added advantage of having received organic certification by a recognised certifying agency named 'INDOCERT', at Aluva. A new website for Vanasree Eco-shop has been developed to facilitate marketing and disseminating information to the public. The Eco-shop has recorded substantial sales owing to its access to a large regional market. This is evident from the record of accounts kept by the Eco-shop during 2015-16 (Table 1). The Vanasree system is an excellent example of amalgamation of conservation and tribal development initiative by the Forest Department.

The major items available for sales at Vanaasree Eco-Shop, Chalakudy include among others:
- Honey
- Kallurvanchi (*Routla aquatic*)
- Incha (*Acacia instia*)
- Pulthailam (*Cymbopogon sp)*
- Dandhapala Oil (*Wrightia tinctoria*)
- Pathimugham (*Ceasalpinia sappan*)
- Eucalyptus oil
- Mango Turmeric Pickle
- Kasthoori manjal *(Curcuma aromatica*)
- Nellikai (*Phyllanthus emblica)* jam

Problems in Management of Vanasree

- The marketing network of the products is not well maintained, only local people come to the Eco-shop for purchasing products.
- All products of Vanasree are pro-

details	Amounts (r s.)
Total Out turn of Vanasree Chalakudy	3239469.50
Collection amount to Anapantham VSS	981093.00
Collection amount to Karikkadavu VSS	136110.00
Processing amount to Randuai VSS	482445.50
Incentive to Chembankandam Bharathamala	280150.00
Other infrastructure development	1311449.50
Net profit of 2015-16	48221.50

traditional Processing unit

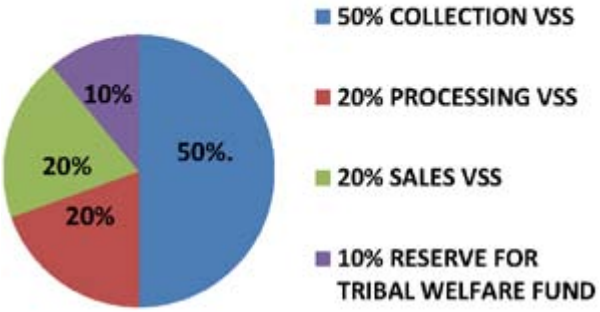
cessed using traditional methods and bulk production is not done.

- The NTFPs from forest are collected in high volume by local tribes. For easy and fast income, they are sold to the middlemen or local buyers at source in the villages of collection.
- The website of the Vanasree Eco-Shop has been developed, however online sale of products does not take place due high rates of courier cost.
- The local tribes collect NTPFs in an unscientific way.

Way Ahead:

- Proper linkage is required for marketing of the products.
- Improvement is required in processing of the product and value addition of products.
- The processing unit requires improvement (equipment needs to be mechanised).
- The storage unit of the collected raw material is far from processing unit.
- Inter exchange of products among eco-shops at different Divisions to increase the range of products is needed.
- Advertising of the eco-shop at government offices for publicity of the products is needed.

Distribution of profit among various VSS



Acknowledgements

- Mrs. R. Keerthy , DCF, Chalakudy Forest Division, Kerala Forest Dept.
- Mr. Shreekumar, RFO, Pariyaram Range
- Mr. Sijo Semuuel, RFO, Machad Range
- Mrs. Sumu RFO, Central Nursery Range, Chettikulum
- Mr. Remasan, Dy. Ranger
- Mr. Ramchandran, Beat Officer

