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Vol. 4, Issue 2, July - September 2023

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Indian Council of Forestry Research and Education

(An Autonomous Body Under Ministry of Environment, Forest & Climate Change)

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VISION

To achieve long-term ecological stability, sustainable development and economic security through conservation and scientific management of forest ecosystems

MISSION

To generate, advance and disseminate scientific knowledge and technologies for ecological security, improved productivity, livelihoods enhancement and sustainable use of forest resources through forestry research and education

ZIBOC

- A new wood preservative which is comparable to CCA.
- Judicious use of preservative in a non-durable wood greatly enhances (6-8 folds) life of products.

Varieties/ Clones developed

- Developed improved germplasm of many forest tree species.
- Released 47 high performing and disease resistant clones of *Eucalyptus, Casuarina, Shisham, Melia* and *Sarpagandha* with a envisaged production gain of more than 20%. The developed germplasm are being made available to the State Forest Departments and farmers for use in plantations.

High performing and disease resistant clone of *Melia* sp.

CYCUS v. 1.0

- Casuarina Yield Calculator Utility Software (CYCUS v1.0) software has been developed to facilitate the farmer and other user agencies in yield estimation which requires only observations on girth of 100 sample trees per acre of plantation.

Wood Welding

Wood welding is new to our country. In this technique wood joints can be made without using nails and adhesives making them more natural and chemical free. A wood welding machine has been designed and fabricated at Forest Research Institute, Dehradun. Success has been achieved in spin welding of wood pieces of few species.

Wood Welding Machine

Indian Council of Forestry Research and Education

New Initiatives

- Transparent wood- a flexible and biodegradable transparent wood has been fabricated using poplar wood veneer and water soluble polymer- polyvinyl alcohol. The transparent wood exhibited high optical transmittance, high haze and light diffusing property.

Natural wood (Left most), Lignin modified wood (middle) and Transparent wood (right most) placed on a paper with letters "IWST"

Heat storage based modified Solar Kiln

- Solar heat storage system based solar kiln has been developed by Forest Research Institute, Dehradun for timber drying. The solar heat is trapped using suitable phase change material (PCM). The New solar kiln is able to trap 39 % more heat in winters as compared to traditional green-house based traditional FRI solar kiln developed during 1970.

Head based storage Solar Kiln

Xylarium

- Collection of authentic wood samples both from India and other countries, depicting wood biodiversity of the country like lightest, heaviest, sweet-smelling, foul smelling, smoothest, streaked, variegated wood and wood of different coloures, etc. The collection of wood cross sectional discs depicting variation in sapwood and heartwood colour is a unique feature of the xylarium.
- Wood identification services.

Xylarium- Collection of Authentic wood samples

Tree hollowness detection technique based on ultrasonic waves

- Forest Research Institute, Dehradun has developed ultrasonic techniques (Non-destructive testing) to detect the location and magnitude of the hollowness of the standing tree. This will help to remove the potential human hazards by way of falling down of such trees during a high wind regime in Urban Forestry.

Measurement of hollowness in a tree using ultrasonic detector

Agroforestry models

- Various agroforestry models (Poplar, Eucalyptus, Melia, Casuarina and Babool) have been developed to improve green cover, enhance farmers income and to mitigate climate change .

Poplar based agroforestry model with wheat

Innovative Bamboo Bottles

- Techniques for making bamboo bottles by using Bamboo Treatment Technologies of ICFRE. Most suitable bamboo species for making bottles are Shil Barak (*Bambusa salarkhanii*) & Barak (*Bambusa balcooa*). One full bamboo is sufficient for making 21 full size bottles and 12 small bottles.

Bamboo bottles

For further details please contact :
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DR. M.P. SINGH, IFS

DIRECTOR
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BENGALURU - 560003

Preface

ICFRE-IWST, Bengaluru is bringing out this issue of "Wood is Good" magazine which includes important articles related to wood technologies developed by ICFRE, wood security and sustainability and articles related to functioning of Forest Development Corporations of different states.

ICFRE Institutes especially ICFRE-IWST, Bengaluru and Forest Research Institute (FRI), Dehradun has developed many technologies in the field of wood science which requires to be disseminated among stakeholders for wider publications and accessing technologies. In this edition few of the wood technologies developed by ICFRE viz. "Naturally added composites produced from waste resources", "Bamboo Mat based Roofing system", "Natural Wood Preservative Formulation from Coconut Shell Pyrolytic Oil" etc. are included, which will immensely help the stakeholders especially entrepreneurs to take up these technologies in consultation with ICFRE to a greater extent.

Wood security and sustainability is one of the important aspect which is covered in this edition with few articles from experts in this field. This includes articles related to sustainable wood sourcing by Indian Paper Industries, sustainability in the Trees outside Forests, overview on Indian timber market being dominated by Latin American countries, etc.

This edition also covers articles on functioning of different Forest Development Corporations of the state to showcase the production aspects and activities being carried out by them to various stakeholders so that they can interact with different Forest Development Corporations as per their need and necessity.

I am sure this edition will create interest and motivation to various stakeholders in subjects related to wood technologies, wood security & sustainability and Forest Development Corporations of the states.

Dated: 10 November 2023

(M.P. Singh)

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CONTENT

IWST activities during July – September, 2023

Sensitization program on Forestry and Wood Science

Sensitization program was organized on 7th July 2023 by ICFRE-IWST, Bangalore for 70 Audit Officers from Regional Training Centre of Indian Audit and Accounts Department (IA&AD), Bangalore. The participant officers learned about various environmental challenges like global warming, biodiversity loss,pollution, environmental degradation, resource depletion,climate change and its impact. The conservation value, protection of endangered species and protection of ecologically valuable natural areas, role of forest and use of wood in climate mitigation etc were also highlighted. They were also apprised about the research activities of the institute during their visit to different laboratories and other facilities.

Azadi Ka Amrit Mahotsav (India@75)

Webinar on An invasive weed for value addition – Lantana Camara

Under Azadi Ka Amrit Mahotsav celebration, ICFRE –IWST organized a webinar on An invasive weed for value addition – *Lantana Camara* was organized on 17th July 2023. The threats of invasion and eradication methods were explained in detail during the presentation followed by discussion on the topic. The potential of Lantana Spp through value addition in terms of particle board, fibre board, laminates, furniture making and other uses were also highlighted. About 50 researchers attended the webinar and enriched their knowledge on value addition of *Lantana Camara*.

Azadi Ka Amrit Mahotsav (India@75) and Mission Life Technical Lecture Series

Under Azadi Ka Amrit Mahotsav & Mission Life, ICFRE-IWST organized Technical Lecture Series during 26- 27 July 2023. Three lectures were delivered by eminent researchers in the field of science. Dr. Amit Roy, Sr. Researcher and Group Leader (Forest molecular entomology), Czech University of Life Sciences, Prague presented on Molecule to Management: Feasibility of RNAi against Ipstypographus (Coleoptera: Scolytinae).

Dr. Amrita Chakraborty Researcher (Microbiologist) Czech University of Life Sciences, Prague presented on Microbes Matter: Understanding the role of microbes in termite holobiont.

Dr. C. V. Yelamaggad, FRSC, Scientist, Centre for Nano and Soft Matter Sciences, Bangalore presented on Functional materials for fundamental science and various applications.

Azadi Ka Amrit Mahotsav (India@75)

Webinar on Standards and selection of panel products for different application

As part of celebration of Azadi ka Amrit mahotsav, ICFRE-IWST organized webinar on Standards and selection of panel products for different application on 28th July 2023 which covered standardization process, major standards related to panel products from wood and other lingo celluloses and selection of panel products for different applications. Focus was also given on Identification of research needs- Revision of standards based on end use application, Amendment to the standards based on present raw material scenario; Formulation of future strategies/road map - Incorporation of plantation/Agriwood in standards, Development of process parameters for making new generation products; Networking of identified research - identifying Institutes/organisations like BIS for long term networking; Future research direction and opportunities for funding. About 50 participants from various fields viz., budding engineers and researchers attended the webinar.

Azadi Ka Amrit Mahotsav (India@75)
Lecture on India's Forest Carbon Cycle Challenges and Early Results

As part of celebration of Azadi Ka Amrit mahotsav, Shri. V. K. Dadhwal, Professor, National Institute of Advanced Studies (NIAS), Bengaluru presented on "India's Forest Carbon Cycle Challenges and Early Results on 7th August 2023.

The lecture covered the results over past two decades on use of EO as well as a major multi-institutional project, National Carbon Project (NCP) under ISRO Geosphere-Biosphere Program. Studies have covered establishment of eddy covariance flux towers in different forest types to measure net carbon exchange. Develop a sampling protocol for relating Earth Observation (EO) to forest above ground biomass. Data driven and machine learning to estimate soil carbon pools and litter fall of forests, Multi-year synthesis with model driven primary production and long-term book keeping models for carbon emission due to forest transformation. Results were presented with emphasis on complementary nature of information from different approaches. Current efforts to bring in long-term forest transformation, forest type/class based inputs, incorporating geospatial dimensions of forest utilization as well as developing and validating recent geospatial products such as AGB were described. Future steps to advance our

Awareness Program on Bamboo Housing Technology and Bamboo Products

ICFRE - IWST Bengaluru and Filed Station Kolkata in collaboration with Assam State Bamboo Mission and District Industries & Commerce Centre, Govt. of Assam organized awareness program on "Bamboo Housing Technology and Bamboo Products" in five Districts during 5-11 August 2023. Shri.Ritesh D. Ram and Shri. Amitava Sil, Scientists made presentation on bamboo processing, earthquake resistant bamboo houses, bamboo plastic composite, charcoal and fuel briquettes from bamboo waste. The awareness program was expected to acquaint entrepreneurs & stakeholders on recent technologies of bamboo processing, product manufacturing, eco friendly housing construction etc.

Independence Day

ICFRE- IWST, Bangalore celebrated 77th Independence Day on 15th August 2023. Dr. M.P. Singh, Director IWST unfurled the flag and addressed the gathering. On this occasion, prizes were distributed to winners of various sports competition. Cultural programme was also organized with participation of staff, student and family members

Research Consultative Meeting with Karnataka Forest Department

The research consultative meeting was held on 23.8.2023 under the Chairmanship of the Director General, ICFRE to understand the research needs of Karnataka Forest Department (KFD) and also to exchange the information related to research activities undertaken by the organizations. Shri. Rajiv Ranjan, IFS, PCCF (HoFF), KFD along with senior officers of KFD were present in the meeting. Dr.M.P. Singh IFS, Director, ICFRE-IWST headed the team of officers and scientists from IWST side.

Presentations were made by officers of KFD from different circles including Dharwad, Madikeri, Bengaluru, Ballary etc. KFD on various research activities carried out by them. Further sceintists from IWST presented four projects for the consideration and funding support from KFD which included project proposals on Sandalwood, Madhuca bourdilloni, Insect pest management in Mahogany, Generation of DNA barcode sequence of timber yielding spp. from Western Ghats. GCR, IWST made a presentation on various ongoing research projects which are related to KFD and requested officers from KFD for collaboration and support in achieving the objectives of the projects.

Actionable Points emerged from the meeting:

- IWST will assist the KFD in analysis of available research data for the joint publication of research findings.
- IWST will carry out the evaluation of Research Trails of KFD as per the requirement of KFD.
- IWST and KFD will exchange the information related to CPTs, clones, selections, etc. of various important tree species.
- KFD will grant permission to carry out research activities in research stations / forest areas on case-to-case basis, as per procedure.
- KFD will consider to extend the funding support for the following Project Proposals of IWST for the year 2023 24.

Short term training on Sandalwood farming and management of its Health

ICFRE-IWST, Bangalore organized a one week training program on "Sandalwood farming and management of its health" from 11th to 15th September 2023 at IWST through physical mode. A total of 33 participants from various states participated in the training program. The technical session included Sandalwood seed and nursery techniques like processing of sandal wood fruits and seed; quality testing; certification of sandalwood plantations; management of insect pest in nurseries and plantations; utilization and assessment of oil content; protection of plantations; cloning using tissue culture; policy and schemes of state forest departments; management of diseases in nursery & plantations; heartwood estimation in standing trees; inter cropping with medicinal plantsagro-forest and silvicultural management; marketing of sandalwood products; identification of sandalwood decay and , damages caused by insects. These aspects were explained to the participants by subject expects working on sandalwood farming. A hands-on session at the IWST nursery to learn about seed handlings and nursery practices, demonstration on assessing the oil content in sandalwood, andobserving health status of sandalwood trees in IWST campus and visit to sandalwood plantation at Kothacheru (Puttaparthi)was also part of the training . Dr. R. Sundararaj, Scientist (Retd.), IWST shared his experience about Sandalwood Spike Disease. Few progressive farmers also shared their experiences on sandalwood cultivation during the training program.

Short term training course on Adhesive for plywood and plywood manufacturing

ICFRE-IWST, Bangalore conducted one week short term training course on Adhesive for plywood and plywood manufacturing during 11th to 15th September 2023. Phenol and amino resin manufacturing with detailed process of cooking, adhesive formulations for making various grades of plywood and plywood manufacturing at pilot scale were demonstrated. The course included PF resin manufacture, Melamine Urea Formaldehyde (MUF) resin manufacturing, characterization of resins synthesized during the training. Phenol and urea formaldehyde resin manufacturing was also demonstrated on 11th and 12th September 2023.

Consultative meeting on Research needs of Forestry Andhra Pradesh

A consultative meeting on Research needs of Forestry in the state of Andhra Pradesh was held between ICFRE-IWST and Andhra Pradesh Forest Department on 12th September 2023 at Tirupathi. Director, ICFRE-IWST and PCCF (HoFF), Andhra Pradesh led the consultative meeting. Important topics of the meeting were Release of teak clones of Andhra Pradesh by following the MoEF&CC protocol for release of the clones, Identification of superior quality features of red sanders and development of tissue culture protocol for mass production, Study on the development, content of heartwood in plantation grown Red sanders and Red sanders in natural forests, Developing molecular markers/primers for identification of illicit red sander material seized in different parts of the country, To study the economics of growing red sanders' wood in farmers field, its marketing and revenue generation for promoting this species for Trees Outside Forests, Identifying/finalizing a list of best performing agroforestry species to be planted in Rayalaseema, Standardization of propagation techniques for RET/Eastern Ghats endemic species to conserve these species for the future, Research and silvicultural improvement of *Soymidafebrifuga* (Somi) tree in *Rampochodavaram* area which is widely used as Dwajastambam and Study on effect of genetic, edaphic and climatic factors on quality of Red Sanders.

Workshop on National Working Plan Code -2023

ICFRE-IWST, Bangalore organized one day workshop on National working plan code -2023 on 14th September 2023. Senior officers/field officials from Karnataka Forest Department Regional office, MoEF& CC, Forest survey of India and scientists from Karnataka State Remote Sensing Agency attended. Dr. M.P. Singh IFS, Director ICFRE-IWST, Bangalore made a presentation on "National Working Plan Code - 2023" and on "Indian Forest Management Standard". The participant officers were explained regarding the salient features of NWPC - 2023 including manual and standard. The field officers interacted with Director, IWST, Director, FSI, officers from MOEF & CC regarding the NWPC-23 and implementation in field.

Workshop on Agroforestry promotion - Policies and Changes in Forest Conservation Act

ICFRE - IWST in collaboration with Regional office, MoEF&CC, Bengaluru organised a workshop on Agroforestry promotion - Policies and changes in Forest Conservation Actunder the chairmanship of Shri. Bivash Ranjan, IFS ADG (Wildlife) MoEF & CC, Government of India on 15th September 2023. The purpose of the workshop was to convey and spread among the tree growers and other stakeholders such as representatives of wood based industries, progressive farmers practicing tree cultivations, representatives of various user agencies, scientists, students, State Forest Departments etc, the aspects of Amendment and the provision in the Act to promote Agroforestry and cultivation of trees outside forest area. Sri. P. Subramanyam IFS, Sri. Mahesh Kumar Shambhu, IFS, Sri. R.K. Sapra, IFS (Retd.), Sri. K.N. Murthy, IFS (Retd.), Sri. Jaydeep Chitlangia, Secretary General (FIPPI) and other participated in the deliberations and provided valuable inputs.

Matecia Building Material Exhibition

ICFRE - IWST, Bangalore showcased wood and bamboo products at the Material and Technology Conclave, part of the Matecia Building Material Exhibition at Pragati Maidan, Delhi, from 22-24 September 2023. The. Dr. M.P. Singh, IFS Director along with scientists participated in the panel discussion in plantation timber for wood industries and interacted with the Architects, wood industrialists, furniture manufacturers and individuals from across India and neighboring countries. The stall attracted over 500 visitors who raised technical queries related to plywood, particle board, MDF, bamboo-based composite, and the training of manpower. This exhibition not only provided valuable insights to newly established entrepreneurs but also served as an inspiration for new startups.

Research Advisory Group Meeting

The Research Advisory Group Meeting (RAG) of the Institute of wood Science and Technology, Bangalore was held on 26th September 2023 to prioritize new research project and to bring in innovation in studies to be carried out in coming years and also to review progress of ongoing research projects of the institute. Projects were framed so as to cater to the research requirements of Forest Departments, wood industries and other end users. The suggestions given by experts and stakeholders from different sectors are then incorporated and project proposals are finalized. Dr. M.P. Singh, Director, ICFRE-IWST chaired the meeting. Scientists from IWST presented projects proposals to RAG members, senior officers from Karnataka, Andhra Pradesh & Goa.

