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WORKSHOP REPORT

INFORMATION AND ANALYSIS OF TREES OUTSIDE FORESTS IN INDIA

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by:

Ram Prasad
P.C. Kotwal
C.S. Rathore
Yogesh D. Jadhav

INDIAN INSTITUTE OF FOREST MANAGEMENT
NEHRU NAGAR, P.O. 357, BHOPAL – 462 003 (M.P.)

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The EC-FAO Partnership Programme on *Information and Analysis for Sustainable Forest Management: Linking National and International Efforts in South Asia and Southeast Asia* is designed to enhance country capacities to collect and analyze relevant data, and to disseminate and up-to-date information on forestry, and to make this information more readily available for strategic decision making. Thirteen countries in South and Southeast Asia (Bangladesh, Bhutan, Cambodia, India, Indonesia, Laos, Malaysia, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam) participate in the Programme. Operating under the guidance of the Asia-Pacific Forestry Commission (APFC) Working Group on Statistics and Information, the initiative is implemented by the Food and Agriculture Organization of the United Nations in close partnership with experts from participating countries. It draws on experience gained from similar EC-FAO efforts in Africa, and the Caribbean and Latin America and is funded by the European Commission.

Cover Design:
Tan Lay Cheng

For copies write to:
Patrick B. Durst
Senior Forestry Officer
FAO Regional Office for Asia and the Pacific
39 Phra Atit Road
Bangkok 10200
Thailand

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FOREWORD

Tree planting is an entrenched part of the cultural, economic and ecological traditions of India. Trees outside forests (TOF) grow on a variety of landscapes and include a unique range of species that are specific to the local environmental and socio-cultural conditions. TOF are an important source of wood and non-wood products, and they have a great influence on the extent, health and productivity of public forests. Unfortunately, their importance has not been properly assessed or recognized by the mainstream policies of land management.

In view of the growing emphasis on sustainable forest management (SFM), tree resources outside public and private forests have been receiving attention from the Food and Agriculture Organization of the United Nations (FAO) and other international organizations. At the national level, the Forest Survey of India (FSI), Dehradun has been actively engaged in the national assessment of TOF since 1991, and the exercise has spread across several states. Such efforts require substantial resources and manpower. As the national node for SFM, the Indian Institute of Forest Management (IIFM) started networking with different public institutions, non-governmental organizations (NGOs) and scientists who are interested in SFM and assessment of TOF.

Apart from FSI Dehradun, Dr. Ravindranath from Indian Institute of Science (IISc), Bangalore and Prof. K.C. Malhotra have been involved in TOF research, focusing on the socio-economic aspects of urban dwellers of Calcutta. I would like to acknowledge the motivation and technical guidance provided by Prof. Malhotra who has been instrumental in organizing the first workshop on the assessment of TOF in India, held from 5-6 June 2000 in Bhopal. His extensive NGO network has been instrumental in recruiting the participation of 30 NGOs for the workshop.

Following that workshop, FAO (Bangkok) supported IIFM's efforts by providing technical and financial support for a three-day workshop at IIFM to consolidate and extend work on TOF. This valuable opportunity and financial assistance made it possible for us to network with other institutions and individuals, who are working on the same theme. I would like to thank Dr. Thomas Enters and Ms. Ma Qiang, both from FAO, for their expert guidance and support on the subject.

Furthermore, I would like to acknowledge the cooperation of our sister organizations like FSI, Natural Remote Sensing Agency, Hyderabad, Dr. Govil (FAO), and all the participants whose valuable inputs have contributed to the outcome of the exercise.

Profs. Kotwal, P. Bhattacharya, R.K. Singh, M.D. Omprakash, C.S. Rathore, and D.N. Pandey, and research staff like Dr. M. Mishra, Dr. D. Dugaya, Dr. S.K.S. Rathore, and Mr. Y.D. Jadhav at IIFM have also extended their cooperation in organizing the workshop.

Dr. Ram Prasad
Director, IIFM

EXECUTIVE SUMMARY

Trees are valuable, and previously looked upon as an inexhaustible, resource of timber and non-timber products. However, people came to realize that the existing stock of trees would last only for a fixed duration, unless commensurate efforts are made to replace the harvested ones through continuing reforestation. Thus emerged the concept of planting trees outside forests on community lands, private lands and in urban areas to meet the needs of society. The environmental services provided by trees outside forests, in rural and urban areas, include protection of soil and water resources, conservation of biological diversity, support to agricultural productivity and sustainability, buffering of desertification and resource degradation processes in arid and semi-arid zones, carbon sequestration, amenity and recreation, and maintenance and improvement of sustained livelihoods.

Cities and human settlements face several environmental problems such as shortage of water, air pollution and sewage management. Deforestation and changes in land use in ever-widening circles around cities are particularly accentuated in arid and semi-arid zones. Indeed, consumption patterns and basic needs of the urban population for products such as fuelwood and construction material are important causes of forest and land degradation. This results in the degradation of soil fertility and the diminution of the tree cover, and contributes to the erosion of the diverse gene pool. The negative impact of forest resource degradation on the nutrition and livelihood of poor urban dwellers is often overlooked in urban development.