ecos Yste M APPr o Ac H

Eco-restoration activities of Shola ecosystem

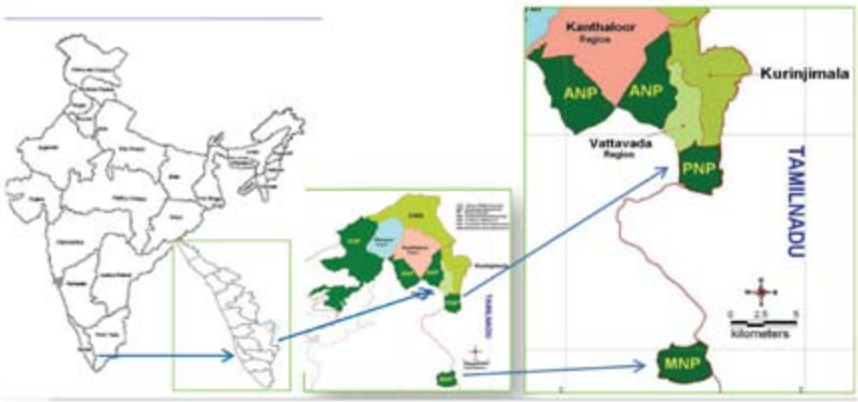
The Shola National Park in Kerala surpasses many other national parks in both beauty and biodiversity. However, it too faces the issue of 'development vs. conservation.'

Alemwapang T. Imchen

The Shola National Park (SNP) situated in the south-eastern part of Western Ghats region in Idduki district of Kerala, is an amalgamation of four protected areas namely, Pampadum Shola National Park, Mathikettan Shola National Park, Anamudi Shola National Park and Kurunjimala Wildlife Sanctuary. All these protected areas represent the typical montane forest ecosystems of the Sholas in Western Ghats. These protected areas are managed by the Munnar Wildlife Division of Kerala Forest Department.

The present case study was restricted to the Pampadum Shola (PNP) and Mathiketan Shola (MNP) National Parks where eco-restoration and rejuvenation of Shola ecosystem is being undertaken as defined by the Management Plan prescriptions. Observations and interactions with field officials were carried out in the month of January 2017.

The Pampadum Shola National Park (PNP) earlier was a Reserved Forest under Kerala Forest Department. From the late 1960s onwards till the late 1990s, the forest department introduced exotic plantation species namely *Acacia mearnsii*, *Eucalyptus grandis* and tropical pines. It was declared as a National Park in December 2003 with the vision



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of "Conservation of Fragile Shola Grassland Ecosystem for Biological diversity, Ecological services and Water security". 'Pampadum Shola' in Tamil means 'the forest where the snake dances', is the smallest National Park in the Kerala state covering an area of 11.78 sq. km. Its altitude varies from 1600 m to 2400 m and it receives both north-east and south-west monsoon rains.

This small area however nurtures about 22 Species of trees, 74 species of herbs and shrubs, 16 species of climbers, 14 species of birds, 9 species of mammals, 100 species of butterflies, 93 species of moths and many more. At present, around 30 per cent of the park area is under exotic plantations which has had a negative impact on the biodiversity and ecosystem of this unique but fragile montane Shola ecosystem. Since 2010, the Munnar Wildlife Division, as per Management Plan prescription has begun to remove the wattle acacias from the park in a manner known as 'phased removal in patches'. In 2015, an accidental forest fire in the Pattyangal hills within the park destroyed around 39 ha of the wattle plantations leaving the area completely bare and thus prone to erosion. The seeds of wattle acacias have been reported to remain dormant but viable even up to several decades on the ground. The fire acted as a blessing in disguise, as the seeds of wattle acacias which had been dormant in the soil sprouted together and it became easy for the forest department to remove all the seedlings in one operation. The Forest Department now is utilising fire as a management tool for the removal of wattle acacias from other parts of the park. The partially burned logs are kept along the contour so as to control soil erosion. It has however been observed that the bare soil is being invaded with other non-native species such as *Eupatorium sp., Ageratum sp., Solanum sp.* and ferns. Hence, they are also being manually removed, dried and burned. The area is being artificially re-vegetated with

uprooting and drying of eupatorium and other exotic weeds

rejuvenation of shola by reintroducing native grasses

native grasses which are palatable to the wild herbivores with the help of volunteers form several nature clubs, schools and colleges.

Munnar wildlife division had already transformed 32 hectares of the Shola NP area which had earlier been under wattle acacia plantation into a favourite foraging ground of Indian Gaur also known as the 'Bison Swamp'.