VVK–KVK Trainings

During July 2023, ICFRE-IWST organized two training programs on "Sandalwood based agroforestry models and its Health" under CAMPA extension funding. The trainings were conducted through Krishi Vignan Kendra (KVK), Raichur and KVK Gangavathi in Koppal District. DCF, Raichur and DCF, Koppal together with Director of Extension, Raichur and Dr. Sundararaj, Scientist (Retd.), IWST inaugurated the programs at Raichur and Gangavati respectively. Around 250 farmers from both the districts participated in the training programs and enhanced their knowledge. The participants were given a brief of the research activities at IWST. This was followed by a lecture on healthy practices to be followed for growing sandalwood and sandalwood spike disease and its symptoms. Progressive farmers shared their experience on raising sandalwood plantations and encouraged fellow farmers to grow sandalwood in their lands.

Memorandum of Understanding Signed

Memorandum of Understanding has been signed between Dr. S. S. Chauhan, Scientist G and Head WPP Division, ICFRE-IWST, Bangalore and M/s RETI ECOTECH, Bengaluru on 14 July 2023 for development of panel board from textile waste. Memorandum of Understanding has been signed between Dr. S. S. Chauhan, Scientist G and Head WPP Division, ICFRE-IWST, Bangalore and M/s East Corridor Consultants India LLP, Lucknow on 25 July 2023 for Development of Heat pressed particle boards from Bamboo at the lab scale. In the presence of Director General, ICFRE, a Memorandum of Understand (MoU) was signed by Director, ICFRE-IWST and Director, Centre for Nano and Soft Matter Sciences (CeNS), Bangalore on 23 August 2023 to take forward scollaborative research activities. Memorandum of Understanding was signed between ICFRE- Institute of Wood Science and Technology, Bangalore and St. Joseph's University, Bangalore on 7 September 2023 to promote joint research and development activities.

Visit of Delegates

- Shri. A. S. Rawat, Director general, ICFRE visited ICFRE-IWST, Bangalore during 23 -25 August 2023. He chaired and attended various meeting and also signed a Memorandum of Understanding betwwen ICFRE and NCBS, Bangalore.
- A delegation from Forest Economy Research Institute, Tokyo, Japan visited IWST on 14 Sept 2023 to discuss about the possibilities of collaboration and cooperation in the field of wood utilization.

Hindi Pakhwada Celebration 2023

ICFRE-IWST, Bangalore celebrated Hindi Pakhwada from 14-28 Sept 2023. Dr. M. P. Singh, IFS, Director of the Institute inaugurated the hindi fortnight. The Director addressed all the scientists, officers and staffs of the institute and encouraged them to use Hindi in day to day official correspondences. He also requested employees to work towards promoting Hindi as

The Patent Office, Government Of India
Patent Certificate

Patent Granted

Patent has been granted to the patentee (ICFRE-IWST) for an invention entitled "Natural wood preservative formulation from coconut shell pyrolytic oil" as disclosed in the patent No. 440779 for the term of 20 years from the 13th day of February 2018 in accordaance with the provisions of the Patents Act, 1970.

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Key Achievements

1. Organized six International Conference on Laminates between 2010 to 2018
2. ILMA Institute of Technology to enhance production capabilities of members employees
3. Restrict import of low quality laminate
4. Study on Cleaner Production
5. Launch of Technical book on laminate
6. Catalogue shows at National and International Level
7. Launch of awareness video on Laminate application
8. Networking with members for raw materials, production, market and government policy related issues
9. Export incentive benefits to laminate exporters
10. Support to PM Cares fund during pandemic

Upcoming Events

1. 7th International Conference on Laminates during Delhi wood March 2021
2. Catalogue show at Interzum, Germany 2021
3. Online technical workshop on production and environment aspects during October 2020.
4. Environment clinic with Pollution control board (December 2020)

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Proceedings of the First Meeting of

ICFRE-WOOD INDUSTRIES COMMITTEE OF INDIA (WINCOIN)

Held on 24th July, 2023 in Hybrid mode

at ICFRE-Institute of Wood Science & Technology (IWST), Malleshwaram, Bengaluru

Welcome – By Dr. N.Palanikanth, IFS, HoD Extension, ICFRE-IWST, Bangalore

At the outset Dr. N. Palanikanth, IFS, Head-Extension, ICFRE-IWST welcomed the Director General, ICFRE and Chairman of ICFRE-WINCOIN, all Deputy Director Generals of ICFRE, all the Directors of ICFRE Institutes, wood industry members, stakeholders, representatives of wood industry associations, experts in relevant field of wood science, tree & genetic improvement from each institute of ICFRE, Dr. M.P. Singh, Director, IWST and Member Secretary of ICFRE-WINCOIN, Forest Officers and Scientists attending online and offline. He further said that ICFRE-WINCOIN is a unique platform comprising of all wood industries associations along with officials and Scientists of ICFRE that would bring synergy in the field of wood science, tree improvement and others, relevant to wood research, which is beneficial to the wood industry, farmers and stakeholders.

Dr.Palanikath, IFS, Head-Extension welcomed Dr. M.P. Singh, Director, ICFRE-IWST and Member Secretary of ICFRE-WINCOIN to give an introduction to the structure and scope ofWINCOIN to the august gathering.

Introduction to the Structure and Scope of WINCOIN - By Director, ICFRE-IWST & Member Secretary, ICFRE-WINCOIN

Introduction to the Structure and Scope of WINCOIN - By Director, ICFRE-IWST & The Member Secretary extended a warm welcome and greeted the Director General, ICFRE and Chairman of ICFRE-WINCOIN, Shri. A.S. Rawat, IFS; DDG Research, DDG Administration, DDG Extension and DDG Education of ICFRE; Directors of ICFRE Institutes; Wood-based industries stalwarts Shri. Sajjan Bhajanka, Shri. Jaydeep Chitlangia, Shri. J.K. Jain, Shri. Moiz Vagh, Shri. Jikesh Thakkar, Shri. Navneet and all the wood based 3 industry representatives who had gathered to the First ICFRE-Wood Industry Committee of India (WINCOIN) Meeting.

He expressed his delight to see a very positive response from the industries for this first meeting both online and offline and proceeded to expound the genesis of this ICFRE-WINCOIN platform, born from long-term and strong association of wood based industries particularly panel product industries with the erstwhile IPIRTI, which now stands merged with IWST, for the continuing interaction of research institutes with industries for the R&D needs of this important sector.

He expressed that the ICFRE-WINCOIN platform has a much wider scope as it is not restricted to only wood panel industries but also to other wood based industries like solid wood processing industries, handicrafts, furniture, etc. ICFRE being the apex body dealing with forestry research has a pivotal role in augmenting wood production in the country in order to bring the sustainability in this sector. This platform will also provide an immense opportunity to the wood based industries and allied sector to interact with the other institutes of ICFRE which have Pan-India presence from Jodhpur to Jorhat and Shimla to Coimbatore. This association would help industries to participate in research and development, putting up the issues faced by the industries for the solutions and help

ICFRE scientists in formulating research programmes based on the requirements of the industries.

He mentioned that the industries who were the lifetime members (11 members) of erstwhile IPIRTI Society became the industrial member of ICFRE-WINCOIN and annual members for the year 2022-23 (42 industrial members) were also requested to extend their membership for this committee. He also urged all other wood-based industries including bamboo based industries, associations and allied sector to join ICFRE-WINCOIN for which the application form and membership details has already been circulated to the industries. He further informed that the WINCOIN platform will offer host of benefits to the industrial member like technical support services, providing solutions to common problems through regional workshops and interactive sessions, preference in providing trained manpower to the member industries, special focus to the problems and needs of the industries in ICFRE R&D projects, standardization and testing services, priority of testing services, providing IWST Wood is Good magazine.

He further informed that the close tie-up of erstwhile IPIRTI with industries has led to many positive developments in the past and the suggestions and inputs of the members in the Annual General Meetings of IPIRTI Society were taken up with full sincerity. He emphasized that the efforts for development of certification of Agriwood and development of Indian Forest Management Standards which were suggested by FIPPI and other wood based industries has been taken up. Implementation of these standards would be extremely beneficial for industries to have certified materials. The proposal to revise wood based industries guidelines has already been circulated by the Ministry for obtaining opinions from State Forest Departments and stakeholders.

He also mentioned that Institute has taken steps to address the issues raised by the Industries like skill manpower, by introducing industrial internship to the Post Graduate Diploma students of Wood and Panel Product Technology and increasing the number of students from this year and also revising the syllabus and structure of the training programme as per the changing requirements of the industries.

He then assured the gathering that the created platform will be mutually beneficial to institute, industries and all other stakeholders and bring in synergy in sustainable wood utilization the country, as this platform would be crucial to take laboratory scale research to the industrial scale for realizing the value of R&D efforts.

In his closing words, he urged the gathering to consistently support and participate for development of this important sector.

Inaugural address - By DG, ICFRE & Chairman, ICFRE-WINCOIN

Dr. N. Palanikath, IFS, Head-Extension welcomed Dr. A.S. Rawat, IFS, Director General, ICFRE, Dehradun for inaugural address of the meeting. The Director General, ICFRE in his inaugural address welcomed Director, IWST, Director, FRI, Director of other ICFRE institutes, All DDGs of ICFRE, Senior scientists of ICFRE institutes and representatives of Wood based industries to the First meeting of ICFRE-WINCOIN.

He appreciated the efforts of formation WINCOIN and brought to the notice of the gathering that with a merger of Indian Plywood Industries Research and Training Institute (IPIRTI), Bengaluru with Institute of Wood Science and Technology (IWST), Bengaluru (as per the 5 notification of Ministry of Environment, Forests and Climate Change (MoEF&CC), Govt. of India), all branches of wood science and technology has been brought under ICFRE-IWST. This merger would be highly beneficial as on one side ICFRE-IWST has strong scientific base and on other side IPIRTI has technology foothold and strong association with wood based industries. This would overall strengthen wood science research.

He was happy that after the merger, a readymade association of IPIRTI has joined hands with ICFRE. He suggested to have the committee at ICFRE level, so that not only ICFRE-IWST, but other institutes of ICFRE like FRI, Dehradun also gets benefitted from the association.He informed that though ICFRE is involved in diverse aspects of wood research, but without the support of stakeholders, the dissemination of research resultis possible. He informed that ICFRE-FRI has been carrying out research for over 100 years and has generated voluminous data on timber and recently on plywood also, which has benefitted the wood industries in the past. However, he was concerned that of late, the association of ICFRE with wood based industry is not that strong which could be due to easy availability of technology from abroador any other constraints. He was hopeful that with the formation of larger forum of WINCOIN, the issues hampering the growth of wood based industries and the research needs of industries with ICFRE institutes would certainly be discussed and solved.

He brought to the notice of all industrial members that ICFRE has been developing varieties & clones of many species which are being used by the wood based industries and are also beneficial to the farmers. He emphasised the need to explore new local species and opined that wood based industries have crucial role in terms of testing and taking forward the research of ICFRE. He informed thatat present ICFRE has developed clones & varieties of Eucalyptus, Poplar, Melia, Dalbergia, Casuarina and is working ontree improvement aspects of 13 species and in another 5 to 6 years varieties & clones of these species would also be available.

For popularization of varieties and clones He further mentioned that, ICFRE institutes like IFGTB, Coimbatore & FRI, Dehradun has developed associations with industries like paper industry and plywood industries by providing technology for propagation of QPM. For further outreach there is a need of larger association with all wood based industries, so that the research reaches the public and industries. The impact of tree improvement research of ICFRE can be assessed by the fact that the tissue culture raised plantlets of teak by ICFRE-IFGTB and seedlings of Melia from ICFRE-FRI has been planted in Chhattisgarh & Madhya Pradesh.

He emphasized that ICFRE is promoting agroforestry and developed various models and some of the models are practiced by the farmers and many more models are being tested in the fields. He felt that there are many issues related to wood, plywood, Bamboo which needs to be addressed by research institutes, he requested for association and cooperation of industries in testing and validation of various research works.

He opined that there are many areas in which collaborative works can be carried out, especially the development of varieties & clones of local species, sustainability aspect of the material for the wood based industries, testing of products developed by the industries. He further informed that the issues pertaining to certification of wood is being discussed at higher levels and once the framework is developed, it will benefit the wood based industries in exporting the products developed by them to foreign countries. In terms of training and man power for wood based industries, FRI deemed university has been conducting M.Sc. Course on Wood Science and Technology and ICFRE-IWST & IPIRTI has been conducting diploma courses. ICFRE is also ready to take up skill up gradation courses as per the requirements of the industries. In terms of policy issues, ICFRE has a Policy Research Cell at ICFRE-HQ, Dehradun which with collaboration of other institutes can take up policy issues hampering the growth of wood based industries.

He concluded that in this meeting with the suggestions of wood based industries and other participants many more areas of research and collaboration would emerge. Through this association he was hopeful of strong partnership between the ICFRE and the wood-based industries to address the challenges and opportunities that lie ahead.

Presentation on the Benefits to the Members/ Industries through ICFRE & its institutes

- By Dr. Geeta Joshi, ADG Media & Extension, ICFRE

Dr. Geeta Joshi, ADG Media & Extension, ICFRE presented about the facilities and services provided by the Institutes of ICFRE. The presentation covered the key thrust areas of research, various technologies, patents, training, testing/consultancy services offered, the infrastructure and equipments available, education, database/ collections and quality planting material provided by ICFRE and the germplasm and xylarium, etc.available with ICFRE and highlighted their potential benefits to the wood industries and farmers.

Presentation made is given as Annexures to this proceedings.

Presentation on "Meeting human resource needs of industry through revised PGDC programme in wood and panel products technology"

– By Ms. Sujatha. D, Scientist-G, HoD PPPT Division, IWST, Bangalore.

Ms. Sujatha. D, Scientist-G briefed that the institute had received suggestions during the annual general meeting and campus interview from various panel industries to provide hands on training at commercial level for the students undergoing Post Graduate Diploma Course in Wood and Panel Products Technology at IWST. Based on their inputs, syllabus for the Post Graduate Diploma Course in Wood and Panel Products Technology were modified to module form comprising of 8 modules with the time duration of 47 weeks and implemented for the present batch of students in January 2023. She updated the detailed topics covered under each module of the course and highlighted that from the present batch the students are given an opportunity to have industrial attachment/ Internship for a duration of 12 weeks. This hands on training under internship program would enhance the industrial work exposure to the students and also provide them the experience to handle with the industrial production. Till date with the support of the industries participation for campus interview, the institute has been successful to provide 100% placement for the diploma holders.

Open-end discussion (Views / comments of Industry, DDGs, Directors of ICFRE Institutes

The session was open for interactionto the Industrial members, stakeholders and Association representatives to put forth their views and comments.

Member Secretary welcomed Shri. Sajjan Bhajanka, Chairman of FIPPI to open the session by presenting his views.

1. Shri. Sajjan Bhajanka, Chairman of FIPPI, thanked DG, ICFRE for giving the opportunity to express his views in this forum. He was delighted that such a big platform is available now, earlier the platform was confined to IPIRTI alone, now with the addition of IWST-ICFRE, FRI & other institutes, the possibility of growth and synergy are fast and immense. In the past, IPIRTI played an important role in helping industry in making plywood, in making cheaper glue and providing testing facility and most important training facility. Earlier, IPIRTI was the only institute which developed manpower for the industry. He emphasized that wood industry has

grown enormously in spite of fact that we are nowhere near to China but still there are more than 2000 manufacturing units in country which needs activity on bigger scale.

He was delighted to hear, so many tactics, techniques in plantation &in other things are developed by various institutions under the ICFRE, but apprehensive that nothing is percolating to industry going downward. At present, the country is facing scarcity of timber. In North India,many of the timber prices have tripled in last 2 years and again several timber species especially plantation timber species are not available. More or less 8 South India also has scarcity which is increasing rapidly. So the need of the hour is giving the country, some fast growing species and more important is percolating the techniques downward to the farmer, to the industry, to make joint forum with industry to help farmers. The institutes through industrycan go ahead and train the farmers to grow the timber species which are fast growing and which gives more timber volume because the per hectare productivity in India is almost 1/3rd in comparison to China and many other developed countries.Sowe need to do certain things very fast and on the wider scale to make sure the techniques developed reaches the farmers and industries and the way we are doing things is not up to the mark and needs improvement.

He further mentioned that, we don't have facility for MDF, particle board and for other new emerging technologies in laboratory scale, 40-50 crores will be required to establish a laboratory level program for this research and this can be kept aside as of now because there are other issues to be resolved especially in plywood, like need of better glue, cheaper glue we need techniques to use a very low diameter material to manufacture veneer and many other techniques. He further informed that we are in right direction and we need to make sure this technology available wider in scale and we can take this techniques to people and to industry.

He thanked DG, ICFRE for emphasising on fast growing timber and more yielding species which is on right direction and the country needs it because our total plywood production is only 5% in comparison to China. China's production is 200 million cu.m/annum and India production is only 10 million cu.m/annum. On the thrust for housing, we requires more and more plywood material and we have to prepare ourselves and we cannot import timber from anywhere so we need to focus on growing our own timber in near future. In this regard he expressed for a concentrated effort making a task force involving all institutes is the need of hour.

Member secretary thanked him and expressed the need of association between institutes, industries & farmers to augment the raw materials especially taking the high yield varieties and clones to farmers. He further informed that the issue will be worked out and will be put forward before the industries especially FIPPI so that we can take forward the issue.

Next, the member secretary requested Directors/ Scientists of ICFRE institutes to put forward their comments.