Despite all these factors, an inventory and operational management plans for TOF generally is lacking. Such a gap is especially significant when India is an agricultural country where vast stretches of land are capable of supporting a variety of plant species. This three-day workshop was an attempt to bring together specialists with diverse backgrounds to formulate a plan to assess the potential of TOF, generate information and raise awareness of TOF as a valuable resource. Based on various studies, IIFM has tried to provide a platform for the exchange of ideas and fruitful consultation for the assessment of TOF to ensure a systematic documentation and policy framework for TOF and their management. A proposed pilot study involving remote sensing technique and ground survey is the best option for carrying out a national assessment of TOF. Large-scale assessments can be conducted based on the pilot study once the results are tested and the methodology is modified to suit local conditions.

INTRODUCTION

The importance of trees can be seen from many aspects and in terms of services they deliver. Trees are not just confined to forests but exist outside the forests also. Trees outside forests (TOF) are of significant importance and perform a number of ecological, economic and socio-cultural functions.

In India, TOF are an important source of wood and non-wood products, and environmental services. Such trees include roadside plantings, woodlots, scattered trees in the landscape, trees in fields, homesteads and orchards. They not only play a very important role in meeting rural people's needs but are also increasingly significant in supplying the commercial sector, especially the wood-based industries, with much needed raw material. Depending on prevalent land-use patterns (ecological and economic) and landscape attributes, TOF may also play a role in carbon sequestration, biodiversity conservation hydrological functions, and erosion control.

A systematic inventory of TOF can help provide a ready reference for policy makers and planners in meeting people's needs. Despite being an important biological resource, however, TOF have not been given due attention in the national forest statistics of India. Information on the status and extent of TOF is scanty and not easily accessible. Sound inventories and databases on TOF have not been appropriately organized. One reason for this deficiency is the lack of cost-effective and practical inventory and assessment techniques, and an absence of clear classification systems. Although, various case studies have emphasized their importance to farms, households and the rural economy, inventories for large areas are generally unavailable. Large-scale inventories and assessments are a high priority for developing management strategies to help sustain tree cover and to design supportive policies that provide incentives to landholders to maintain or increase the number of trees on their land.

The Forest Survey of India (FSI) took a lead in assessing TOF in Haryana, Uttar Pradesh, Rajasthan, Gujarat, Karnataka and West Bengal (FSI, 2000). While FSI has completed the study in Haryana, the assessment in the other states is continuing. Similar efforts on a smaller scale were also attempted by other institutions. The Kerala Forest Research Institute, Indian Institute of Forest Management (IIFM), Indian Institute of Science (IISc), and recently the Tata Energy Research Institute (TERI) have used different approaches and assessment methodologies, which complicates comparisons and hinders the development of a national overview and database.

The potential to coordinate the efforts of the different institutions for speedy assessments of TOF is immense. There is also a need to develop a common methodology by drawing on the strengths of different approaches used. Time requirements for assessing TOF based on conventional ground-based surveys is a cause of concern. It is therefore necessary to test the efficacy of alternative methodologies for more rapid large-scale appraisals, especially the use of remote sensing (RS). The various institutions agree that a concerted effort based on a review of existing knowledge would result in a more effective approach for assessing TOF.

In a first workshop on the national assessment of TOF that was held at IIFM in June 2000, it was estimated that there are 24 billion TOF in India (Prasad *et al.*, 2000). Participants were from a vast array of institutions engaged in this work. As a follow-up, IIFM organized a three-day workshop bringing specialists from diverse backgrounds to review and develop an action plan.

Objectives and outputs of the workshop

The five main objectives of the workshop were as follows:

- review the status and existing survey methodologies of TOF in India;
- identify priority areas/topics for assessment;

- identify potential for inter-institutional partnership for assessment of TOF in India;
- develop terms of reference (TOR) for an exploratory study on the potential of using RS data for assessing TOF; and
- agree on an action plan and identify topics for further studies if necessary.

The workshop achieved the following outputs (contained in this report):

- Workshop report comparing different methods used for ground-based assessment of TOF, and considerations of other methodologies that can be used
- List of potential users of data collected for TOF
- List of institutions with relevant data
- Identified parameters and criteria and indicators for TOF assessments
- TOR for exploratory study of the cost-effective use of RS in TOF assessments
- Action plan for standardization of TOF assessment methodologies
- Identification of further studies

DIFFERENT METHODS FOR GROUND-BASED ASSESSMENT OF TREES OUTSIDE FORESTS

During the workshop, the participants deliberated on various issues related to the ground-based assessment of TOF. Various preferential rating scales were designed and discussed (see section on "Parameters, criteria and indicators"). A review of methodologies for TOF assessment is given below for a quick reference.

Review of methodologies for assessment of TOF

Assessment of TOF in Haryana in North India by Chaturvedi (1990)

Chaturvedi (1990) classified trees planted on non-forested lands as (i) homestead planting (ii) commercial tree planting, and (iii) tree planting on farmlands.

In homestead planting, all trees with breast girth of 15 cm or more were enumerated. Plants of lower dimensions were ignored. Measurement of girth at breast height was carried out by semi-skilled enumerators. The distribution in girth classes was very wide. No method of sampling could, therefore, deliver accurate results with acceptable limits. Since the trees were concentrated in a small area, it was convenient to carry out total enumeration rather than sampling. Apart from number of trees, this assessment provided data on growing stock in cubic meters, which was quite useful for planning raw material supply to industries, village artisans, etc.