The eco-restoration works in Mathikettan Shola National Park (MSNP) is quite different from that followed in Pampadum Shola National Park. 'Mathikettan' which in Tamil means 'Mind confuser', was earlier a part of Cardamom Hill Reserves (CHR). The Government of Kerala in October 2003 notified 12.82 sq. km. of CHR area as 'Mathikettan Shola National Park' with the vision of "Restoration and Conservation of Shola

Ecosystem for Biological Diversity, Ecological Services, Water Security and ensuring Ecological Connectivity". The Cardamom Hills, which actually span more than 700 sq. km in the south-western Ghats region are the original home of over 1,720 species of flowering plants, 16 species of mammals, 91 species of reptiles and 84 species of amphibians. About 36 species of plants falling in the Rare Endangered and Threatened (RET) category are found here. The altitude here ranges from 1200 m to 1981 m. For several centuries, the region has been under cardamom (*Elettaria cardamomum*) and coffee (C*offea sp.*) plantations for commercial purpose. This has led to several environmental issues. There is no natural regeneration under the montane forests as these exotics have taken its place. The forest department under the current management plan is systematically removing the cardamom and coffee from the Park area. Scientific studies, since 2015 are being carried out on several randomly selected sample plots of 10m X 10m for monitoring of natural regeneration in these plots after the exotics are artificially removed. Within the quadrat/plot frame, the occurrence of plants is recorded using an appropriate measure of abundance. The data is compared with old data which was collected before the removal of the exotic species from the quadrats. The recorded data based on these stidies are providing encouraging results as the proportion of native species are increasing. This can be verified by visual observation as well, as areas which once had no natural

A panaromic view from Mathikettan Shola National Park

regeneration of native species are now being slowly occupied by them. However, continuous monitoring and management needs to be carried out. The eradication of coffee plants is a more challenging task compared to cardamom plants as the former is easily dispersed by native wild animals which relish its ripe fruits and later disperse the seeds in their droppings. Such seeds then sprout vigorously and are now gradually spreading into the core areas as well. This requires a robust strategy to tackle the issue.

The Shola National Park surpasses many other national parks in both beauty and biodiversity. However, it too faces the issue of 'development vs. conservation' as in most other protected areas of the country. Even though the Forest Department is doing a commendable job in rejuvenation of the Shola ecosystem, the demand for construction of an inter-state highway right through the core area of Pampadum Shola National Park puts the future of this protected area at great risk. As for Mathikettan Shola National Park, it is one of the last remnants of the original forests of the Cardamom Hills. Moreover, it also acts as a perennial water source for meeting the needs of both humans and wildlife. It is the origin of several perennial streams which merge with River Panniyar. It has been observed that the plantation owners use the water from these streams to prepare insecticide formulations which are then sprayed regularly over thousands of hectares of cardamom plantation. This wanton use of insecticides and pesticides in these regions is slowly leading towards an ecological calamity. Moreover the habitat of the animals and their historical corridors have been have been converted into exotic plantations. This leads to several conflicts between humans and elephants as well. This is a major issue and needs the support and goodwill of all stakeholders if any lasting solution is to be found for conservation of the unique Shola forest ecosystem in the area.

Acknowledgements

- Mr. Prasad. G., Wildlife Warden, Munnar WL Division, Kerala Forest Department.
- Mr. Sibichand, Asstt. WL Warden, Munnar WL Division.
- Dr. Rajan, Biologist, Munnar WL Division.
- Mr. Bhavadas, Ecologist, Munnar WL Division.
- Mr. Shaji, Section Officer, Pampadum Shola NP, Munnar WL Division.
- Mr. Jayaprakash, Section Officer, Mathikettan Shola NP, Munnar WL Division.

Note: Articles may be sent at the following email ID:
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There will be two layers of review of the contributions; Faculty and the Directorate review. Evaluation and review at the faculty level in the training institutes/academies will be undertaken under the guidance of Director/Principal/Head of the institutions. Even very specialized and technical topics shall be presented in simplified format so that frontline staff and forest community are able to appreciate and understand the topics. Articles shall be written in a popular style, easily understandable and in simple English.

However depending on the response to this programme, arrangements can be made for translation of the magazine into the vernacular. A short note about the contributor and the reviewer shall accompany the article. The note shall contain name, age, postal and e-mail address, course, academic accomplishments, and important assignments held. The evaluation would be done on following criteria:

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    - Instead of an abstract the article will give information on the location, the period when the field work was carried out
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