2. Director, FRI congratulated ICFRE for constituting this platform wherein, ICFRE institutes can share their research works to industries and industries can share their research requirements with the institutes. With respect to research in FRI, she informed that good quality germplasm of Melia dubia has been developed by FRI and being used for propagation by

farmers and industries. FRI also provides trainings to wood based industries and they can take up customised trainings to industries as per their specific requirements and full-fledged M.Sc.course in wood science and technology is being provided.

3. Director, IFP, Ranchi informed that they have developed clones of Poplar especially for North Bihar area and extensive plantation of Poplar has been carried out by farmers. Further he suggested for industry partnership in propagating the clone. Further, he informed that Agroforestry models have been developed and in partnership with Forest department, Bihar these are being implemented in farmers field. In this regard Shri. Sajjan Bhajanka, Chairman FIPPI further suggested to bring it in larger scale and seminar/workshop with industries needs to be organised to sensitise them and taken to farmers for mass propagation.

4. Dr. Shivakumar, Sceintist/representative of IFGTB said that generally poplar, eucalyptus, Melia dubiaspecies are being used for plywood. Many farmers request to suggest local species which could be used for manufacturing plywood and need to identify other local species to be propagated. Member secretary requested him to flag some of the clones of the species which requires up scaling, so that industries can take note of them and come to IFGTB for up scaling. He informed that recently IFGTB has taken up research on indigenous species like Diospyros ebenum, Xyliaxylocarpa & Chloroxylonswietenia which can be taken up for planting in farmer's 10 field. Collection of germplasm from natural forests is on progress and clonal selection is yet to start.

5. Shri. Suresh Bahety, Editor-in-chief, Ply insight requested for cooperation of IWST for resource/technology, which would address the issues of wood industries and farmers of Yamunanagar. He also requested for branch of FRI or other institutes at Yamunanagar so that requirement of Yamunanagar can be taken up. He requested for ease of communication between ICFRE Scientists and farmers. The Director, IWST replied that establishing new institute specific to Yamunanagar will be difficult, however ICFRE institutes can take up the research needs of Yamunanagar wood industries whenever required.

6. Dr. Sawar Dhanania, Chairman, Rubber Wood, Kerala thanked the chairman for constitution of this platform which provided an opportunity to introduce rubber wood to the industries which can also be used for timber &plywood. He also informed that recently MoU has been signed with ICFRE for research on Rubber wood. He informed that countries like Srilanka and Malaysia has taken up huge rubber wood plantations and furniture using rubber wood and exported to all over the world including India. Further he suggested that the rubber wood technology should be on par with that of Malaysia and European countries. He mentioned that near Kottayam, Kerala around 400 plywood industries have come-up as the demand for plywood is increasing and using rubber wood as raw material. He also informed rubber wood plantations are available at Assam where industries can come up using rubber wood. Tripura Forest Development Corporation has been using furniture's from Rubber wood for last 10 years and hence the potential for rubber wood is enormous. He suggested that Rubber wood in collaboration with ICFRE can give training to farmers on growing rubber wood and bring in more awareness among famers about the use of rubber wood in plywood manufacture and can indulge in research on rubber wood through their Rubber Research institute. He also requested education wing of ICFRE to give focus on research and training on the process aspect of rubber wood to be made into furniture's. He also requested for partnership with ICFRE and industries on rubber wood research.

7. Shri. Jinendra Jain from Greenply industries informed that they wanted to go for demonstration & research plots with pure germplasm and contacted many research institutes to supply authentic germplasm and the response was so poor. He expressed his concern that it is difficult to get the germplasm even for demonstration plots and requested for intervention in right direction to resolve the issue. He also suggested for introducing carbon credits to the farmers so that they can get benefitted through it.In reply, ADG (M&E) ICFRE informed that we are encouraging the demonstration plot and the issue raised by him will be looked into and resolved at the earliest. Member secretary assured that ADG (M&E), ICFRE will be nodal point to industries in this aspect of coordinating and supplying quality germplasm to industries.

8. Shri. Rajashekar, Timber Federation appreciated the initiative of ICFRE to organize the first meeting of ICFRE-WINCOIN members which will strengthen the unity.He suggested to consider having the meeting on weekends so as to enable all industries to attend the meeting. Further he highlighted the research requirement on the subject of phasing out

of the hazardous chemical methyl bromide (mBr) and to resolve the issue in plant quarantine department and requested the scientist of ICFRE to suggest an alternative chemical to methyl bromide. He requested for changes in import policy of timber as only few species of timber are allowed for import whereas in the form of furniture, the restriction on the same species is not there which negatively affects the wood industry and only cheaper species are allowed for import. Also, he requested for plant protection unit at Hyderabad with minimum manpower which would simplify the import and export of timber. He mentioned that timber is the only renewable raw material used in construction field hence the export and import of timber should be made user friendly.He also expressed that studies on soil testing and the species suitable in respective states shall be explored.

9. Director, AFRI, Jodhpur, mentionedthat handicrafts wood industries in Jodhpur is one of the biggest employing around 1 lakh people and there are around 250 small scale industries at Jodhpur. They export annually around 400-500 crores. AFRI had an interaction with the handicrafts association and found thatthe technology used by them is much ahead than technology available with ICFRE, hence he suggested to open up research in new and superior technology than what the industry uses. He also mentioned that around 85% of timber is used from India and 15% of the timber is imported from China, Malaysia.Dalbergia sissoo/Shisham along with mango wood and Acacia are used by the handicrafts industries.He informed that the handicraft industry people has an issue related to exporting Dalbergia sissoo handicrafts to abroad, which is restricted under CITES and need for single transit pass for transport of timber. Further he informed that AFRI has developed 3 clones of Dalbergia sissoo and transferred CPTs of Neem, Ailanthus to farmers which can be grown at field and fast growing in arid regions. He further informed that AFRI is open to any collaboration with industries in these fields. Member secretary informed that IWST had a visit to handicraft units at Jaipur to understand the problems and working on it. Further informed industries to contact AFRI if they want quality clonal material to be raised in the region of Rajasthan and Gujarat.

10. Shri. Dwara Ramakrishna, General Secretary, Timber federation suggested to use indigenous wood as far as possible in the wood industry and there is urgent need to identify agroforestry plantation spp. all over the country. Also, requested ICFRE scientists to suggest more and more indigenous species of timber to be used in the wood industry. He requested to provide solution to the termite attack on wood which deteriorate the wood, which is the main reason for decreased percentage of usage in wood in building construction. He requested to throw light on the use of sawdust in 12 manufacture of particle boards/briquettes, so that the wood industry/ sawmills are benefitted by using the saw dusts.

11. Shri. Naval Kedia, President of Timber federation requested for popularising the few species that were being used earlier in handicraft industry such as haldu, kadam and encourage the farmers to take up plantation of these species. The concept of wood seasoning, use of modern machinery, saw-milling to be made popular to carpentries of handicraft industry vide training and demonstrations. He requested for providing training online to the farmers and wood industry carpenters. The Director, IWST said that efforts will be made to provide the same. He also suggested to reprint the old books on carpentary which is available with the institutes.

12. Shri. Subhash Jolly, President, Wood Technologist Association thanked for the gesture of organising this meet. He informed that as suggested by Sajjan Bhajanka, there is need to increase timber wood production for the wood based industries since, one third of the industries are closed due to increase in rates of timber and focussed effort is required for increasing the timber production through farmers field.

13. Shri. Jikesh Thakkar, vice president, M/s, Rusil Decors/President, All India panel manufacturers Association, highlighted the shortage of skilled labour in wood industry especially in panel industry and IWST can increase the number of trained advanced wood workers. The platform should be used for discussion on policy issues and providing technology research support to industries.The Director, IWST said that a meet will be organised shortly with the wood industries regarding the certification of farm wood and app which is being developed by IWST for certification which is beneficial to the wood industries. Jitesh Thakur further informed that in years to follow, the growth of wood based industries will be manifold and requirement of skilled manpower is essential. Director, IWST ensured that short term courses will be initiated to resolve the solution of manpower.

14. Shri. Arjun Patel from Federation of Karnataka chambers of commerce and industry requested to bring farmers and wood industry people together so

as to put-forth which species of timber have to be planted as per demand.

15. Shri. K.N. Murthy, Retired Forest Officer suggested to educate the farmers to take up plantation of timber species, which is in demand especially Melia dubia. ICFRE to transfer the required technology and methodology for the same and bridge the gap between demand and supply. He suggested bringing in the concept of rate contract with the industry and farmers.

16 Shri. Navnit Gujjar, M/s. Kandla Timber, President of Karnataka Timber Association informed that the forest policy implemented at Gujarat is user friendly 13 and requested to bring the same forest policy in Karnataka. He requested to establish an unit/branch at Kandla and to impart trainings to the local people.

17. Dr. C.N. Pandey, Technical Advisor , FIPPI insisted on creating a database of wood species used region-wise in the wood industry and requested to transfer the technology/use of advanced machinery in sawmills and wood industries. He expressed that ICFRE should take up the Certification of Nurseries so that the farmer will be confident to purchase the saplings.

18. Shri. Ashish Mishra from Greenlam industries expressed his views as follows :

a. Need for dedicated R&D by ICFRE Institutions to evolve new breed of Clones, Species & Hybrids that are "tailor made" for Panel & Ply Industry. WINCOIN could play an anchor role in initiating Industry-Institution Collaboration on specific projects identified through subject-specific workshops.

b. Need for an online "National Agroforestry Research Online Repository" wherein all stand-alone R&D projects completed / underway w.r.t. Agroforestry at all institutions of ICFRE & Industry are displayed for Public access. This will avoid repetitive R&D and quick solutions to many issues faced by users at ground level. This could be developed as subscription based platform operated, handled and managed by WINCOIN.

c. Need to influence and re-orient the production and supply chain models of FDCs to include Timber & Panel-Wood as a separate product. Currently all FDCs are managing & operating their plantations & wood supply chains mainly to supply "Pulpwood" to Pulp & Paper Industry. The present and ever expanding humongous demand from Panel & Ply Industry has not been taken in cognizance of FDCs so far.

d. Need to form regional chapters / sub-committees of WINCOIN for addressing needs related to specific regions. The WB Industry being too large, versatile, fragmented and geographically spread out all over the country, the multipurpose needs can be better addressed if assimilated at smaller regional level rather than through a PAN India endeavour.

e. Need to have modern "Model Mother Nurseries" at ICFRE Institutions to propagate and provide Mother Plants for Industry / Private Nurseries from where the Clones can be provided for testing and mass multiplication by entrepreneurs, farmers, Industries for supplementing to Farm Forestry / Agroforestry programs.

Further he informed that, the meeting was very interactive and that he looks forward to the leadership of IWST for organizing more regular meetings, region wise seminar / interactive meet with the industries and reassured his continued support and active participation in the overall interest of WINCOIN and Wood Based Industries

19. Shri. M.P.Khemka from TUFWOOD doors requested to introduce incentive scheme as an encouragement to the farmer to plant timber species, which are in demand.

The Member secretary ensured that the views/comments of the industrial members will be considered and WINCOIN will help in resolving some of the issues faced by the wood industry. He also encouraged industrial members to come forward with their issues, so that research can be oriented on line with the requirements of industry and for transfer of technology.

The meetingof the WINCOIN ended with vote of thanks by Dr. Shakti Singh Chauhan, Scientist-G/HoD-WPP Division. He thanked the Chairman, Member secretary, DDGs of ICFRE, Directors of all institute, all the industrial members, Wood industries association members, stakeholders for making the first meeting of ICFRE-WINCOIN a grand success.

Actionable Points for ICFRE and its Institutes with respect to the First Meeting of WINCOIN held on 24/07/2023

The first meeting of WINCOIN under the chairmanship of DG, ICFRE was held on24/7/2023 at ICFRE-IWST on hybrid mode. Around 140 participants including industrialmembers, representatives of wood industries associations, officers, scientists & scholars attended the meeting both online and offline and interacted on issues related with WINCOIN and its role in the promotion of wood based sector in the country.

Based on discussion held during the meeting followings are the main actionable points for the ICFRE and its institutes:

1. Tree improvement programme should focus on species required by wood based industrieson regional basis.
2. Promotion of high yielding clones/varieties of fast growing species developed by ICFRE among the farmers through industries to meet the demand of raw materials of the industry.
3. Nursery should be created at every Institute for supply of quality planting materials to the industry and other stakeholders.
4. ICFRE should take up certification of nurseries for quality planting material.
5. MOUs with the wood industries may be signed w.r.t. plantation programme based on superior clones/ varieties of ICFRE.
6. Revision of existing training programmes. Efficient and skilled human resource development and skill upgradation of the existing staff for the industry through focused/tailored short-term training programmes in hybrid/online mode.
7. Percolating research outcomes from the fields and labs to the factories through frequent interactions including regional seminars with industry, farmers and other stakeholders.
8. Development/revision of wood testing standards based on research findings of the institutes
9. Technical support for policy matters related with wood based industries through policy research cell of ICFRE with collaboration of other institutes
10. All the institutes should be brought under "Treegenie" platform
11. Directorate of Plant Protection, Quarantine and Storage may be part of future meetings of WINCOIN.
12. Circulation of periodicals, magazines, books and other information to the industry and other stakeholders through emails, social media, website and other means.

Highlights of the Tour of Dr. Madan Prasad Singh, Director, IWST and Dr. B.N. Divakara, Scientist - F&PI of Indo-German Project IWST, Bengaluru to Germany from 19th to 29th June, 2023

A research visit was conducted to Germany from 19th to 29th June, 2023 as part of ongoing project entitled "Spatio-temporal landuse patterns at rural-urban interface and the relationship between green areas and biophysical features – Phase II" funded by Department of Biotechnology, Govt. of India, New Delhi.

20-06-2023

Meeting was held with Dr. Uwe Muuss, Director, International office and Dr. Netra Bhandari, Director India Office, Georg-August University, Goettingen. The main objective of the discussion was to explore the possibility of coordinating and supporting the academic exchange activities and research cooperation projects.

In the afternoon, visit was made to Institute of Forest Inventory and Remote Sensing and met German Counterpart Prof. Christoph Kleinn, the Director of the institute and Dr. Neils. In-depth discussions was held on the progress of ongoing research work in phase II, further plan of work with the collaborating objectives and preparation of final report of the ongoing project. Discussion was also held about identify and advance manuscript ideas and drafts of joint scientific publications.

Further discussion was held with Prof. Dr. Carsten Mai, Senior Scientist, Wood Biology and Wood Products division, Georg-August University on works related to wood science and exploring the possibilities of collaboration with IWST. Visit was made to the facilities of the division and information on the activities going on in the division was collected. They explained in detail about the work on particle boards, fiberboards, oriented strand boards, plywood and laminated venner lumber boards. The research on binders and recycling of wood based panels, chemical and thermal treatment of wooden materials and importantly lightweight designs in wood were very well discussed.

21-06-2023

Visit was made to Northwest German Forest Research Institute (NW-FVA), Goettingen and discussed with Prof. Dr. Matthias Albert. They are having core competency on Applied forest research, Long-term monitoring and Knowledge transfer directed towards the requirements of practical forestry. The major focus of priority research topics are as follows;

a. Adoptation strategies to climate change
b. Forest risk management
c. Securing timber supply
d. Securing biological diversity
e. Operational control

The NW-FVA is a joint research organisation for the states of Hesse, Lower Saxony, Saxony-Anhalt and Schleswig-Holstein. The NW-FVA is responsible for applied forest research and for advising forest owners, forest enterprises, administrations and politics in the participating states. It is in charge of 2.7 million hectare of forest, which comprises almost a quarter of the forests in Germany. At its two locations in Göttingen and Hann. Münden, 135 permanent employees are serving the forest estate and its owners. A varying number of temporary employees are also engaged for short-term projects.

The NW-FVA is divided into five departments: Forest Growth, Forest Protection, Forest Genetic Resources, Environmental Control and Forest Nature Conservation. The core competencies of the NW-FVA are long-term monitoring, applied research and the transfer of knowledge. Their remit is orientated to the needs of forestry practice. Climate change, globalisation and the increasing demands of society on the forest are among the main challenges today and for the future. The complex issues which arise are tackled in interdisciplinary teams, both within the NW-FVA itself, and in collaboration with other research institutes and universities in Germany and across Europe.

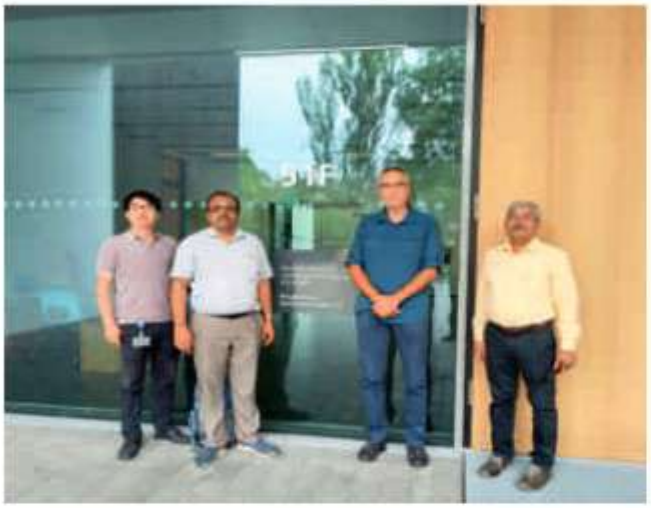
Afternoon visit was made to Old Botanical garden of Goettingen University. The Old Botanical Garden is as old as the University of Gottingen itself and is still located on the same site. It was founded in 1736 as a "hortus medicus", because botany ("herbalism") at that time was primarily the study of medicinal plants and was practiced by physicians and pharmacists. The founder and director of the garden from 1736 to 1753 was the famous physician, botanist and poet ALBRECHT VON HALLER (1708-1777), who collected plants in the Alps and in the Harz mountains for the botanical garden and also had a first "Gewächs-Saal" built a few years after its foundation. With the interest in colonial goods and the voyages of discovery to distant parts of the world, botanical gardens became receiving stations for countless exotic plants that were still unknown to science, and botany developed from the auxiliary science of medicine to the study of the structure and life of the plant and the diversity of plant species. Botanical gardens contributed significantly to this development. The Göttingen Botanical Garden has always had particularly species-rich collections, and so until the middle of the 19th century adjacent plots of land had to be purchased several times, first inside, later also outside the Stadtwall. 3 tunnels connect the greenhouse area with the open land beyond the rampart.