Commercial tree planting was not found in the study site at Dhanawas, but 10 planting units were observed in Berka Alimuddin. The areas of these sites varied from 0.05 ha to 2.12 ha. Therefore, a total count of trees by girth classes was carried out.

Sampling of tree planting on farmlands was based on three independent samples of 30 drawn from random numbers taken from the Fisher and Yates Tables (1963).

This was reportedly the first study of its kind where three villages in Haryana State in North India were selected for assessment of TOF in three types of landscapes. However, the criteria used to select the three villages out of a total of 6,988 villages were not described. In India where there are over 650 000 villages, total enumeration may not be feasible, as it would require a great amount of time and resources to complete the work. This study also did not consider other landscapes such as sides of roads, canals, drains, railways, ponds, and other community areas with substantial tree cover. Thus, poor representation of all landscapes is a major weakness in this study. The classification may be applicable on a small scale but not for a national-level measure of TOF.

Study of TOF by Kerala Forest Research Institute

Krishnankutty (1992) adopted a stratified three-stage sampling procedure. The percentage of dry land area under agricultural use to the total area under agricultural use and population density was calculated from the data available from the State Land-use Board and the 1981 census report, respectively. In all, 15 strata were formed on the basis of five classes of percent dry land area under agriculture use and three population density classes. The villages were then classified under the different strata accordingly. Revenue villages in each stratum were treated as first stage units of sampling. The villages in each stratum were chosen at random.

Although the study recorded the precise number of trees in homesteads, it failed to acknowledge the importance of trees planted on roadsides and those growing on barren lands. Furthermore, trees on

lakesides and backwaters were also not included in the assessment. However, this was reportedly the first such effort to systematically enumerate wood resources in the homegardens of Kerala. This study provided the background of methodology and accorded adequate importance to the tree resources growing in the homegardens outside the public forests. This assessment provided good account of the contribution of homestead gardens in meeting domestic requirements of fuelwood, small timber, and some inexpensive construction material for households. Thus, the study not only enumerated trees, but also calculated the volume from recorded tree dimensions. This information on raw material availability can have significant influence in planning sustainable management of natural forests. It is also relevant for estimating the potential of homestead gardens for domestic use of timber and non-timber products and cash income in the event of emergency such as marriage of children and other ceremonies.

The Karnataka experience of Dr Ravindranath and Dr Somasekhar (Indian Institute of Science, Bangalore)

Ravindranath and Somasekhar (1995) adopted methodologies to appraise the distribution of tree species on various farm sizes in a semi-arid Ungra in Tumkur District of Karnataka. They studied tree diversity and density on farms, the location-specific nature of the tree species, the rationale for the choice of species and the possible end-uses. To investigate the impact of landholding size and economic status on tree-growing practices, a stratified random sample of 30 households was selected to include 6 farmers in each of the following categories: landless, marginal (<1 ha), small-scale (1.01 to 2 ha), medium size (2.01 to 3 ha), and large-scale (>3 ha).

This methodology gives a better sampling technique to enumerate TOF in rural settings. However, urban areas and the inventory of urban trees are excluded. In addition, the methodology does not consider railway and roadside trees, which are also important TOF resources in India.

The emphasis of this study was mainly on tree diversity and density in terms of species and number of trees. The study did not collect information on height, girth, and therefore, did not assess the volume of trees on farmlands.

The FSI Experience

The FSI began a regular inventory of TOF in 1991 based on stratified random sampling. A district (or a group of districts) in a state was treated as a stratum and villages as a final sampling unit. The number of sample villages to be surveyed in a state was decided by a pilot study. The boundary and area of each of the randomly selected villages were obtained from the Revenue Department and all trees standing in the selected villages were physically counted and measured. The team leader was provided with the list of sample villages to be inventoried, along with maps of their locations (at 1:50 000 scale). The entire village was divided into suitable angular quadrants in such a way that the inventory of each quadrant could be completed in one working day. Generally, living trees above 10 cm in diameter were measured and counted but in some states trees up to 5 cm in diameter were also measured. In Haryana State, out of a total of 7 000 villages, 290 villages were selected for TOF inventory.

The inventory would have taken four years to complete. To accelerate the process, the methodology was modified in 1999. Analysis of the completed inventory of non-forested areas gave significant positive correlation between village area and number of trees and also between the population size of villages and number of trees. This relationship has been utilized to fix the sample size of other states and dispense with the additional task of conducting a pilot survey. States are being divided into agro-ecological zones and each zone is being treated as a stratum. The number of sample villages in each zone is decided on the basis of proportional allocation. The precision level is slightly reduced because of reduction in the sample size. Further, the proportion of trees enumerated in a village was also reduced by 50, 25 and 10 percent if their number exceeded 2 000 and lies between 2 000 to 5 000, 5 000 to 10 000 and more than 10 000,

respectively. With the modification, the inventory in four states – Andhra Pradesh in the south, Gujarat, and Rajasthan in the west and West Bengal in the east – is nearing completion. The number of villages selected in these states were 110, 142, 141 and 167 out of a total of 27 999, 18 509, 39 810 and 40 890 villages, respectively.

This sampling method covers a wide array of landscapes and tree types, but the information on the inventory and sampling method for urban areas needs further elaboration. The amount of time taken for the exercise is also a constraint. Ground verification is needed as the trees in rural areas might already be harvested for fuel and fodder by the time the survey took place in the village. It is virtually impossible for one agency to enumerate the TOF in the whole of India. The size of the country and time constraint are the biggest hurdles for large-scale inventories.

This study has been more elaborate than other studies reported in terms of sampling intensity, area coverage, and number of the tree units per village.

Study of TOF from the socio-ecological point of view by Malhotra and Kumar (1987)

Malhotra and Kumar (1987) studied the socio-ecological aspects of the avenue trees in Calcutta, particularly tree density, species diversity and associated human activities. The methodology involved the selection of a 4.6 km stretch of road in Calcutta and a complete census (species and number of trees and the related human activity) of all the planted trees separately on both sides of the road. The human activities associated with each tree were also recorded. The authors found that the avenue trees in urban centers not only performed important ecological role, but also played significant socio-economic and religious roles in the lives of the urban dwellers. Several hawkers/vendors set up their stalls selling fruits, vegetables, sweetmeat, etc. under the shade of trees growing in the urban areas. The authors emphasized the need for a systematic collection of data on trees along the roads, parks and residential areas in other cities also.

The study stresses on the social aspect of the avenue trees only, and fails to extend the inventory to include an array of sites and urban landscapes apart from roadsides (such as trees on institutional lands and household trees). Therefore, the method that has been tested on roadside trees cannot be adequately applied to trees on farm bunds and plantations. Moreover, the study focused on the socio-ecological functions of the TOF and therefore has restricted value for its replicability. The study does not provide the total volume of trees as present along the roads.

Assessment of TOF through sampling and secondary information by the Indian Institute of Forest Management

The IIFM started the work on a national assessment of TOF as a collaborative project with over 30 NGOs from across the country in June 2000, based on secondary information and sample field survey. It was considered desirable in view of limitation of resources and lack of well-defined methodology for sampling. These NGOs and partner institutions were selected on the basis of their fieldwork on the subject in the respective areas.

Secondary information was collected from the following sources:

- Land Record Office
- District Statistical Office
- District Rural Development Agency (DRDA) offices
- District Collectorate
- Municipal Corporation offices (parks superintendent)
- Research institutions in the area
- Village-level interviews
- Tourism Department (for maps)

- Various plantation companies
- Public sector coal companies who raised compensatory afforestation
- NGOs engaged in tree plantation and watershed works
- District Forestry Office (social forestry/research and extension)

Field surveys were conducted to collect primary data on TOF in the State of Madhya Pradesh, as detailed below.

1. The State of Madhya Pradesh was broadly divided into three categories: urban, semi-urban (including district headquarters and small towns), and rural areas.
2. The State was divided into five main zones: North, East, West, Central, and Southeast.
3. Five major cities in the urban areas were chosen from each of the following zones: Gwalior (North), Jabalpur (East), Indore (West), Bhopal (Central), Bilaspur (Southeast).
4. One district headquarter in the semi-urban areas (near the selected city, i.e. the nearest possible semi-urban area was taken irrespective of the distance) was selected for each zone.
5. Four villages within 10 km from the district urban center, one each in the North, East, South and West of the district urban center, were selected in each zone.

TOF assessment by the Cardinal Grid Method (CGM©) in urban areas

The target urban area is divided into four main categories depending on the ownership pattern as follows:

- Landscapes were broadly divided into residential, institutional, roadside, and garden/pond/park/temple.
- Zones: 4 quadrants were laid in each zone of the selected city, i.e. East, West, North, South, Central.
- Data collected include number of trees, species, girth classes, and height classes.

The distribution of the sample areas is further differentiated as shown below:

a. Residential

Sample plot size: 100x100 m quadrant was taken in each zone of the city, and the trees were totally enumerated in the selected quadrant along with an estimate of the number of households.

b. Institutional

1. If an institution has an area of less than 3 ha, total enumeration was to be carried out.
2. In institutions with more than 3 ha, 20x5 m quadrants were laid in the institutions' precincts where the trees were planted.
3. Zonal criteria: 3 institutions in each zone (total of 15 in a city) i.e. East, West, North, South, Central.

Critical analysis of Cardinal Grid Method (CGM©)

The Cardinal Grid Method (CGM©) was applied and tested in Gwalior City, which was divided in three zones, namely Gwalior City, Lashkar and Murar. The method was discussed at length during a brainstorming session.

The study appeared to be based on systematic sampling, which could give rise to biased results. Extrapolation of results should be considered. Participants emphasized the need for random sampling in the initial stage to minimize potential errors. The selected grids were based on the spatial layout of

Gwalior, and are interchangeable. The city was divided into directional grids, the center being the densest populated area. The importance of selection of samples through the ring method by giving examples leading to extrapolation of the number of trees was discussed. The relationship could be assessed through a semi-variogram model. The proposed CGM© method needed to be further refined based on the field experiences and suggestions of the participants.

Garden/pond/parks/temple side

These were selected on a case-by-case basis depending on the occurrence of trees.

Sampling unit: 20x5 m, four quadrants per hectare of the target land

Striplands

Table 1. Available striplands in India

Land category	Potential (million km)
Roads	1.2
Railway lines	0.6
Drains	0.2
Canals	1.5
Around cultivated lands on bunds and boundaries	60.0

Source: Govt of India, 1982 .

Roads and rails

Four transects of 10x100 running meters were laid in each direction (North, East, West, South) on both sides of the city's state highway roads.