It has two parts, the Old and New Botanical Gardens form a single unit whose parts work hand in hand: In the New Botanical Garden, visitors can take extended walks through the Alpinum, forests of North America and Japan, herbaceous plants, flower meadows, a vineyard, and a rose garden, and open spaces and climate-controlled experimental greenhouses are available for ecological-plant sociological research conducted by the Department of Ecology and Ecosystem Research. In the Old Botanical Garden, a large variety of hardy and tropical plant species can still be found in display and collection houses, which are used intensively for teaching and research by the Department of Systematic Botany

22-06-023

Visit was made to Fraunhofer Institute for wood Research (Wilhelm-Klauditz-Institute WKI) and had a meeting with Prof. Dr. Ing. Bohumil Kasal, Director WKI, Dr. Tunga Salthammer, Deputy Director WKI, Dr.

Stefan Friebel, Dr. Erik Uhde. They explained about the divisions and showed all the activities happening in the institute.



The Fraunhofer WKI specializes in bio-based chemical products and materials, production technology, functional integration, lightweight construction, material and product testing, recycling processes and indoor air quality. Almost all processes, materials and products resulting from our research activities are used industrially. We operate worldwide and work project-related with research institutions and industrial partners, e. g. with companies from the wood and furniture industries, the construction industry, the chemical industry, the packaging industry and the automotive industry. Our particular strength is our holistic research approach. We develop materials and technologies for a bio-based, resource-conserving and climate-friendly economic cycle - from raw materials to development and quality assurance to recycling.

Sustainability has been the focus of the Fraunhofer WKI since it was founded in 1946. The founder and namesake Dr. Wilhelm Klauditz was looking for solutions to make optimal use of the scarce supply of raw wood caused by the war and to make waste and small wood technically usable. He is regarded as a co-founder of the modern wood-based materials industry.

At the Fraunhofer WKI, we look at a wide range of renewable raw materials and their holistic use from production to recycling. A particular focus is on sustainable lightweight construction solutions. Our holistic research approach also includes the development of material recycling processes, life cycle analyzes and indoor air analysis.

Almost all processes and materials that result from the research activities of the institute are used industrially. The customers of the Fraunhofer WKI include companies from the wood and furniture industry, the construction industry, the chemical industry, the packaging industry and the vehicle industry. With its research and development, the Fraunhofer WKI makes an important contribution to the development of a bio-based circular economy (bioeconomy).

As an accredited test center, the Fraunhofer WKI carries out material testing and quality monitoring tasks. It appraises cases of damage and advises on questions of damage restoration. The quality assurance of wood products and other materials using non-destructive methods such as thermography, ultrasound or computer tomography expand the spectrum of the institute.

With the application center for wood fiber research HOFZET ® and the integration into the Open Hybrid LabFactory, the important promising new area

of fiber composites is currently being systematically supplemented and expanded. Together with the Technical University of Braunschweig, the topic of building construction and lignocellulose-containing materials are being strengthened in the center for light and environmentally friendly buildings ZELUBA .

Since October 2010, the Fraunhofer WKI has been headed by Professor Dr.-Ing. Bohumil Kasal. Prof Dr Tunga Salthammer acts as his deputy. The institute was incorporated into the Fraunhofer Society in 1972 and with around 175 permanent employees and an operating budget of 16 million euros, is one of the largest institutions for applied wood research in Europe. Around 8,600 m 2 of offices, laboratories, technical center and workshops are available for processing research orders.

The Fraunhofer WKI is a member of the Fraunhofer Group for Materials and Components – MATERIALS, the Fraunhofer Vision, Construction, Lightweight Construction and Textile Alliances, the Fraunhofer Networks for Sustainability and Science, Art and Design, and the Cultural Heritage Research Alliance. Within the Fraunhofer-Gesellschaft, the Fraunhofer WKI has a unique position with regard to the holistic research approach to the material use of wood and lignocellulosic materials.

They are working on following innovative field of research

a. Technology for wood and natural fiber based materials
b. Material analysis and indoor chemistry

c. Binders and coating
d. Quality assessment
e. Centre for light and environmentally friendly structures ZELUBA
f. Application center HOFZET

The main research highlights of WKI are as follows

a. Strand based hybrid material for structural components
b. Building product emissions and indoor air quality
c. New material for UV-curing processes
d. Material use of spruce calamity wood
e. Long-term behavior of adhesive bonded wood hybrid systems
f. Life-cycle analysis in plastic injection molding simulation

We presented the activities of IWST and discussed about the possible areas of collaboration.

24-06-2023

Met Indian Ambassador to Germany Mr. Parvathaneni Harish, IFS at Indian House, Berlin and discussed about the prospects of collaborating with German institutes working on wood science and technology. Afternoon, visited historical places in and around Berlin viz. Brandenburg Gate, German parliament building (the Reichstag), Berlin Wall, Berliner Don, Holocaust Memorial, Kaiser Wilhem Memorial Church.

27-06-2023

Visit was made to Bavarian Alps forest near Kimsee, Herren-insel, Frauen-insel, Gstatadt, Zauberwald and Koenigssee, Bavarian Forest, German Bayerischer Wald, mountain region in east-central Bavaria Land (state) southeastern Germany. The Baverian Forest accupies the highlands between the Danube River valley and the Bohemian Forest along Baveria's eastern frontier with the Czech Republic. Locatedlargley inthe Regierungsbezirk (administrative district) on Nieberbayern (Lower Baveria), the highlands parrelel the southeasterly flowing Danube for about 90 miles (145 km) from the Cham and lower Regen rivers to the Austrian border east of Passau.

The Bavarian Forest, occupying mainly granite and gneiss hills, is divided into two sections by a sharp quartz ridge known as the Pfahl. The ridge runs roughly along the Regen valley and ranges from 65 to 100 feet (20 to 30 m) in height. The Vorderer Forest, or Danube Hills, a rolling plateau situated to the southwest between the Danube and the Pfahl, seldom rises more than 3,300 feet (1000 m) above sea level, Medow, isolated farmsteads, and small hamlets dominate the landscap; only the higher and steeper slopes are still wooded. M=Northeast of the Pfahl is the Hinterer Forest, a higher and almost continuously forested mountain region where human settlement is confined to a few longitudinal valleys. Its highest peaks include the Groser arber, with an elevation of 4,777 feet (1456 m), and the Rachel, Lusen, Dreissselberg, and Frosser Falkenstein.

The climate of the highlands is severe and wet, supporting only modest yields of rye, oats, and potatoes produced on small valley farms. Coniferous forest predominates, with spruce the main species at higher altitudes and a mixed woodland of spruce, sliver fir, and beech found at lower levels. Lumbering, woodworking, and glass grinding are the principal industries. The tourist trade is expanding as the reputation of the Bavarian Forest as a beautiful and uncrowded holiday resort area spreads. Each year many visitors explore the Bavarian Forest National Park, where more than 98 percent of the park's 50.5-square-mile (130.8-square-kilometre) area is tree-covered and many species of

plants, birds, and small animals thrive. Principal towns of the mountain region are Regen, Zwiesel, Waldkirchen, and Grafenau.

28-06-2023

Visit was made to Department of Wood Science in Technical University Munich. The members of this focus area of the Life Science Engineering department are organized in the Wood Research Munich (HFM: Hilzforschung Munchen), which conducts coordinated research and development, and offers services with the aim of using wood as a renewable resource in a broad range of applications in a material-efficient, high-performance and sustainable manner.

Their work covers both fundamental and application-oriented approaches. It ranges from advancing the

biology, chemistry, physics and mechanics of wood as a material at different length scales per se, over systematic analyzes of the energy and material flows in the forestry/wood value chains to biotechnological applications of wood-degrading and -modifying fungi. The overarching goal is to scientifically advance the potential of forest products, and wood in particular, in the transformation towards a modern and sustainable bio-economy.

Learning/ Outcome of the visit

1, Reviewed the progress achieved in phase II of the project.

2, Planned for coordination in data collections and drafting of joint scientific publications in the second phase project.

3, Discussed about the possibility of future collaboration after phase II completion.

4, Discussed and exploring the possibilities of collaboration with.

a, Wood Science and Technology division, Georg August University on works related to wood science Fraunhofer Institute for Wood Research

b, (Wilhelm-Klauditz-Institut WKI).

c. Technical University Munich, Division of Life Sciences.

Wood Security: A Step Towards Aatma Nirbhar Bharat

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1. Introduction:

Forests provide timber for manufacturing of domestic and industrial products. During the British Rule, the forests were exploited indiscriminately to meet the demands of ship building, railways, etc. Even after Independence, the exploitation of forests continued which not only provided timber but also provided land for cultivation of agricultural crops to meet the shortage of foodgrains. The National Forest Policy (NFP) of 1952 enunciated that the forests would meet the raw material requirements of wood-based industries. The diversion of forest lands for non-forestry purposes continued unabated till 1980, which slowed down after the enactment of the Forest Conservation Act (FCA), 1980. As per the National Forest Policy (NFP) of 1988, the focus has shifted to conservation of forests and the wood based industries are bound to meet their demands of raw materials by establishing direct relationship with the farmers. During the late seventies and eighties, as per the recommendations of the National Commission of Agriculture in 1976, the states implemented externally-aided social forestry projects, which not only met the demands of timber but also led to popularisation of agroforestry.

2.0 Status of Forest Resources

As per the India State of Forest Report, 2021, the recorded forest areas (RFA) of India is 77.53 million ha, which is 23.6% of geographical area of the country. The area under Trees Outside Forests (TOF) is 29.29 million ha (forest cover outside RFAs -19.72 million ha plus tree cover - 9.57 million ha), which is about 8.9% of geographical area of the country. The total growing stock of wood in the country has been estimated as 6,167 million cum comprising 4,388 million cum inside RFAs and 1,779 million cum outside RFAs (TOF). The major timber species in forests include sal (*Shorea robusta*), teak (*Tectona grandis*), chir pine (*Pinus roxburghii*), (*Terminalia tomentosa*), fir (*Abies pindrow*), kail (*Pinus wallichiana*) and deodar (*Cedrus deodara*) (FSI, 2021). The most important species in rural areas that are important for wood production include mango (*Mangifera indica*), kikar (*Acacia arabica*), *Eucalyptus spp*, rubber (*Hevea brazilensis*), (*Grewia oppositifolia*), shisham (*Dalbergia sisso*) and poplar (*Populus spp*) (Anon., 2020b).

2.1 Availability of Timber

National Forest Policy of 1988 emphasized on conservation of forests, hence as a consequence, the annual harvest of timber from forests declined from 10 million cum in 1970s to about 04 million cum by 1990 (CSE, 2017). The landmark judgement of the Hon'ble Supreme Court in popularly known Godavarman case (1996) resulted in halt of felling operations in RFAs which were not under approved working plans, hence wood production from forests further reduced to 02 million cum annually . The supply of wood from forests, including Forest Development Corporations (FDC), is about 3.2 million cum (CSE, 2017). The demand of timber is mainly met from the TOFs, specially the agroforestry. As per report of the Forest Survey of India (FSI), the annual potential timber production from TOFs in our country was 85.2 million cum in 2020 (FSI, 2020). As the actual data of timber production from TOF, is not available, hence potential production of timber from TOF has been used. Secondly, the data regarding availability of timber from TOF, forests and imports are not available in same time frame, hence the estimated availability of timber is indicative only. The estimated availability of timber in the country, is as follows:

Table 1 : Timber Availability in India

Source	Timber (million cum)	Per-centage	Reference
Forests	03.2	03	CSE, 2017
TOF	85.2	82	FSI., 2020
Imports	15.0	15	Anon.., 2020a
Total	103.4	100	

As per the projections provided by WWF, the demand for Roundwood Equivalent (RWE) was expected to increase from 58 million cum (in 2000) to 153 million cum (in 2020) in our country (Anon., 2017). It is evident from the above table that there is a mismatch

between the demand of wood and its availability, which might be due to over estimation of projected demand, illegal removal of timber from forests and outdated data of availability of timber.

Table 2 : India, Roundwood Demand by Wood-based Sector, 2021-2030 (million cum RWE)

Year	Pulp & Paper	Furniture WBIs	Plywood & other	Construction	Total
2021	12.5	9.0	15.4	22.7	59.6
2022	12.5	9.5	17.9	21.8	61.6
2024	12.5	10.4	23.9	20.0	66.8
2026	12.5	11.4	32.1	18.1	74.1
2028	12.5	12.4	42.9	16.3	84.1
2030	12.5	13.3	57.5	14.5	97.8

RWE-Roundwood equivalent (Kant et al, 2021)

As per above table, the demand for wood for 'plywood and panel indusry' increases exponentially from 15 million m^3 in 2021 to more than 57 million m^3 in 2030. This increased demand of plywood will be mainly due to shifting of the demand of solid wood to this sector. It is a positive development for wood sector as it is quite difficult to produce large timber locally due to focus on conservation of forests, secondly solid wood is costly and thirdly it is easy to manufacture composite wood for which raw material may be easily produced by the farmers and fourthly production of wood from farmlands will increase the income of farmers.

3.0 Export and Import of Wood and Wood Products

3.1. International Trade of Wood

To meet the demands of large sized timber, the country has liberalized the policy of importing timber since 1990s. India has become second-largest importer of tropical logs in the world, and import of timber is about 6 million cum while there is a decrease in imports of roundwood logs from 6.1 million cum in 2014-15 to 4.4 million cum in 2019-20, and the import of sawn wood has increased from 0.6 million cum to 1.7 million cum during this period (Bansal, 2021). The top four species of timber imported by India are teak (*Tectona grandis*) gurjan (*Dipterocarpus alatus*), meranti (*Red Shorea spp.*) and beech (*Fagus spp.*) (Anon., 2017). The imports of timber are mostly from Myanmar, Malaysia and Indonesia. The sizeable quantities of hardwoods are also sourced from Central Africa (Nigeria, Ivory Coast, Ghana, Togo and Gabon), the Americas (Brazil, Panama, Papua New Guinea, Costa Rica and Ecuador), and even as far away as New Zealand (Anon., 2016).

3.2 International Trade of Wood Products

India not only imports wood products like plywood, veneer, particle board, fibre board, pulp and waste-paper, newsprint, paperboards and furniture but also exports most of them except for pulp and waste paper, and newsprint. The exports also include antique furniture, handicrafts, wooden toys and swings. The Indian handicrafts are very popular in developed countries namely, USA, Canada, Australia, Belgium, France, Germany, Italy, Netherlands, and UK. The cheap and skilled labour and large supply of timber species has made our industry as one of the important suppliers of handicrafts to the world market. This industry supports and provides major employment opportunities in rural India to over 05 million artisans (Anon., 2016). The Indian export and import of wood and wood products have shown a growing trend, however, value of exports is much less as compared to imports. India imported about 15 million cum of wood and wood products in 2017 and their worth was about Rs 44,119 crore during 2019-20 (Anon., 2020a, Anon., 2020c).

3.3 Illegally Logged Imported Wood

Although India strongly supports sustainable forest management, wood and wood products may be imported into India without certification. A study by the International Union of Forest Research Organizations shows that India is the third largest importer of illegally logged timber in the world, after China and Vietnam, and accounts for close to 10% of the global illegal wood trade (IUFRO, 2016). India's imports of illegally sourced timber and wood products increased dramatically during 2002-11, from one million cum to 3.5 million cum. (Anon., 2016). The imports of illegally sourced wood are logs from Sarawak (Malaysia and Indonesia) and Myanmar, and plywood, furniture and paper from China, and pulp and paper from Indonesia (Anon., 2016).

3.4 Forest Certification

Forest certification ensures sustainable cultivation and harvesting practices by following all the local, national and international laws applicable for such cultivation and plays a key role in promoting conservation of forests, secured livelihoods of the workforce, international trade in wood and wood products. The developed countries have put in place stringent verification processes for import of wood and wood products through forest certification. A 2015

WWF study estimated that it costs almost five USD (INR 410) per cum for certification in a natural tropical forest and another 3.5 USD (INR 287) per cum per year to maintain the certification. The same study assessed the benefits at around six USD (INR 492) per cum of round wood equivalent production, outstripping average annual costs and estimated opportunity costs. These benefits, however, rely partly on achieving a price premium for certified timber, but not all markets offer such a premium (Dietrele et al., 2020). Hence, voluntary certification of wood and wood products may be enforced in our country to ensure its trouble free international trade and eliminate the import of illegal wood and wood products.