Canals

One transect of 10x100 running meters were laid every 3 km length on both sides of the canal.

In rural areas, there are a number of unclassified landscapes with trees. The procedure to inventory this kind of vegetation is important, but is not included here. The CGM© is applicable only to urban areas.

Analysis of the methodologies

The methodologies provide various ways for assessing the TOF resources. The first method justifies the stratification of landscapes but fails to include the roadside and railside trees. Each of the methodologies described above provides a unique dimension to the enumeration process. Malhotra and Kumar considered roadside trees but not trees on farmlands. The FSI methodology suggested total enumeration of trees in the study area, although it is clearly not feasible to inventory a diverse and vast country like India completely. Therefore the ideal method for TOF assessment would be a judicious mixture of methodologies that would cover both urban and rural areas, be representative enough to reduce errors, and be cost and time effective.

LIST OF POTENTIAL USERS OF DATA COLLECTED FOR TREES OUTSIDE FORESTS

Several potential users of this important but largely unrecorded information include academic institutions such as IIFM, TERI, Indian Council of Forestry Research and Education (ICFRE), universities, as well as industries that face the difficulty in procuring raw material within their industrial catchments. Policy makers (state and central government), donors (World Bank, ITTO), NGOs, United Nations organizations (FAO, UNDP) and civil society may be other stakeholders (Table 2).

Table 2. Potential users of TOF database

Users	Variables of interest	Purpose
National users		
Forest-based industries (NTFPs including medicinal plants)	species, annual production	raw material supply
Wood-based industries (sawmills, plywood, paper, etc.)	volume, species, size	raw material supply
Woodfuel-based industries (brick, kilns, tiles)	volume	fuel supply
Forest Development Corporations	species, volume	planning and marketing
Watershed Department	extent, number, species	soil and water conservation
Planning Board	extent, volume, use pattern, economic and social values	resource planning at district and state levels
Revenue Department		
Policy makers*:* - MoEF - Planning Commission - Economic and Planning Committees	extent, species, distribution, biomass cover, biodiversity, social and economic contribution at the macro level	policy planning, capacity building, socio-economic development, administrative and legal frameworks, budget allocation
Other developmental agencies such as DRDA/PWD/CDA, etc.	extent, volume, species	energy planning, avenue plantations, etc.
International agencies		
FAO	cover, extent, volume, species, ownership, biomass, economic and social contributions, etc.	development of global and regional policy and planning, capacity building, sustainable forest management, carbon sequestration and climate change management
UNFF	cover, extent, volume, species, ownership, biomass, economic and social contributions, etc.	development of global and regional policy and planning, capacity building, sustainable forest management, carbon sequestration and climate change management
GEF	biodiversity status conservation and management	biodiversity and climate change management
Banks/donors		
NABARD	species, growth, value	extending loans, cost of cultivation
World Bank, ADB, etc	extent, cover, volume, species, growth, GNP, GDP	sustainable socio-economic development
Bilateral donor agencies (ITTO, DFID, USAID, SIDA, CIDA)		

LIST OF INSTITUTIONS WITH RELEVANT DATA

Table 3. List of institutions with relevant data

Information owners	Variables of interest	Purposes
State government department		
Revenue Department Commission to Land Records DRDA, PWD, Water Resource Dept., etc.	extent, number, volume	land-use planning
Forest-based industries		
NTFPs including medicinal plants	species, annual production	raw material supply
Wood-based industries- (sawmills, ply wood, paper, etc.)	volume- species, size	raw material supply
Local institutions		
FPCs/	extent, volume, species at micro (village) level	livelihood, micro-planning
VFCs/Panchayats/NGOs	extent, volume,	
Panchayats	species	energy planning, avenue plantations, etc.
Farmers	species, number, volume, market value	economic benefit, farm portfolio
Academic institutions, forestry/ecological institutes		
IIFM	extent, species, stand, volume, economic and social contributions	policy analysis, teaching, training, research, consultancy, extension, natural resource accounting (national level)
FSI	area, cover, volume by age/species	primary data generation, Inventory
TERI	biomass	energy planning, carbon sequestration
CSO	land use, resource valuation	national social accounting
NRSA	land use, cover	surveillance, monitoring, quantification, net primary productivity (NPP)
ICFRE	growth, volume, utilization, and marketing (national level)	research, development of ecological/ economic models, extension
Agricultural universities	species, growth, volume	agro-forestry, farm forestry and its variants, models, research, extension
Other academic institutions (MoM)	species, growth volume, extent	academic purposes

PARAMETERS, CRITERIA AND INDICATORS FOR ASSESSMENT OF TREES OUTSIDE FORESTS

Any method for assessment has several positive and negative aspects that make the method suitable or unsuitable under a given set of conditions and resources. These may be the factors such as costs , time, technical manpower availability, and so on. These aspects can be assessed systematically to derive a set of criteria and the corresponding indicators. *Criteria* are the basis against which a resource is to be assessed. The *indicator* is the proof of the occurrence or non-occurrence of the resource/methodology and is judged accordingly. Thus, the criteria and indicators(C&I) are the basis on which the utility of a resource or a system can be judged. These C&I, when selected properly and administered judiciously, can provide a better picture of the utility of a system or method. The broad set of C&I for TOF assessment is shown in Table 4.