It is important to note that more than three-quarters of India's timber products are exported to the countries that now have laws in place to restrict import of illegal wood and wood products (Bansal, 2021). There is, therefore, a need to put in place specific measures to ensure that India's imported raw materials and domestic wood used by wood based industries are legally sourced. The duty concessions on import of wood, sawn wood, and other wood products that are used for export after value addition through handicrafts/manufacturing, may be made (Bansal, 2021). The enforcement of voluntary certification of wood and wood products will also help the farmers in getting better prices for their timber. As the imported timber may become costlier in future due to its increased demand and strict enforcement of certification regime in exporting countries, so promotion of the composite wood panels may be the right strategy in the long run.

4.0 Self-Reliance in Wood Production

The raw material demands of composite wood panels and pulpwood based industries are generally met through farm wood, while the demands of sawn wood-based industry are met mainly through imported timber. India has already achieved self sufficiency in producing small sized wood from farmlands but still heavily dependent on imported timber due to deficiency of large sized timber from the forests. The Government of India has launched '**Atmanirbhar Bharat Abhiyan**' to reduce dependency on imports and encourage production of local products. For achieving self sufficiency in wood sector, the domestic production of large sized timber needs to be enhanced. Our country has sufficient land resources, favourable climatic conditions, technical know how and manpower to produce large sized timber, but adequate incentives to plantation companies, industries, farmers, etc., are missing for attracting the investments to this sector. Hence, the Government of India may formulate National Wood Use Policy under which National Wood Action Plan may be implemented in a time bound manner. The decision for raising medium and long rotation trees has to be taken on priority as the production of timber will start only after 10-15 years after the implementation of the action plan.

4.1 How to Increase Domestic Wood Production?

It is not in the interest of the country to continue the import of timber indefinitely, hence domestic production of timber needs to be enhanced.

4.1.1 Production of Large Sized Wood

The large sized wood is mainly harvested from the state forests but the focus of forest management has shifted towards conservation after implementation of National Forest Policy of 1988. The judgement in Godavarman's case by the Hon,ble Supreme Court in 1996, has further strengthened the policy of conservation of forests and the yield from forests has declined. The policy of conservation of forests needs to be reviewed keeping in view the increasing import of timber, and need for sustainable production of timber from forests.

4.1.1.1 Identification of Production Forests

If we exclude the area under national parks and wildlife sanctuaries which is 16 million ha, the remaining forest area is 60.74 million ha in our country. With much focus on conservation of forests, the yield from 60 million ha of forests is about 3.2 million cum only. Hence, the removal of timber from the forests is about 0.04 cum/ha/yr which is too low as compared to the world average productivity of 2.1 cum/ha/yr (Lal P, 2020). As per the National Working Plan Code, 10% of RFAs may be used for production forestry through quality plantations. Hence, about six million ha of forests can be safely reserved for production of large-sized timber (MoEFCC, 2014). In past the handing over of the degraded forests to the private sector was too cumbersome, but with recent amendment in Forest Conservation Act-1980, it may start yielding result. Initially 1% of forest areas (6 lakh ha) may be leased for raising medium (MRT) and long rotation trees (LRT) for attracting investment under Public Private Partnership (PPP) model. Forest corporations may also be incentivized to shift their plantations from short rotation trees (SRT) to Medium and Long rotation trees. A committee may be constituted to make recommendations regarding quality and quantum of lease rate of forest lands to be leased out to forest corporations, plantation companies and industries, and the required incentives like discounted loans, capital subsidies and tax concessions to be provided. The terms

of conditions for attracting investment in forestry sector may be proposed in such a manner that they are comparable to returns from existing avenues of investments available to investors and also covers the risk of plantations which are living entity. If this strategy works, larger areas of degraded forests may be leased out to private sector for raising productive plantations through intensive management.

4.1.1.2 Production of Large Sized Timber from Forests

Presently, 1.28 million ha of forest lands have already been leased out to 11 Forest Development Corporations (FDC) in the country (CSE, 2017). Keeping in view the shortage of large sized timber, it is proposed that FDCs may be incentivized to raise medium and long rotation plantations only, which may produce large sized timber. To increase the production of large sized timber from forests, the annual incremental yield from production forests needs to be harvested. But there is lot of resistance from environmentalists and bureaucracy in felling the natural forests or green felling of trees and there is excessive biotic pressure on natural forests, hence production forests need to be delieneated.

4.1.1.3 Production of Large Sized Wood Timber Farmlands

Keeping in view the resistance against leasing out degraded forest lands to the private sector, the other alternative is that the cultivation of medium and long rotation trees may be promoted on farmlands under contract farming, as there is about 35 million ha of farmers' owned uncultivated wastelands and current fallows (CSE, 2017). The plantations may be raised under the following two categories:

I. Medium Rotation Trees

The plantations of gamhar (*Gmelina arborea*), kadam (*Anthocephalus cadamba*), silver oak (*Grevillea robusta*), kikar (*Acacia arabica*) and other local species which are having average rotation of about 20 years, are covered under medium rotation trees. As per a 1990 study, the mean annual increment (MAI) of gamhar at 20 years rotation was 10.5 cum/ha/year (CSE, 2017). NABARD estimates that a yield of 0.4 cum of peelable timber can be easily obtained from a kadam tree under rotation of 10 years. At a spacing of 5m x 5m, 400 trees can be planted in one hectare, resulting in productivity of 16 cum/ha/year (CSE, 2017). To get early timber harvest, it is proposed that 70% of plantations whose average MAI has been assumed as eight cum/ha/yr at rotation of twelve years due to variations in species and site qualities, may be raised under this category.

ii. Long Rotation Trees

Traditionally, the plantations of teak (*Tectona grandis*) and shisham (*Dalbergia sissoo*) have long rotation of about 60 years. As the demand for timber of teak kept on increasing, plantation management intensified but harvesting age too, simultaneously, kept on decreasing in order to maintain its supply. Felling cycle of 60 years decreased to low of 20 years as this species caught the fancy of farmers owing to its suitability for small scale planting, high value timber, initial fast growth and ease of cultivation (Jha, 2016; Mittelman, 2000). The MAI for 20-year-old teak plantations in Tripura and 38-year-old plantations in Uttar Pradesh, was 8.4 cum/ha/year and five cum/ha/year in Tripura and Uttar Pradesh, respectively. As per All India Teak General Volume Table, the MAI of teak plantations is about seven cum/ha/yr for site quality II/III at the age of 30 years (Katwal, 2005). Hence, it is proposed that 30% of plantations may be raised under this category, which might be felled at the age of 20 years, whose average productivity has been assumed as six cum/ha/yr due to variation in species and site qualities.

4.1.1.4 Projected Production of Large Sized Wood

The projected annual production of wood from one million ha of farmlands (table -3) would be 7.4 million cum of timber worth about INR 71.8 billion at present market rates and would generate employment of about 38.2 million person days.

Table-3 Large Sized Wood Production from Plantations in Farm Lands

Species	Area (m ha)	Rotation (yr)	MAI (cum/ ha/yr)	Felling Area (m ha)	Timber Prod (m cum)	Rate of wood (Rs (Rs /cum)	Value of wood in billion)	Man-power /ha (days)	Total Man-power (m days)
MRS	0.7	12	8	0.058	5.6	8000	44.8	500	29.2
LRS	0.3	20	6	0.015	1.8	15000	27.0	600	9.0
Total	1.0			0.073	7.4		71.8		38.2

The productivity of farmland plantations may be more as compared to forest plantations, due to better quality of plants, improved silvicultural practices, better quality of lands and better management practices. The plantations would be harvested at reduced rotations, which will provide juvenile wood, hence intensive research and development (R&D) efforts are needed to improve its utilization. Efforts are also needed to improve its longevity and durability through proper seasoning and preservative treatments. Keeping in view the outcomes of R&D efforts and market demand, rational decision regarding the reduction in rotation of various species of trees, is urgently needed.

The farmers may be encouraged to cultivate tree crops of medium and long rotations through more incentives. The plantation companies may have buy back arrangement for purchasing the timber from farmers under contract farming to motivate them for producing large sized timber. To popularize the farming of trees, easing the felling and transit rules for the various tree species is necessary.

4.1.2 Production of Small Sized Wood

After implementation of National Forest Policy of 1988, the wood based industries established direct linkages with the farmers for sustained availability of raw materials from their farm lands. WIMCO Ltd. (U.P.) and ITC, Ltd. (A.P.) encouraged the farming of poplar and clonal eucalyptus in UP, Uttarakhand, Punjab and Haryana and Andhra Pradesh during 1980s through providing quality plants, package of practices, bank loans and assured buy back arrangement of timber. These integrated projects have developed forward and backward linkages between farmers and wood-based industries. Hence, it is suggested that the Government of India may encourage the involvement of private sector to increase the production of farm wood which will not only meet the demand of raw materials but also increase the income of farmers.

4.1.2.1 Projected Production of Small Sized Wood

To increase production of farm wood, if one million ha of farmlands is brought under short rotation tree species like poplar (*Populus deltoides*), eucalyptus (*Eucalyptus hybrid*), Malabar neem (*Melia dubea*) casuarina (*Casuarina equisetifolia*), Subabul (*Leucaena leucocephala*), etc.. The small timber production and manpower generation are shown in table-4.

Table-4 : Wood Production and Manpower Generation from Farm Lands

Species	Area (m ha)	Rotation (yr)	MAI (cum/ ha/yr)	Felling Area (m ha)	Wood Prod (m cum)	Rate of wood (Rs (Rs /cum)	Value of wood in billion)	Man-power /ha (days)	Total Man-power (m days)
Euc., Pop., Casu., MD, etc.	0.7	5	25	1.4	17.5	5000	87.5	450	63
Other	0.3	5	10	0.6	3.0	3000	9.0	400	24
Total	**1.0**			**2.0**	**20.5**		**96.5**		**87**

(Lal et.al., 2020)

The proposed plantations on one million ha of farmlands might annually yield about 20.5 million cum wood worth of INR 96.5 billion and might generate employment of 87 million person days. The comparatively high income from farmland plantations has generated healthy competition with agricultural crops, however, the area under agroforestry fluctuates depending upon their relative profitability.

5.0 Policy Initiative

It is suggested that a High-Powered Committee under Cabinet Sectretary consisting of all the stakeholders, may be constituted in the Government of India to take decisions on various issues like increasing domestic production of large sized timber, promoting upgradation of wood-based industries and attracting FDI in Wood Sector in a time bound manner. India has a vast potential to produce timber and manufacture wood products for which Government of India may take the following policy initiatives:

- Formulating National Wood ActionPlan{Ministry of Commerce and Industries (MoCI)}
- Setting up Wood Development Board (MoCI)
- Increasing investments for increasing timber production from forests through public private partnership {Ministry of Finance (MoF), Ministry of Environment, Forest and Climate Change (MoEFCC)}
- Incentivising plantation companies and industries through discounted loans, capital subsidies and tax concessions for production of large sized timber (MoF, MoEFCC)

- Attracting investment from large foreign and local industrial groups to manufacture quality wood products (MoCI)
- Encouraging industry to adopt voluntary certification of wood and wood products (MoEFCC; MoCI)
- Enforcing minimum support pices of farm wood and its trade in the ambit of Agricultural Prices Commission {Ministry of Agriculture and Farmer Welfare (MoaFW)}
- Including Furniture and Panel Industry under the Production Linked Incentive (PLI) scheme (MoCI).
- Treating Wood based Industries at par with Food Processing Industry (MoCI)
- Reducing Goods and Services Tax (GST) on farm wood and their products (MoCI)
- Reviewing EXIM policy for encouraging the export of wood and wood products (MoCI)
- Extending all the incentives, concessions and facilities like integration with electronic National Agricultural Market (eNAM), priority lending, kisan card, etc., available to agricultural crops to the tree crops (MoAFW).

6.0 Conclusion

The emphasis on speedy development of long rotation plantations and wood-based industries will not only meet the local demands of wood and wood products but also help in increasing their exports. This will be a win-win situation for India as expansion of this sector will increase income of farmers, generate employment opportunities specially for school drop-outs, business opportunities for various stakeholders, enhancement of the revenue of government, earn foreign exchange and help in conservation of environment.

References :

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The Macro Contours of "Sustainability"– in the "Tree Outside the Forest- TOF" Sector of India

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Introduction

Sustainability objectives as decided through SDGs are fast approaching its deadline to achieve it before the 2030 timeline, and in this process all the Goals & Indicators -trying to capture the interwoven elements of sustainability to capture is one aspect but then pressure to "Develop" often overshoots beyond its adjective " Sustainable". India's strong tradition of "Sustainability" in "Public forestry" - started with "Working Plans" - way back, in 1890's or even earlier in a quite a rudimentary form. One can say it was confined to "public forestry" and was limited to few aspects like "sustainable, Harvest". Ensuring commensurate regeneration of young forest - was the key basis to it.

Background

Theoretically all right, but we have seen how the two great Wars particularly the II World War - exacerbated the excessive demand on various forest timber/NTFPs - and Indian forests were made to yield to higher harvest beyond what was prescribed in the so called scientific management "plans". Such kind of ad hoc - excessive harvesting had its toll on the emerging "Sustainability' concept at a large-scale forestry landscape of India. Then came our independence; when the most onerous task for. The country was to feed its teeming millions. With agriculture sector operating in its primitive ways / poor on technology/inputs etc.- our Govt. allowed massive dams/canals for irrigation and for it diverted huge areas of natural forest (rather the most fertile one) for converting them and facilitating them to enhance agriculture. Even this was not enough, all the form of developmental activities- were land based - like Industry , roads, towns etc. and they all got "forest land" as freely (without any restrictions)as possible. This huge reduction in forest area- yielding a diverse set of products and services, helped enhance the Agriculture sector contribution by increasing its acreage and also its productivity, and in this process – contribution of Forestry sector to the economy reduced. The Colonial Govt. of India Plan for developing agriculture sector in India – drafted by Dr J.A. Voelcker) - clearly reflected the attitude of society, highlighting the prime importance of agriculture – compared to other disciplines and the relegated position of "forestry" also - terming it the hand maid to "Agriculture". But even this report could visualize the depleting soil quality and its possible remediation by Tree growing in farm lands.(Voelcker,1893)

The resultant poor and reducing productivity of Public Forest of India

When we see the poor contribution of forestry sector in GDP; it must account for the forest- constantly being reduced of its resource based (i.e. Forest area getting depleting hugely- being diverted to several developmental projects) can be one prime reason. It also shows how our earlier planners; were oblivious to the fact that "forestry" is also greatly contributing to society and the agriculture sector, by offering various product and services- without any upfront cost. With increasing number of injudicious diversions in past, even the leftover forest has been getting still more depleted (under the newer pressure of ever-increasing population and land hunger for other sectors) in their quality and quantity- all having repercussion on Forest Productivity. After the independence; another charge to Industrial Development, also came to the public forest- making them supply cheap "forest produce-like, Timbers, bamboo and other NTFPs". Many industry were setup with their poor "cooked up" economics - working on extremely cheap raw materials form Public forest. For the "Public forestry" - the extremely low prices of products, at which it was forced to supply to such industries – and it was a kind of huge subsidy to various industries. But in long run it spoilt the both, i.e. the inefficient /unprofessional industries could not sustain themselves even getting the dirt cheap forest raw material and further it ruined the very "Sustainability" of nascent Forest ecosystems. The pressure to "harvest" from "the public forest "to feed these industries - started growing beyond the sustainable limits to meet their constant/inefficient industrial demands – leading often to not backed by adequate "regeneration status" in the forest. Sometimes -these unsustainable harvesting practices flourished with the connivance of unscrupulous officials, and still more important reason was to meet the "Revenue

target-based regime"- which encouraged "harvest for Revenue "even from the depleting forests- leading to further aggravated situation.

Thus, the total production of wood in India from state-owned forests has been hovering around 2 million m^3 on average while around 45 million m^3 is produced from areas outside forests. This trend is likely to continue as is evident from the near consistent production figures given in Table 1, below.

Accounting in India is for the financial tear (1st April to 31st march), ** based on three – year moving averages

RWE= roundwood equivalent ,(Kant and Nautiyal 2021)

This trend is very well reflected in the reducing outturn from the forest and their declining growth rate , contribution to GDP of country,Table-2.

Table-1 total timber production by the Public forest of India. (million m^3 RWE)

Year	Production from Public forests (RWE)
2005-06	2.33
2006-07	2.39
2007-08	2.60
2008-09	2.31
2009-10	2.18
2010-11	1.89
2011-12	1.78
2012-13	2.07
2013-14	2.39
2014-15	2.20
2015-16	2.09
2016-17	2.20
2017-18	2.16**
2018-19	2.15**
2019-20	2.17**

Table- 2 Growth rate in value of output of various sub-sectors/segments of agriculture and allied sector during various phases since 1950-51

Sub sector/ segment	Pre-Green Revolution	Food crisis period	1st phase of Green Revolution area	Green revolution in restricted sification	Wider adoption and diver-	Start of globali- sation +Export	BGRI+ Diversi- fication
	1950-51 to 1961-62	1961-62 to 1967-68	1967-68 to 1975-76	1975-76 to 1979-80	1979-80 to 1996-97	1996-97 to 2005-06	2005-06 to 2022-21
Crop sector	3.09	0.78	2.19	-0.01	2.88	1.60	2.55
1.1 Fruits & vegetables	0.96	6.15	5.43	1.96	3.25	2.86	4.53
1.2 Other crops	3.36	0.09	1.65	-0.41	2.81	1.27	1.91
2. Livestock	1.45	0.49	2.70	4.45	4.41	3.44	5.36
3. Fishery	5.43	4.25	4.34	0.54	6.12	2.90	7.10
4. Forestry	0.68	4.25	2.03	-4.51	0.20	1.64	1.53
5. Total (1 to 4)	2.29	1.61	2.27	-0.24	2.88	2.07	3.44

Note: Output at 2011-12 prices., BGRI: Bringing Green Revolution to Eastern India Source-(Chand etal.2023)

In addition to this, the Trees outside Forests (TOF) are also are a major source of supply of timber. Such sources are either plantations raised by industries on their own land, or on farmers' land under buy-back arrangements, or agro-forestry practices in farmers' fields. But the demand of NTFPs and timber have been increasing in the country, both for the domestic purpose and for export purpose. The trigger of "demand" for trees on one hand and growing understanding for trees for their ecosystem services - especially for their enhancing usefulness in farming context - has renewed a new interest to "Agroforestry" in the country. Incidentally the tree growing culture, had been in practiced in our country for a significant past.

But the growing discipline of "modern Agriculture" often ignored it; often considering it undesirable activity - which often interfered to "developed agriculture ".However, unlike "Public forestry", which was governed by well stated policies, practices and yet failing to attain "sustainability" (even in limited sense); the Agro forestry or various kinds of tree farming in combination with vast variety of agricultural practices (has been the farmer driven) and now offers a huge scope to meet the growing demand of Industry/ other sectors. But Tree growing is being driven diverse set of actors, particularly by farmers, located in diverse context and hence - expecting the "Agroforestry "sector(even at the Macro level) at to be "Sustainable "in this complex background - would be a farfetched idea. Yet if some elements of sustainability if not brought at this stage – like ensuring consistent annual produce of timber (both at the national of subnational level): any kind of wood/NTFP based Industrial development - based on it- can not be meaningfully planned for the Long term. On one hand it would be a risky proposition to growers/farmers.

The aspirations of Demand side

On other hand, Industry's expectation of "sustained and predictable supply" from the farmers (contributing to supply, with their hope of consistent and predictable demand)- has to be matched. But farmers, located in diffused geographies - struggling with their own specific socio/Economic/climatic context; often has resulted in an unpredictable outcomes in the past (both temporal and spatial variability in tree resource base - often not matching with the Industrial or other sectoral demand). This mismatch results in price volatility of wood- which neither good for industry nor for the farmers. Unfortunately the different policies by Agricultural/forest/ Industry and other dept. formulated so far have not been able to see these complexities in harmonized manner and thus unable to make it "Sustainable" activity -till date. Further if we see further deep to the supply side - which has not been sustainable in aggregate sense, but also highly unsustainable in composition of supply -i.e. the different components of products and services, like variety of timber/NTFPs etc. in disaggregated forms from the demand side of Industry only. This aspect is going to be more complex, also of high concern- when we see the impending various other dimensions of Environmental security and climate change to the society etc. to be mitigated by such TOFs. Contrast to this-as India aspires to be leading economy of the world with 5Tdollar barrier crossing so soon, there is huge pressure to produces a variety of timber and NTFPS domestically, that too in the required quantity and in predictable manner as well. The fallout of this policy adhocism has resulted in huge and growing imports of various timber/NTFPs - over the past years (which often are sourced from the dubious sources. – thus having a huge bearing on global/ national sustainability aspects of products (as, products made of these dubious sourced woods if it has to be exported, will find difficult to withstand required standards of scrutiny)

Year	Wood in rough	Hoopwood	Sawnwood	Veneer sheets	Fibreboard	Plywood &panels	Sulphate pulp	Sulphate pulp
2009	1,191.77	0.39	42.16	19.95	40.60	36.71	238.86	1.33
2010	1,334.26	0.38	57.43	27.02	77.25	52.32	394.41	2.13
2011	1,828.94	0.51	130.96	45.74	84.31	112.42	463.55	1.81
2012	2,004.68	1.61	159.73	55.80	91.67	90.24	414.67	1.41
2013	2,033.64	0.50	184.31	65.73	96.32	80.63	451.56	22.29
2014	2,010.89	0.70	205.37	91.19	87.63	84.90	461.77	22.39
2015	1,564.8	80.47	283.64	174.01	87.18	85.78	466.92	1.11
2016	1,277.53	0.25	275.44	200.19	88.46	79.84	445.38	0.65
2017	1,206.09	0.03	367.73	219.53	106.12	97.80	484.09	1.54
2018	1,117.66	0.04	423.05	234.34	121.90	121.4	1561.30	3.21
2019	993.63	0.02	466.28	280.84	103.34	107.63	507.94	2.05

Prima facie these figures could be alarming as it also reflects as heavy burden to the nations precious foreign "Currency". But the demand of Industry for wood and allied product to cater to domestic and export market has been so acute-that has triggered a huge increase in Agroforestry activity- starting with limited choice of species which have been outperforming the conventional agricultural crops. But even "Demand Side" is also not very stable – varying with the economic performance of different countries - public choices etc. Here the demand side's feedback loop to the farmers is often too Long and slow (and still more long, the

response time of the farmers- if they decides it to change his quantity and composition of products- suiting to changed market requirements). Anybody conversant with the time taken by tree growing activity compared to agriculture crop cultivation- can appreciate this limitation posed to the adhoc growth of Agroforestry sector, particularly for the tree growing farmers(who are the most vulnerable link in the system).

In this light, a very disturbing trend is being observed in the Agroforestry sector" of India – where the wood based industries are desperate to get raw material from any where and at any cost- without any considerations for the sustainability. This tendency results in not only overharvest but even affects the regeneration and creates a new trigger for new planting activities-but not backed by the future demand , and when such crop will mature- it will have enhanced risk of price slump. These indicators if not captured timely and addressed adequately, would jeopardize not only the agroforestry based – industrial ecosystem but even the environmental Sustainability of the Country.

The need of robust, simple, cost-effective way to monitor the TOF resources - a case study

In this background, a case-study is presented- selectively highlighting its salient findings (for the methodology, no comments are offered – but the attempt to identify/monitor the tree resources – at individual tree level on a big scale in cost effective manner is unique to this research study) . Of course, this study is promising on the count, a third party can do it , to bring the element of credibility. In the study, the tree growing inventory of India, from 2010/2011 to 2018/2022 have been made and how suddenly ,the mature trees have been (harvested or over harvested) - leading to very depleted scenario with young age crops tree crops .This sudden removal of selective felling ,could possibly create the wide supply gap in near future.

Need for a robust, efficient and regular Resource Assessment of TOF

Methodological improvement helps

Agroforestry trees represent a vital part of India's landscapes, However, only little is known about human appropriation of trees outside forests, in such agroforestry systems- at macro level. Trees outside of forests are often not well-documented. The systematic quantification of tree resources within these systems is challenging at national scale as current mapping approaches mainly capture block plantations but less in individual trees on farms(Rizvi, R. H. et al. 2020). The current technological progress is still lacking and that makes tree cover and count in India also uncertain, and possibly makes it one of the most overlooked aspect of resource estimation. The current lack of robust monitoring mechanisms has contributed to an insufficient understanding of sustainability and the desired management practices(Brandt et al. 2023). But earlier also (Brandt et al. 2020) have been able to map the crown size of each tree more than 3 m^2 in size over a land area that spans 1.3 million km^2 in the West African Sahara, using submetre-resolution satellite imagery and deep learning (Zanaga, D. et al 2021)[4], by which detected over 1.8 billion individual trees (13.4 trees per hectare), with a median crown size of 12 m^2, along a rainfall gradient from 0 to 1,000 mm per year. Identifying and assessing such isolated trees (outside of forests) also suggests a way to monitor them globally, useful to improve policy practices.

Case Background

The study uses mapping of all agroforestry trees, excluding block plantations, in India for year 2010/2011 and 2018-2022, which revealed a count of about 0.6 billion trees. They further tracked each tree crown over the years and found around 11±2% of the large trees (about 96 m^2 crown size) mapped in 2010/2011 disappeared by 2018.

Further it found during the period 2018-2022, more than 5 million large farmland trees (about 67 m^2 crown size) have vanished(Brand et al. 2023).

The major findings

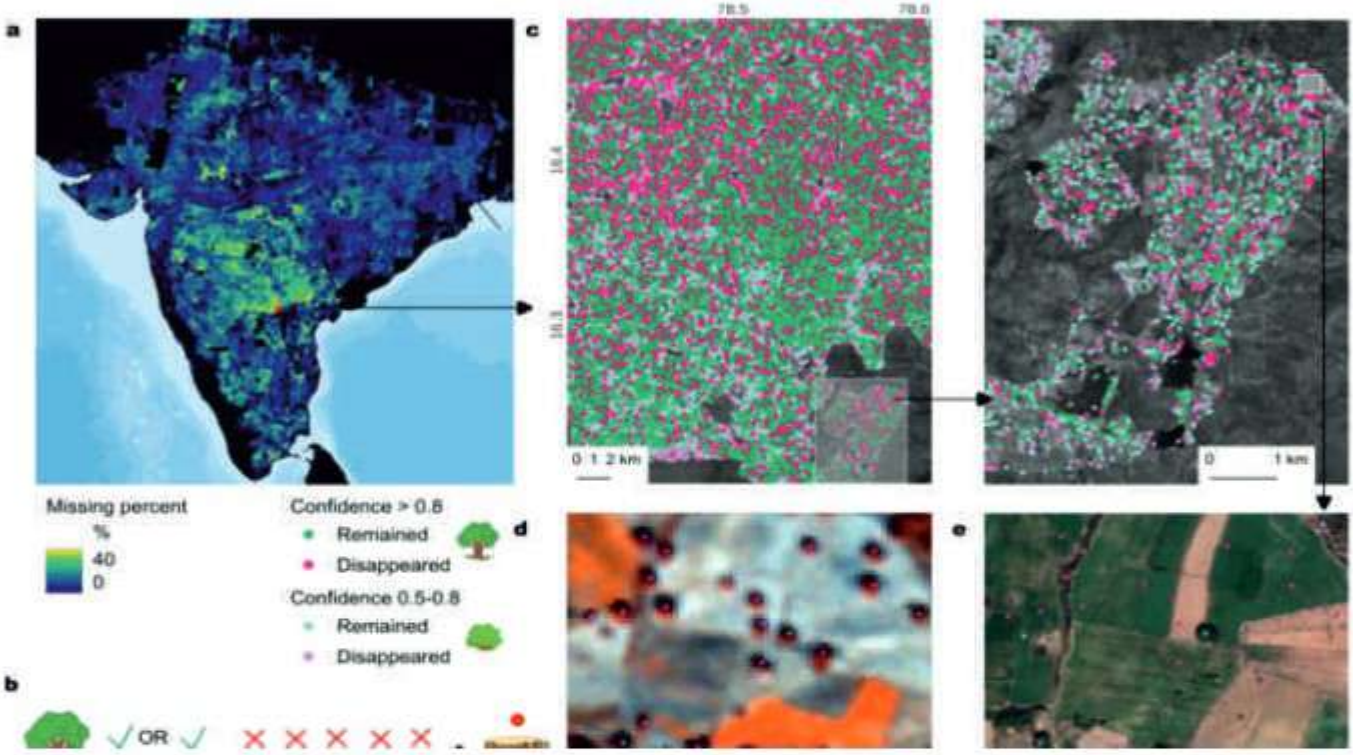
The study found that trees detected by RapidEye with a confidence >0.8 have an average crown size of 96 m^2 (for methods, see original paper), which implies that the trees covered by this analysis were generally mature trees that have reached a later stage of development, and such a high loss rate of mature trees over less than a decade is unexpected. The disappearance of mature farmland trees was observed in many areas, but numbers rarely exceed 5-10%, except for areas in central India, in particular in the states Telangana and Maharashtra, where it documents massive losses of large trees (Fig. 1). Here, several hot-spot areas have lost up to 50% of their large farmland trees, with up to 22 trees per km^2 disappearing (Figure 1c-e). Also smaller hot spot areas of loss are observed, such as in eastern Madhya Pradesh around Indore (Extended Data Fig. 1).

It found that 5.3 million trees (2.7 trees per km^2) observed in 2018/2019 were not detected in 2020-2022. Trees with a change confidence above this threshold on average have a crown size of 67 m^2. The uncertainty in the number of disappeared trees was 21%, quantified by manually checking a random sample of 1000 trees classified as disappeared. This number of disappeared

trees, considered a conservative estimate due to the method applied, was still high considering that a majority of the losses must have occurred between 2018 and 2020. Several hot-spot areas stand out: The example shown in Figure 3b-d is not a local exception from the rule, as was observed in similar situations all over Indian croplands, reflecting a considerable national scale thinning of India's large agroforestry trees over such a short time period. Some regions have lost more than 50 trees per km^2(Brand et al. 2023).

The outcome of this study is manifold:

The database generated does not only provide a complete inventory of mature agroforestry trees, but also offers the opportunity to locate and quantify trees that have disappeared. The database includes detection confidence values for each year 2018-2022. If a tree that has been detected with a high confidence (above a given threshold) is not detected anymore over several consecutive years, there is a high probability that the tree has disappeared..



The major observations, as discussed in details are-

Severe losses in large agroforestry trees 2010-2018 India has experienced massive losses of large farmland trees, illustrated here at the tree-level tracked with RapidEye (2010/2011) and PlanetScope (2018-2022). A , Trees that have disappeared are shown here as percentage in relation to the total number of mapped trees in 2010 aggregated to 5x5 km grids. b, A tree detected in either 2010 or 2011 but not during 2018-2022 was classified as disappeared. If a tree mapped in 2010/2011 was observed in any of the years between 2018-2022, it was classified as remained. c, Trees mapped with RapidEye have an average crown area of 96 m^2 (confidence >0.8; see Methods). Many regions have lost up to half of these large trees within farmlands during 2010-2018 (note that only trees in farmlands are considered, using WorldCover[4] as mask layer). d, Trees mapped with RapidEye in 2010, shown here as a false color composite. e, The same area I in 2021 is illustrated here with Google Earth imagery, showing that only three of the large trees have remained. Remaining farmland trees: 22 million; disappeared: 2.5 million (confidence >0.8).

Presence of agroforestry trees during 2018-2022

Every tree within farmlands, urban areas and bare areas was mapped and their density is shown here summed at the hectare scale. b

A demonstration of the framework to map the dynamics of individual trees in different agroforestry systems. Disappearance of trees can be caused by natural factors, part of management practices, or related to disturbances, depending on the agroforestry type.

Severe losses in large agroforestry trees 2010-2018 India has experienced massive losses of large farmland trees, illustrated here at the tree-level tracked with RapidEye (2010/2011) and PlanetScope (2018-2022).

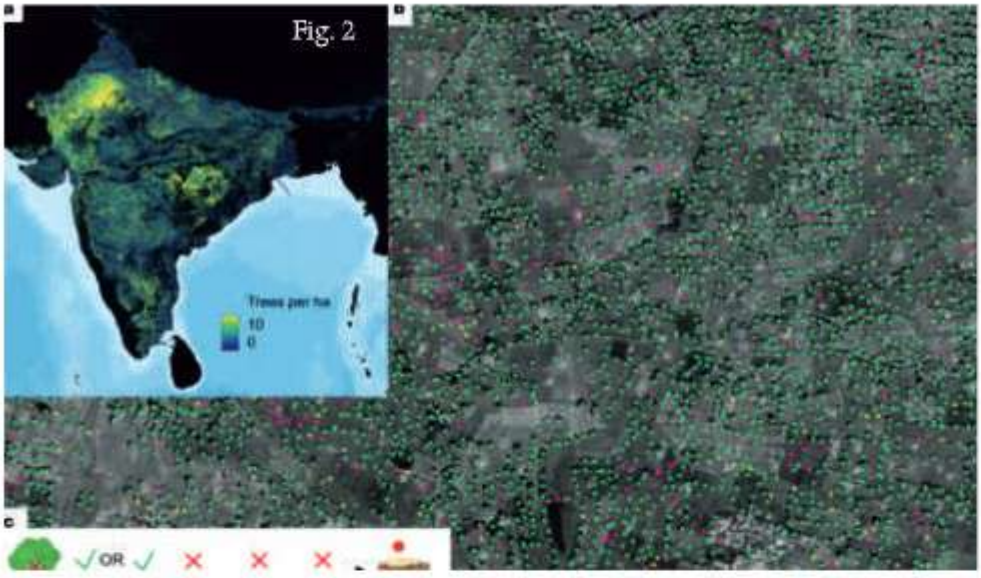


Fig. 2

The base maps are from Google earth, 2021. c A tree that was detected in either 2018 or 2019 (or both) with a high confidence but was not found in three consecutive years (2020-2022) was mapped as disappeared, shown here as red points. Number of mapped trees 597,638,431. See Extended Data Fig. 2 for an illustration of the workflow.