Table 4. Criteria and indicators for the assessment of trees outside forests

Attributes/criteria for assessment	Indicators
Precision	Standard error
Time	Time per district
Cost	Cost per district
Robustness/practicability	- Training person-days - Training costs
Replicability	Applicability to varying situations (macro-level applications)

These C&I can be modified and elaborated according to the specific need(s) of the site. The observations thus obtained can be rated, as shown in the example below. The rating scale is a flexible tool and can be standardized accordingly.

Table 5. Scoring scheme

Indicator	Methodologies (scores)				
	Ground sampling	Aerial photography	Remote sensing	Remote sensing + ground survey	Secondary information
	1	2	3	4	5
Precision	8	9	5	8	3
Time	4	6	7	7	8
Cost	5	3	4	1	8
Robustness	3	5	6	9	2
Replicability	2	2	5	9	2
Total score	22	25	27	34	23

*The rating scale is a preferential scale, ranging from 1 to 10 in this case.

- Precision: a high value indicates a higher preference
- Time: a higher value indicates greater preference.
- Cost: a lower value indicates higher costs and thus lesser preference.
- Robustness: a higher value indicates greater robustness.
- Replicability: a higher value indicates more replicability (e.g. ground sampling (score 2) indicates that the method is less replicable over a period of time because the time required for ground sampling is lengthy and during that period the vegetation changes substantially.)

Thus, remote sensing and ground survey (column 5) carries 34 points and is the best method considering all 5 criteria namely precision, time, cost, robustness and replicability.

Replacing the numerical values by qualitative information was also suggested. A topographic plot design matrix was designed as shown in Table 6.

Table 6. Topographic plot design matrix

Criteria	Topography		Geometry of plots		
	Mountain	**Flat**	**Block**	**Linear**	**Scattered**
Area	Small	Large	1.0 ha	0.1 ha	5 ha
Shape	Uneven	Even	Square	Strip	Round
Design	Nested	Quadrant	Quadrant	Transect	Case-wise

This matrix would help in understanding the site and the location where the process is being carried out in a more reliable and efficient manner.

ACTION PLAN FOR THE STANDARDIZATION OF ASSESSMENT METHODOLOGIES FOR TREES OUTSIDE FORESTS

Participants at the workshop agreed and considered that the northeastern region of India is a special case since most of the forests are classified under community forestry. Table 7 summarizes the sampling criteria proposed by the participants, and Table 8 the action plan.

Table 7. Sampling criteria

Nature of area		Size of area (ha)	Proportion of sample (percent)	Number of samples (n)	Total sample size
Block plantation	Orchard	1 000	25.0	100	400
	Com. plantation	500	12.5	50	
	Coastal	500	12.5	50	
	Woodlot	2 000	50.0	200	
Linear/strip plantation	Farm land	300	30.0	30	100
	Rail	200	20.0	20	
	Road	200	20.0	20	
	Canal	300	30.0	30	
Scattered plantation	Pond/tank	1 000	20.0	20	100
	Homestead	1 000	20.0	20	
	Sacred grove	1 000	20.0	20	
	Dispersed	2 000	40.0	40	

It was also agreed that the sampling distribution 1.0-0.1 percent be drawn by the stratified random sampling method. The plot size may be considered as:

Block : 1 ha

Linear strip : 0.1 ha (500 m x 2 m)

Scattered : 5 ha

Total sample intensity would be N= 600 from 10 km^2

Table 8. Action plan for standardizing the methodology

Task	Responsibility	Time	Cost (US$)**	Remarks
Review of literature/work to be updated	IIFM, Bhopal	June 2001	5 000	*Sources*: U.P., Gujrat, Haryana & research paper of Dr. Krishnakutti – FSI, GTZ – Dr. Govil; Western Ghat - French Institute, Pondichery; Pakistan, Bangladesh & Sri Lanka – ADB Book. (Ganguly's research paper)
Pilot study for standardization of methodology	FSI, NRSA, IIFM (3 Talukas* to be selected first and survey to be carried out, networking with other institutes like WII, FRI, KFRI, IISc, TERI, State forest departments)	31 Dec 2001 (7 months)	20 000	36 villages @12 villages/taluka to be surveyed. Total cost of survey including GIS and workshops.

*Taluka = a small area that represents an administrative unit under district administration (1 Taluka = twelve villages)

**US$ 1 = 47 INR (Indian rupees)

TERMS OF REFERENCE FOR EXPLORATORY STUDY OF THE COST-EFFECTIVE USE OF REMOTE SENSING IN THE ASSESSMENT OF TOF AND IDENTIFICATION OF FURTHER STUDIES

Study area

The exploratory study was planned to take place in Bhopal District, Madhya Pradesh. This district was carved out of the Sehore District in 1981 and provides an ideal test site in terms of its size, spread of TOF and proximity to IIFM. Spreading over 2 772 km^2, it is a relatively small area. Rural areas in the district are largely agricultural having a fair abundance of field perimeter, roadside, bundside and village orchard trees.

The district is covered by the Survey of India topographic map sheets 55E/1,2,3,4,5,6,7,8,9,10,11,12 at 1:50 000 scale. At 1:25 000 scale, the district is covered by 48 Survey of India map sheets with East, West, North and South quadrants for each of the above numbered map sheet.

Remote sensing data

It is proposed to use the Indian Remote Sensing Satellite IC PAN and LISS III data for the exploratory study. While the PAN data provide a good 5.8M^2 spatial resolution, the LISS III data are at a spatial resolution of 23.5 M^2 multi-spectral data sets.