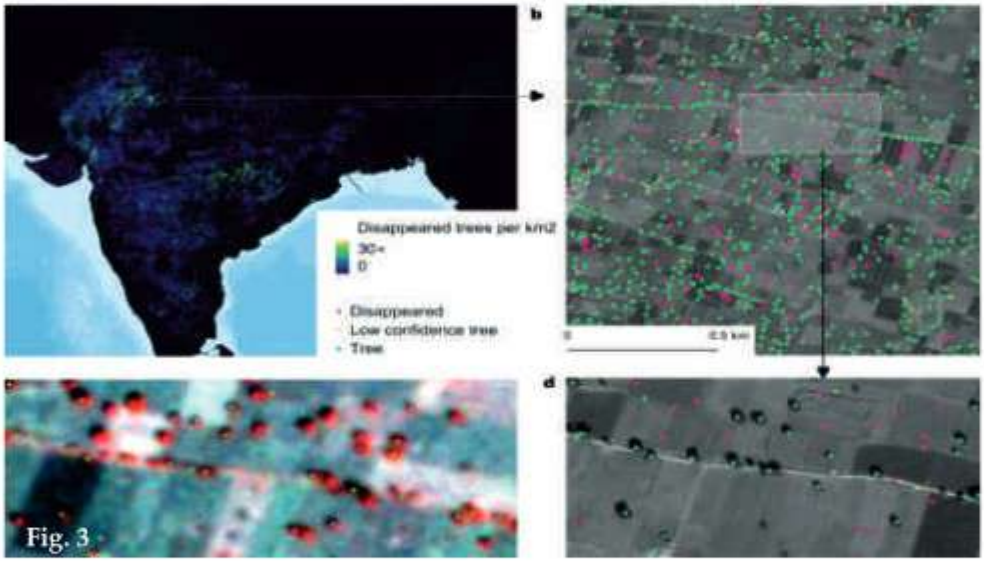


Fig. 3

Disappearance of farmland trees 2018-2022

A study estimated that 5.6 million trees have disappeared between 2018/2019 and 2020-2022, here shown per km². **b**, Zoom to a hot-spot area in the northwestern India where a substantial part of large farmland trees have disappeared over recent years. **c**, A Planet Scope scene captured in 2019, where trees classified as disappeared are still alive. The scene is shown as a false color composite with NIR as red color, causing tree crowns to appear in reddish colors. d, A considerable number of the trees detected in 2019 are not present anymore in 2022, visualized here with a Google Earth base-map. The crown sizes of the disappeared trees here are >150 m² (manually measured on the screen), which means trees were mature(Brandt etal 2023).

Lessons and Way forward

Though the major drawback of above discussed case study is that it lacks clarity in offering annual status and further it does not give focused sub-regional picture (may be the state wise/district wise assessments would have been useful in giving – appropriate policy directions. With these temporal details, this analysis would have given finer guidance to future "Agroforestry policies" of India. Yet even in its current shape; few important take aways of the study are -Potential applications beyond inventorying are the monitoring of such large scale harvest of trees and the subsequent remedial actions. The amount of excessive harvest- driven by ad hoc demand has to be moderated. As huge import is not only a issue for Govt, but for the organized industries and even having wider ramification to mass of growers (who would be the worst affected by the volatility in the prices of timber) A crude correlation of "hotspots" of these "excessive harvesting" of mature trees collated with other evidences-like assessments of FSI, data of Industrial development etc. FSI report – breaking it down to species level etc. are desirable and that might give better insight to such Agro forestry resource assessment and its possible attempt to match it with "Real time demand" and thus bring a semblance of sustainability in agroforestry sector of India, at macro level. As India's tree growing activity enhances, and thus the related wood/fibre-based industries/enterprises- the land use change pattern would be changing drastically. This pattern and composition, may not be in congruence with the other sectoral requirements of the country (Gupta et al. 2013).

Keeping these requirements and of broader sustainability, would of prime concern. The whole activity needs to be planned/ regulated/ moderated – before the distorted overall change in area under Trees/TOF/agroforestry etc.,(its spatial distribution - both at the macro scale and micro scale, and then the composition of the tree crops, its admixture with the diverse herbs /shrubs/ etc. takes place).The diversity dimension of the trees /TOF is currently is already overlooking it in favour of the biomass/fibre productivity or processing requirements of end products. This failure of the regulatory system can have huge future ramifications as the huge mass of future TOF should and would not only be valued for values like Carbon alone. We need greenery from tree/forest ecosystems for much more diverse values- including catchment protection, biodiversity, pollination, recreation etc. and then last but not the least the "livelihood opportunities". Livelihood is one unique aspect of trees/forest which offers succour to millions of marginalized communities (located in far-flung, remote locations) an option to dignified life in the midst of their own place. This holistic welfare expectations of the Indian society needs to internalized in its future plan of expansion – reflecting in the shape of any policy /strategy/action plan for Tree/TOF growing in India, to make it in sync with the "Sustainability Principles".

References :

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Common Facility Centre at IWST

Common Facility Centre (CFC) has been established inside IWST campus during the year 2016. The CFC houses many modern wood working and bamboo processing machines. CFC extends wood and bamboo processing facilities to various stake holders, self-help groups, NGOs, wood based small scale/cottage industries and local artisans. All the machines can be used on payment basis during all working days (Monday to Friday) from 9:00 AM to 5:30 PM. The details of available wood working and bamboo machines and their description are given below.

A. List of Wood and Bamboo Working Machines

No.	Name of Machinery	Description
1	Surface Planer	Suitable for removing rough surface of the wood by planing.
2	Thickness Planer	Suitable for sizing the piece of wood in two dimensions
3	Sliding Table Panel Saw	Suitable to cut a wood lumber/panel board to the required sizes in different cutting like rip cut, & scoring for pre lamboard.
4	Small Table Circular Saw	Suitable for rip cutting, cross cutting, and chamfering of wood.
5	Multi Spindle boring	Suitable for multi boring on wood/panel boards like vertical, horizontal and angular bores.
6	Spindle Molder	Suitable for edge profiling and contouring.
7	Belt Sander	Suitable for sanding the surface
8	Finger Jointing Machine	Suitable for joining small solid wood pieces
9	Seasoning Kiln	Suitable for seasoning the wood(Capacity: 200 cft)
10	Bamboo Cross Cutting	Suitable for cross cutting of Bamboo culms.
11	Bamboo Semi Half Splitting	Suitable for splitting the bamboo culms to rectangular strips.
12	Bamboo Variable Size splitting	Suitable for splitting the bamboo culms to number of strips.
13	Bamboo External Knot Removing	Suitable for removing external knots of bamboo culms.
14	Bamboo Thickness Planning	Suitable for thickness planning of bamboo strips to variable size.
15	Bamboo Slat Gluing	Suitable for gluing the bamboo strips for making panel of different sizes.
16	Bamboo Panel Drier	Suitable for drying glues bamboo panels.

To use the facility and for further details, please contact:
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Industrial Agroforestry: Ensuring Wood Security in India

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1. Introduction:

Forests are a vital natural resource that contribute significantly to the diverse social, cultural, and political environment of India. India's forest cover has seen a dynamic interaction of growth, decrease, use, and restoration over the last 15 years. The total forest and tree cover of the country is 80.9 million hectares which is 24.62 % of the total geographical area of the country (ISFR, 2021) and it accounts for 2 % of the World's total forest area (Annual Economic Survey, DEA, 2022).

Wood being one of the major contributors in the economic growth of India, is the product of forests. In the past, forests in India were the primary source for timber but nowadays, due to the over exploitation of the forests, certain laws and regulations came into force which restricted the extraction of timber from the forests. Several acts and policies in India such as **Indian Forest Act, 1927** which aims at regulating the transit of forestry products and the duty leviable on timber and other forestry products; **Forest Conservation Act, 1980** which is concerned with the conservation of forests and their resources by restricting the use of forest land for non-forest purposes; **National Forest Policy, 1988** emphasizes on the ecological role of the forests and least importance being given to the production of (industrial) wood for market; **Ban on Green felling** in India which restricts the felling of trees, center the forests as a conserving entity, restricting its productive role. These policies "affected the timber supply from government forest areas and created a huge gap in supply and demand of timber".

In the present scenario, the wood-based industries in India are witnessing faster growth. Industries involved in the production of pulp, paper and paper boards, newsprint, construction materials, furniture and handicrafts, packaging material, rayon grade pulp, agriculture implements, sports goods, plywood, veneered particle board, medium density fiber board, match box, pencil industry, etc. are major wood-based industries in India. These industries are heavily dependent on imported timber for the supply of raw material, as the plantations are not sufficient to meet their demands (Poonam et al., 2020). Therefore, India's overall trade imbalance (imports minus exports) for wood products has increased. In their report, Kant and Nautiyal (2021) has forecasted the demand of timber in India for the major wood-based industries namely pulp and paper, furniture, construction, plywood and other wood-based industries from 2021 to 2030. The total demand for these four sectors has been projected to grow from 59.64 million m^3 in 2021 to around 98 million m^3 in 2030. The supply of wood from the natural forests for meeting the demand of wood-based industry is very low, the reason being the forests are mainly managed for their ecosystem services and low productivity of our forests (0.7 $m^3 ha^{-1} year^{-1}$) (Samy et al., 2022).

India is the third largest importer of illegally felled timber in the world. Between 2010 and 2018, India's import value of illegal wood and wood products was positioned at Rupees 388 billion from all over the world (IUFRO, 2016). According to a study by World Bank, this market will grow at a rate of 20% every year in the coming years. A lot of Indian money is going into this illegal trade. So why don't we do something about it? Instead of buying this illegally logged timber, we can buy timber from our farmers by allowing them to raise plantations on their farm lands. This will prove a significant step in saving the foreign reserves of the country. These plantations will act as an insurance during emergencies for the farmer and help in doubling his income when combined with crop and livestock (Dhamodaran T.K., 2021). Therefore, in order to reduce the import of illegally harvested timber as well as ensuring the optimum supply of the raw material, industrial agroforestry is one of the most imperative alternatives to fulfill the demand of industries.

Industrial Agroforestry/ Commercial Agroforestry:

It is a sustainable land use system having potential to produce industrial raw material in a shorter span of time. Today, industrial agroforestry is being combined with contract farming. Trees with industrial importance are grown along with the agricultural crops, which not only helps in fulfilling the demands of wood-based industries but also sustains the farmers' livelihood by increasing income. It also helps in improving the nutrient status of soil, food security and improve microclimate (Samy et al., 2022). In India, poplar and *Eucalyptus* are widely planted in Indo-Gangetic plains (IGP) and hence, are considered the birthplace of

commercial or industrial agroforestry (Chavan et al., 2023). Over five lakh hectares (ha) of area is occupied by the poplar and *Eucalyptus*-based agroforestry systems in IGP. Species like *Melia composita, Gmelina arborea, Dalbergia sissoo,* Bamboo, and *Leucaena leucocephala* were also adopted by farmers along with these systems (Chaturvedi et al., 2017). Conventionally, the agroforestry systems in IGP were sustained for the ecological and livelihood security of the region. Various observation of these regions, suggested that farmers in this region retain trees on farm bunds for obtaining different products such as timber, fuel wood, fruits, fodder, etc. Trees such as *Ailanthus excelsa, Melia composita, Dalbergia sissoo, Populus deltoides, Eucalyptus* spp., *Mangifera indica,* etc. are majorly grown in parts of Haryana and Punjab. In the Tarai region of Uttar Pradesh and Uttarakhand, *Dalbergia sissoo, Syzygium cumini)* and *Trewia nudiflora* are widespread. *Dalbergia sissoo* is commonly planted in a field with other preferred species such as *Tectona grandis, Eucalyptus tereticornis, Emblica officinalis,* and bamboos for livelihood in some parts of Uttar Pradesh and Bihar (Chavan et al., 2023).

Populus deltoides-based agroforestry:

This system has altered the old-style subsistence-based tree farming into industrial agroforestry. Poplar farming has gained popularity among the farmers of the IGP in the last 30 years. Poplar has been planted by taking up appropriate crop combinations (such as sugarcane, wheat, turmeric, and medicinal crops) with suitable spacing. An average of 50-60 mega grams ha^{-1} of biomass can be produced through modern technologies and scientific management of poplar-based agroforestry systems. Poplar-based agroforestry is a very profitable business as substantial wood production can be achieved along with income from the intercropping and this can provide a benefit-cost ratio of 1:2.13 (NFP,1988). As poplar can be harvested in only 5-8 years, it has become very prevalent as one of the fastest-growing industrial wood species in the world, earning a sale price of rupees 4000 per ton (Chauhan et al., 2012).

Eucalyptus-based agroforestry:

Eucalyptus is a non-native, quickly growing tree that is planted all over the world. Due to its ease of cultivation and resilience to harsh environments, it is planted on a variety of agricultural areas as a monoculture and as a component of agroforestry programmes. It has about 625 species and sub-species with different varieties. About 200 years ago, *Eucalyptus* was introduced in the Nilgiris Hills of Tamil Nadu from Australia. Originally introduction of *Eucalyptus grandis* was intended for the afforestation of high-range grasslands in Kerala but later on it became the most significant species for pulpwood plantations in Kerala. *E. tereticornis, E. citriodra, E. globulus,* and *E. grandis* are other species of *Eucalyptus* that are being grown in India (Raj et al., 2016). In the late 1960s and early 1970s because of the extension efforts of the State Forest Departments, the planting of *Eucalyptus* had taken a new shape in India. Gradually *Eucalyptus* become noticeable all over India, although it was more prevalent in Punjab, Haryana, western Uttar Pradesh, Gujarat, Tamil Nadu, North Bengal, and Andhra Pradesh. (Dhillon et al., 2018).

Growth trends in Industrial Agroforestry in India:

Presently, owing to large-scale demand from pulp and paper industries, commercial agroforestry is becoming more and more prevalent and is projected to be practiced over 5 million hectares of area with tree species belonging to genus of *Eucalyptus, Populus, Casuarina, Leucaena, Ailanthus, Melia, Anthocephalus, Acacia, Bombax,* etc. Recently, in panel and reconstituted board industries, *Melia dubia* is gaining popularity. An estimated 150 million tonnes of firewood and 100 million cubic metres of timber or pulpwood for domestic and commercial purposes will come from agroforestry. Agroforestry has been estimated to generate 4000-million person days of employment annually through nursery and plantation activities. Addition of about 15 million tonnes of organic matter through leaf fall, 60 million tonnes of carbon sequestered annually in tree components (apart from soil and carbon locked in wood products) has been estimated to come from agroforestry. An estimated Rs. 10,000 billion is generated from wood and pulpwood each year, while Rs. 30,000 million is coming from firewood (Dhiman 2013). Through Public-Private Partnership (PPP) model, the demand of raw material of the private sector like pulpwood, match wood and other plywood industries can be fulfilled and new strategies in agroforestry for benefitting the farmers will indirectly help the country in achieving the targeted forest cover. (Dhamodaran T.K., 2021).

National Agroforestry Policy (2014):

With the adoption of National Agroforestry Policy in February 2014, India became the first country to have a comprehensive policy on Agroforestry in the World. The objective is to boost and increase tree plantation in a complementary and integrated manner with crops and livestock to improve productivity, employment, income and livelihoods of rural households, especially the small farmers. It will also assist in meeting the raw material requirements of wood-based industries and reduce import of wood and wood products to save foreign exchange of our country. The major highlights of the National Agroforestry Policy (NAP) are: establishment

of institutional set-up at the national level to promote agroforestry under the mandate of the Ministry of Agriculture, GoI; simplify regulations related to harvesting, felling and transportation of trees grown on farmlands; ensuring security of land tenure and creating a sound base of land records and data for developing an market information system (MIS) for agroforestry; investing in research, extension and capacity building and related services; access to quality planting material; institutional credit and insurance cover to agroforestry practitioners; increased participation of industries dealing with agroforestry produce, and strengthening marketing information system for tree products. To begin with, at national level, the policy acknowledged twenty important multipurpose tree species grown under agroforestry systems to be relieved from all restrictions related to harvesting, transportation and marketing. The policy focuses on encouraging contract farming, public private partnership (PPP) for promotion of agroforestry on roadside/canal side/barren community land. This will ensure active participation of farmers and help in achieving 33% forest cover, ensuring raw material security to wood-based industries as well as environmental security (Dhamodaran T.K., 2021)

Challenges for Industrial Agroforestry in India:

One of the biggest challenges for the Industrial agroforestry sector in India is poor marketing infrastructure for the agroforestry produce in the country except in the few states. Consequently, buyers and middlemen get most of the profit. Lack of awareness of technical and economic data on different agroforestry models results in poor institutional finance and insurance coverage in agroforestry (National Agroforestry Policy, 2014). Likewise, cumbersome, overpriced and tedious legislations in respect of tree felling, timber transportation, processing and marketing make farmers cautious regarding the adoption of agroforestry (Chavan et al., 2014). In the same way, strict tax regime at various stages of processing by multiple agencies makes it even more difficult. As a result, the imported material is gaining more popularity than the domestic agroforestry produces. Therefore, it becomes important to check these restrictions and ease the whole process starting from growing raw material to the final product (Dhamodaran T.K., 2021).

Another challenge for the commercial agroforestry sector in India is poor extension system that hinders the proper dissemination of the research outcomes to the targeted stakeholders. In India, two-third of the farmers has small and marginal land holdings and they often remain devoid of the benefit of the agroforestry related schemes because farmers with major land holdings get all the benefits (Kumar et al., 2017). Therefore, special programs on agroforestry models for marginal and small farmers should be introduced to benefit them (Verma et al. 2012).

Opportunities:

Agroforestry systems in India include both traditional and modern land use systems and have significant potential in many aspects such as providing employment to rural as well as urban population through production, processing and value addition of agroforestry produce. A study by Singh and Dhayani estimated that one hectare of the plantation has the potential of generating about 450 man-days of employment meaning 30 million ha of plantation can generate about 15,000 million man-days of employment in addition to creating job opportunities in wood-based value chain (Singh and Dhayani, 2014). Furthermore, around 100 million cubic meter timber/pulpwood for industrial and domestic use can be generated from agroforestry system meant for timber and pulpwood production (Chavan et al. 2015) and this fulfills the country's timber demand by 65%, plywood demand by 70-80% and raw material demand of pulp and paper industries by 60%. In addition, it produces 150 million tonnes of firewood which fulfils half of country's firewood demand. As the population of India is increasing at a very alarming rate; the land-holding size of farmers is also shrinking rapidly and agroforestry is the only way to optimize the farm productivity (National Agroforestry Policy, 2014). Agroforestry systems have the potential to provide farmers with higher financial returns as they are highly productivity.