The multi-spectral data would provide analysis avenues exploiting spectral properties of vegetation that will corroborate tree identification using PAN data. It is therefore felt that data from both LISS and PAN sensors would probably yield the best results in the identification of TOF.

Analysis and interpretation

A suitable sampling design will be developed for carrying out this exploratory study. The sampling design will cover various strata to ensure appropriate representation of diverse areas. The satellite data will be analyzed at IIFM using the ERDAS Image processing software. Administrative/village boundaries and major land features, which will also help in tree counts, will be digitized and superimposed on the satellite imagery using the ARC/INFO GIS. Field verification based on the sampling design will be carried out to ascertain the accuracy of image interpretation. Costs of the various activities will be noted to provide a realistic cost-accuracy-feasibility evaluation for the modified methodology to ease replication in other areas. Table 9 shows the costs for the study.

Table 9. Estimated costs for the exploratory study

Project activity	Cost in US$
Digital data	
LISS III Digital / Geocoded Paper Print Scene/s on CD ROM Media for the Study Area	4 700
PAN Digital / Geocoded Paper Print Scenes	8 000
Interpretation charges	
Field visit expenses for 2 field investigators	2 600
Computer consumables, map production and photography	1 100
Scanning and digitization	1 100
Interpretation costs including computer time and consultation	1 700
Miscellaneous costs	
Out of station travel	500
Reports	300
Total	20 000

CONCLUSIONS AND RECOMMENDATIONS

TOF are an important resource and play a key role in sustainable forest management. The natural forests are diminishing under pressures of urbanization and other human interferences like encroachment in the forests and agriculture on encroached lands. Planting trees in rural areas as well as in and around human settlements and cities will help increase the forest cover, ease pressures on natural forests, and provide services and goods to meet timber, fuelwood, fodder and non-wood forest product demands. To make these plantings sustainable, careful consideration must be given to their role in overall land-use patterns. Trees are also important in the socio-cultural lives of the people, and are an important resource for the wood-based industries.

This workshop appreciated the importance of TOF and also their various dimensions of utility and methods of estimation. TOF have a lot of implications on SFM and also contribute substantially to the raw material requirements of industries.

The most important users of TOF data are the industries dependent on the tree resources as raw materials. Government departments and the educational institutions that are linked to natural resource management are the major owners of TOF-related information.

Four main constraints for methodologies to assess TOF are cost, time, accuracy and technical knowledge. All the methodologies – remote sensing, ground-based sampling methods, aerial photography and total enumeration – have some drawbacks and are unable to meet all requirements simultaneously.

Some significant conclusions of the workshop are:

1. TOF assessment over a large area is a lengthy exercise and hence involves much technical manpower and financial resources.
2. Therefore, a small-scale assessment methodology should be tested for its accuracy, cost-effectiveness and the length of time required.
3. Secondary data sources provide vital information for the sustainability of TOF.
4. Networking of NGOs in different parts of India would serve as a major source of TOF information.
5. RS techniques alone, though accurate and precise, are not cost effective. The forest cover shows a spatial-temporal variation and hence the precision of the information generated should be linked to its potential use value. If the information is too precise but the costs involved are enormously high, it decreases the prospects of repeat measurements over a short interval.
6. Ground-based methods (mainly sampling methods) are suitable for large area inventory of TOF. Though they involve a lot of manpower, they are cost-effective and can generate information that is useful for the researchers within the permissible error limits. Hence they can be repeated over shorter intervals and are useful in frequent monitoring of the resource.
7. India has no policy for the management of TOF. A small exploratory study would help to initiate the formulation of guidelines to establish such a policy in the country.

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ANNEX 1: LIST OF ACRONYMS

ADB	Asian Development Bank
CDA	Coastal Development Authority
CGM©	Cardinal Grid Method
C&I	Criteria and indicators
CSO	Central Statistical Organization
DRDA	District Rural Development Authority
FAO	Food and Agriculture Organization of the United Nations
FPC	Forest Protection Committee
FRI	Forest Research Institute
FSI	Forest Survey of India
GEF	Global Environmental Facility
GIS	Geographical Information Systems
ICFRE	Indian Council of Forestry Research and Education
IIFM	Indian Institute of Forest Management
IISc	Indian Institute of Science
MoEF	Ministry of Environment and Forest
NABARD	National Bank for Agricultural and Rural Development
NGO	Non-governmental organization
NRSA	National Remote Sensing Agency
NTFP	Non-timber forest product
PWD	Public Works Department
RS	Remote sensing
TERI	Tata Energy Research Institute
TOF	Trees outside forests
TOR	Terms of reference
UNFF	United Nations Forum on Forests
WII	Wildlife Institute of India

ANNEX 2: LIST OF PARTICIPANTS

1.	Anoop Kumar Dy. Director (M.U) Forest Survey of India Dehradun 248195	Phone: 135-755042 (Res): 135-773034
2.	Rajesh Kumar Deputy Director (MDMU) Forest Survey of India Dehradun 248195	Phone: 135-755042 (Res): 135-757021 Ext. 4663 Email: fsiha@nde.vsnl.net.in
3.	A.K. Bhardwaj Faculty Scientist Wildlife Institute of India Post Box No.18, Chandrabani Dehradun 248001	Phone: 135-640111 to 640115 Ext. 260 (Res): 135-640111 to 640115 Ext. 329 (Direct): 135-642793 Fax: 135-640117 Email: anilbhardwaj@wii.gov.in
4.	C.B.S. Dutt Head Forestry & Ecology Division National Remote Sensing Agency Balanagar Hyderabad 500036	Phone: 40-3878842 (Res): 40-7765363 Fax: 40-3879677 Email: dutt_cbs@nrsa.gov.in
5.	Pankaj Srivastava Dy. C. F. (Lok Vaniki) M.P. Forest Department Bhopal	Phone: 755-551334 (Res): 755-552452 Email: srpankaj@bom6.vsnl.net
6.	Shivendu K. Srivastava Head, Extension Division Forest Research Institute PO New Forest Dehradun 248006	Phone: 135-758606 (Res): 135-757729 Email: shivendu@icrfre.vp.nic.in
7.	Kailash C. Govil Regional Project Coordinator (ECP/RAS/162/JPN), FAO Room No.109, ICFRE Building FRI Complex Dehradun 248006	Phone: 135-752872 Fax: 135-752873 Email: rpccb@nde.vsnl.net.in
8.	D.P. Singh Forestry Advisor to Govt. of M.P. F-1, Janaki Enclave Kolar Road Bhopal 426016	Phone (Res): 755-424051, 755-424049

9.	L.N. Sharma Deputy Commissioner Land Record Pari Bazar Bhopal	Phone: 755-542873 (Res): 755-557976
10.	K.S. Bhadoria Dy. Commissioner Land Records and Settlements Gwalior Madhya Pradesh	Phone: 751-341584 Fax: 751-324811
11.	Sunil B. Banubakode c/o Director Wildlife Institute of India Post Bag No.18 Chandrabani Dehradun 642008	Phone: 135-640112 Ext. 238 Fax: 135-640117

List of participants from IIFM, Bhopal (Phone : 91-755-775716; Fax: 91-755-772878)

12. Ram Prasad (ramprasad@iifm.org)
13. P.C. Kotwal (pckotwal@iifm.org)
14. Vijay Kumar (vkumar@iifm.org)
15. R.K. Singh (rksingh@iifm.org)
16. C.S. Rathore (csr@iifm.org)
17. S. Raghavan (sreesh@iifm.org)
18. Suprava Patnaik (spatnaik@iifm.org)
19. Manish Mishra (manishm@iifm.org)

IIFM Rapporteurs

1. S.K.S. Rathore (sanjair@iifm.org)
2. S.P. Singh (spsingh@iifm.org)
3. B.R. Phukan (phukan@iifm.org)
4. M.D. Omprakash (prakash@iifm.org)
5. Dharmendra Dugaya (dugaya123@rediffmail.com)
6. Yogesh D. Jadhav (yogeshdj@iifm.org)

ANNEX 3: SUMMARY OF PAPERS PRESENTED DURING THE WORKSHOP

Remote sensing based non-forest timber resource assessment.

Dr. C.B.S. Dutt (NRSA)

In the presentation various methods for assessing TOF were highlighted which are given as under:

- Complete enumeration of TOF
- Estimation through aerial photo interpretation
- Multi-stage sampling
- Remote sensing stratified segment sampling
- Stratified random sampling
- Stratified systematic sampling
- Multistage segment sampling

He highlighted the effectiveness of every method and their utility along with *level of accuracy* and *cost effectiveness*. The aggregation was explained through statistical equation and cumulative estimation with the help of icon distribution curve.

The cost and time involved in the exercise along with the accuracy level for estimation of TOF for a district was discussed. The presenter informed the house that the cost would be roughly Rs.10-12 lakhs per district. The comparative cost involved in carrying out the exercise manually was also given a thought. The issue of the getting industrial finance to meet the exorbitant cost was discussed. This would ultimately lead to less dependency on forest resources. The issue of sensitivity involved in the data and its collection through remote sensing was highlighted.

Presentation 2:

Shri Anup Kumar (FSI) presented his paper titled *"Tree resources outside forest."*

It included the following objectives:

- Assess extent of plantation raised under different forest schemes by different agencies and individuals
- Estimate growing stock and species wise number of trees available in TOF

The presentation described the definition of TOF and elaborated the tree resources in the non-forested area which are as under:

1. Farm forestry
2. Village woodlots
3. Block plantation
4. Road side plantation
5. Ponds side plantation
6. Railway side plantation
7. Canal side plantation

8. Others

The presentation further highlighted the zone wise division of the study area. *The study area was divided into*:

- Agro-climatic zone(First stage strata),
- Districts (Second stage strata), and
- Villages (Sampling Units).

Estimation of the sample size for the study area was done by mean and standard deviation methods.

The examples of Rajasthan, M.P vis-a-vis TOF assessment were discussed. It was agreed that the time consumed in carrying out the exercise would be too high. The need of technical expertise for the collection of data was emphasized as also the issue of collecting the information for district level. Rajesh Kumar, FSI, informed that their study was based on different agro-climatic zones and more accurate at State level. It was informed that total of 219 villages was covered and trees of more than 10cm diameter were counted in the FSI study. In reply to a question asked by Director, IIFM, it was informed that field team consists of 4 people and taken 6–8 months (depending upon the size/area of the village) time to cover one village. On an average the field team counted 800 trees per day in the FSI study.