Conclusion:

Agroforestry in India for industrial purpose is gaining attention as it has the potential to address the issue of timber demand and supply imbalance in India. Additionally, it will help the farmers in enhancing their living standards through providing better employment opportunities. *Populus* and *Eucalyptus* based commercial agroforestry systems are widely popular in Northern India. The shortcomings of these systems can be overcome through policy interventions and technology, thus overcoming the shortage of raw material for wood-based industries. Moreover, this will help in enhancing the ecosystem services, and there will be myriad opportunities for small and marginal farmers in terms of employment in India. Effective implementation of National Agroforestry Policy (2014) in India can fulfill the dual objectives of increasing forest cover as well as security of raw material supply to wood-based industries.

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Wood Security and Sustainability in India: Researchers Perspectives

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Introduction:

Wood is a versatile and renewable resource that has been integral to human civilization since time immemorial (Fig.1). In older times, wood was derived primarily from trees in forests, and now the focus is shifted to plantations and other trees outside forests, especially timber-based agroforestry practices and systems.

It offers a sustainable solution with minimal carbon impact. Throughout history, people have harnessed the potential of wood for various purposes, including the construction of homes, crafting furniture, fashioning agricultural tools, and even fueling household needs.

Fig. 1 Wood as a renewable material

Wood security and Sustainability

The conservation and management of forests and wood resources are referred to as "wood security" or "timber security" in order to guarantee their sustainability and availability for present and future generations. It includes many facets of preserving, using responsibly, and conserving wood and forest resources. Forest management, protection against illicit logging, reforestation and afforestation, biodiversity conservation, community engagement, climate change mitigation, forest fire management, research and monitoring, and legal frameworks are all vital components of wood security.

Hence, the security of wood is crucial for maintaining a steady supply of wood and wood-based goods, protecting the environment, boosting economies, and maintaining biodiversity. Responsible forestry and conservation practices, together with other sustainable wood management techniques, guard against habitat loss, deforestation, and the reduction of essential ecosystem services. By keeping forests functioning as carbon sinks, wood security also aids in reducing the effects of climate change. Additionally, it protects cultural linkages to forests, maintains employment and livelihoods, and averts the harmful effects of illicit logging and unsustainable practices, fostering peaceful coexistence between people and environment.

Fig 2 : Pictorial representation of Wood Security and Sustainability cycle of Rubberwood (Source: https://www.sampoernakayoe.com)

Major challenges and solutions

India's remarkable economic growth has led to a surge in demand for wood and wood-based products, resulting in a gap in domestic production and a lack of compliance with domestic regulations. There are no domestic price regulations or established domestic pricing patterns for the timber that is offered in India. The lack of proper mechanism for production, trade export and import also hinder timber supply and demand, only a fraction of the over 50 million m of logs produced by the Indian wood industry in 2015, as reported by ITTO (2017), were exported.

Table 1: Production and Trade- Export and Import of wood and major wood products

	Production quantity 1000 m^3	Import quantity (1000 m^3)	Domestic consumption (1000m^3)	Export Quantity (1000 m^3)
Logs (Ind. Round wood)	49,517	4383	53881	19
Sawn wood	6889	869	7744	14
Veneer	295	415	702	9
Plywood	2537	141	2627	51

(ITTO Data, 2017)

Illegal logging, deforestation, overharvesting, and forest degradation are some of the traditional problems regarding wood security. Apart from that, conflicts over land ownership and poor governance make managing forests sustainably more difficult. The complexity is increased by the effects of climate change, rising market demand, the requirement for certification and traceability of invasive species, and the rights of indigenous people, etc. To address these challenges, India has focused on the cultivation of trees outside of forests (ToF) over the past decade, particularly within the frameworks of agroforestry and farm forestry systems.

When compared to the potential wood output from TOFs, which could satisfy 45% of India's entire timber demand, the amount of timber produced from government forest areas is bitterly little, around 3.4% of total need, but they haven't been properly utilised because of inconsistencies in state-level TOFs' rules (FSR 2019). This suggests that TOFs have enormous potential to fulfil the rising demand for timber. As can be observed from the table below, which was identified during an investigation of the impact of forest regulations on wood output in India, data on timber production in India appears to be inconsistent. Hence there is the need for new policies to address the gap between supply and demand of timbers in India.

Table 2: Demand of wood by different wood based-industries in India (in Million Meter Cube)

Industry	1998*	1999*	2000*	2005*	2010*	2015**	2020**
Paper and paper boards	4.5	4.5	4.5	9.0	15.4	26.2	35.8
Construction	13.6	14.6	15.9	19.4	22.1	26.3	28.5
Packaging	4.4	4.5	4.6	5.5	6.4	7.6	9.0
Furniture	2.3	2.4	2.5	3.4	4.6	5.9	7.5
Agricultural Implements	2.0	2.1	2.1	2.3	2.5	2.5	2.5
Plywood	10.1	10.5	11.0	14.0	18.0	22.9	29.2
Others	15.1	16.0	17.1	20.3	25.9	31.4	40.2
Total	52.0	54.6	57.7	73.9	94.9	122.8	152.7

(Source Ghosh and Sinha 2016. *Actual Demand **Projected Demand)

Also, to guarantee a steady supply of wood resources while preserving ecosystems and biodiversity, sustainable practices are essential for domestic pricing patterns for the timber that is available in India (Wood is Good, 2021). Also, the Forest Department's auctions typically reflect a yearly increase in the minimum price. Therefore, the country's import-export policy (EXIM) should be evaluated to improve the price in the market so that it is financially feasible to grow trees on farms.

This kind of strategic shift aligns with the vision outlined in the National Forest Policy of 1988 and the National Agroforestry Policy of 2014. By promoting the sustainable cultivation of trees outside of traditional forested areas, India aims to meet its growing wood requirements while also preserving its valuable foreign exchange reserves. This shift towards more sustainable and locally sourced wood production signifies a positive step in the country's journey towards a more environmentally conscious and economically sound future.

In India, the availability of wood supplies and the ecosystem services given by forests are gravely challenged by deforestation issues caused by illegal logging, shifting land uses, and infrastructure development. To address these problems, India has enacted legislation such as the Forest (Conservation) Act of 1980 and the Wildlife Protection Act of 1972, which aim to control forest resources and safeguard endangered species. These regulations must be strictly

followed in order to assure timber security. Furthermore, supporting sustainable forest management practices, such as Joint Forest Management (JFM) projects that engage local communities in forest conservation and management, is critical.

In a nation like India, where there are many different kinds of forests, scientific forest management is crucial to guaranteeing sustainability and wood supply. In this regard, in 2004, the first working plan code was released, and later in 2014, it was subsequently amended. However, considering the changing trends in forest management and emerging threats to the sustainable development ambitions of our country, the Ministry of Environment, Forests, and Climate Change has released the new National Working Plan Code (NWPC 2023) with effect from July 1, 2023. It is a very inclusive document that follows the criteria of sustainable forest management.

It also incorporates Indian forest management standards, which state forest agencies are free to apply in line with local needs and particular conditions. The "National Forest Certification Programme" (NFCP) will ultimately recognise the forest areas for scientific management as a result of this. It also included the Trees Outside Forests (ToF) Certification Scheme and the Chain of Custody Certification Scheme, showcasing their commitment to the sustainability and security of our nation's wood supply.

Along with that, government programmes such as the National Afforestation Programme and the Green India Mission focus on reforestation and afforestation initiatives to replenish wood resources. Certification systems such as the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) assist consumers in identifying ethically sourced wood products. Furthermore, India's enormous bamboo resource provides a sustainable alternative to traditional wood, contributing to wood security.

Researcher's Perspective on Wood Security and Sustainability

Researchers play an important role in promoting environmentally friendly practices in the wood industry. They undertake environmental impact studies, looking at how wood harvesting and processing affects things like carbon emissions, water usage, and habitat damage (Wear et al., 2002). Research also aids in the identification of biodiversity hotspots in forests and evaluates how different harvesting practices influence local flora and animals, hence guiding conservation efforts (Bawa & Dayanandan, 1997). They also aim to improve sustainable forest management by emphasising ethical harvesting, replanting, and afforestation techniques (Oliver et al., 2014).

To lessen the demand for traditional wood, they investigate alternate materials such as bamboo and engineered wood products. The findings of research have an impact on the laws and policies that regulate forest management and trade, contributing to wood security and sustainability (EIA, 2012). Through audits and assessments, researchers also contribute to the establishment and enhancement of certification programmes such as FSC.

Researchers disseminate their insights through scholarly journals, conferences, and public awareness initiatives (Berkes, 2009). To evaluate the efficiency of sustainable forestry practices, they regularly monitor changes in forest conditions and wood supply. To cope with wood security and sustainability concerns, researchers interact and share best practices on a global scale (Perez-Garcia et al., 2005).

Conclusion

Proper mechanisms are necessary to address the issues of timber demand and supply in Indian Scenario to combat the issue of wood security and sustainability. Researchers are needed to assist in the implementation of ecologically friendly practices in the wood industry. Evaluation of the consequences of logging on carbon emissions, water consumption, and ecosystems while detecting biodiversity hotspots, as well as studies relating to the influences of forest management practices by encouraging moral harvesting and investigating alternatives such as bamboo. Researchers from around the world collaborate to explore wood sustainability and security. Keeping an eye on forest conditions and exchanging best practices is essential.

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Sustainable Wood Sourcing by Indian Paper Industry: Past Experience of Imports, Lessons Forgotten, Crisis Ahead and Suggested Path Forward

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The annual wood demand of Indian "wood based pulp and paper" industry is approx. 12.5 million per annum (+/- 10%) and is expected to increase to 15-16 million MT by 2026-27 keeping in view all the announcements of (a) capacity enhancements in southern side, and (b) augmenting of agro-residue pulp line with wood pulp lines in north India.

At present, these mills' source their wood requirements largely from farm forestry resources in India. These resources have been developed across India with active interventions and support of many of these mills by way of modern nurseries, high yielding varieties and awareness/ education campaigns and buy back. Such efforts started around 1991 post 1988 Indian Forest Policy. Now these programmes are well refined and planned operations, as an integral part of the paper mills businesses.

While the mills invested fairly in capacity building in terms of trained manpower, infrastructure of nurseries and extension activities, the farmers devoted large areas in agroforestry in various parts of India. Seeing is believing. Consequently, many private nurseries came up in Andhra-Telangana, Pondicherry, UP, Uttarakhand, Punjab, Gujarat etc. Wood was surplus by 2007-08 w.r.t 4-5 harvesting cycle.

However, by Oct 2011 one of the largest group, in integrated pulp and paper industry of India, started looking for wood resources in Indonesia and Africa, besides exploring Myanmar for acquisition options. Many other groups started to forecast shortages by 2012, when the wood prices started increasing shapely.

India witnessed large scale imports of wood logs and wood chips during 2013 to 2016. The details are mentioned in table 1.

These details are till the time author monitored the data, before proceeding for an assignment out of India. It is estimated that such imports continued for another year thereafter and estimated quantities being another 0.5 million MT, taking the total imports, in 3 years, to approx. 1.63 million MT.

Table 1 Wood Logs and Chip imports in India - 2013 to 2015

Sr.	Date of Arrival	Ship	Material	Country of Origin	Landed port	Supplier	User mill	MT as received Approx
1	Jun-13	ELINI T	Acacia Logs	Malaysia	Gangavaram	Sidima	JK-JKPM	16,800
2.	Jun - 13	ANDALUSIA	Euca Globulius Chips	Australia	Marmagoa	Mitsui	WCPM	44,000
3.	Aug-13	ANDALUSIA	Euca Globulius Chips	Australia	Marmagoa	Mitsui	WCPM	44,000
4.	31/08/13	ABM Dynamic	Acacia Logs	Malaysia	Kakinada	Louis Teak	ITC	16,000
5.	Aug-13	MV STANIS	Euca camaldulensis chips	Thailand	Kakinada	Sudima	ITC	18,000
6.	04/09/13	ELINI T	Acacia Logs	Malaysia	Adani - Hazira	Sudima	JK-CPM	17,127
7.	02/09/13	CRIMSON POLARIS	Euca camaldulensis chips	Thailand	Marmagoa	Marubeni	WCPM	40,000
8.	29/09/13	MV Jupiter	Euca camaldulensis chips	Thailand	Kakinada	Sudima	ITC	31,000
9.	06/10/13	CHIPSTAR	Acacia Chips	Vietnam	Vizag	ITOCHU	JK-JKPM	37,500
10.	15/10/13	Animonia	Euca Urophylla Chips	South Africa	Marmagoa	Sumitomo	WCPM	40,000
11.	11/11/13	CRIMSON POLARIS	Euca camaldulensis chip	Thailand	Marmagoa	Marubeni	WCPM	43,924
12.	20/11/13	ANDULUCIA	Euca Globuus Chips	Australia	Marmagoa	Mitsui	WCPM	44,000
13.	05/11/13	MV ENY	Acacia Logs	Malaysia	Kakinada		ITC	19,500
14.	10/10/13	m.v. Mariner J	Acacia Logs	Malaysia	Kakinada	Louis Teak	WCPM	15,000
15.	21/12/13	CRIMSON POLARIS	Eucalyptus chips	South Africa	Marmagoa	Marubeni	WCPM	35,000
16.	20/01/14	Brilliant Poineeer	Eucalyptus chips	South Africa	Marmagoa	Marubeni	WCPM	40.000

Sr.	Date of Arrival	Ship	Material	Country of Origin	Landed port	Supplier	User mill	MT as received Approx
17.	27/01/14	MV DAIO Excelsior	Acacia Chips	Vietnam	Kakinada	Marubeni	BILT	45,133
18.	12/01/14	ANDULUCIA	Euca Globulus Chips	Australia	Marmagoa	Mitsui	WCPM	44,000
19.	16/02/14	Brilliant Poineeer	Eucalyptus chips	South Africa	Marmagoa	Marubeni	WCPM	31,977
20.	03/03/14	MV ABM Challenger	Acacia Logs	Malaysia	Kakinada		ITC	16,017
21.	15/03/14	MV DAIO Challenger	Eucalyptus chips	South Africa	Kakinada	Marubeni	ITC	34,329
22.	26/03/14	Brilliant Poineeer	Euca Globulus Chips	Australia	Marmagoa	Mitsui	WCPM	42,168
23.	25/04/14	MV DAIO Excelsior	Eucalyptus chips	South Africa	Kakinada	Marubeni	ITC	31,895
24.	05/05/14	Brilliant Poineeer	Eucalyptus chips	South Africa	Kakinada	Marubeni	ITC	32,464
25.	08/05/14	MV Importer	Acacia Logs	Vietnam	Kakinada		ITC	6,921
26.	25/05/14	MV Tropical Pegasus	Eucalyptus chips	Thailand	Vizag	Marubeni	JK-JKPM	15,800
27.	29/05/14	MV DAIO Excelsior	Acacia Logs	Malaysia	Marmagoa	Marubeni	WCPM	38,550
28.	15/06/14	MV Green Bay	Acacia Logs	Vietnam	Vizag	Hua Hang	JK-JKPM	37,800
29.	19/06/14	MV Grand Furtuna	Eucalyptus Logs	Thailand	Kakinada	Marubeni	ITC	3,842
30.	22/06/14	Brilliant Poineeer	Eucalyptus Chips, Wattle Chips	South Africa	Marmagoa	Mitsui	WCPM	35,000
31.	27/09/14	MV DAIO Excelsior	Eucalyptus Chips	South Africa	Marmagoa	Mitsui	WCPM	32,500
32.	21/09/14	Brilliant Poineeer	Eucalyptus Chips, Wattle Chips	South Africa	Kakinada	Mitsui	ITC	31,737
33.	07/11/14	TUPI MAIDEN	Acacia Logs	Malayasia	Vizag	Sudima	JK-JKPM	14,200
34.	05/11/14	Brilliant Poineeer	Eucalyptus Chips, Wattle Chips	South Africa	Marmagoa	Mitsui	WCPM	32,000
35.	18/12/14	Brilliant Poineeer	Eucalyptus Chips, Wattle Chip	South Africa	Marmagoa	Mitsui	WCPM	31,737
36.	12/01/15	MV DAIO Excelsior	Eucalyptus Chips, Wattle Chip	South Africa	Marmagoa	Mitsui	WCPM	31, 275
37.	22/02/15	MV DAIO Excelsior	Eucalyptus Chips, Wattle Chip	South Africa	Kakinada	Mitsui	ITC	32,301
			Total till February 2015					1,23,497

The indicative CIF Prices of wood chips during 2013-2016 were in a range as given in table 2:

Table 2 : Wood logs and chips, Import Prices 2013-2016

Country	: US$/BDMT		
	Unit	Minimum	Maximum
Malayasia : Acacia Logs	US$/MT	95	120
Australia : Wood Chips	US$/DBMT	193	195
Thailand : Woos Chips	US$/DBMT	165	175
South Africa: Wood Chips	US$/DBMT	175	180
Vietname : Wood Chips	US$/DBMT	155	165

At the same time, in 2015, the prices during the tender, by AP Forest Development Forest Corporation, peaked at around Rs 6900-7000 per MT, for debarked eucalyptus, delivered at plantation site collection point. This is equivalent to farm gate price for harvested, debarked wood.

The changed scenario, of big gap in domestic wood demand and supply, consequently forced the mills for improvement of domestic farmers' wood prices, especially in mills catchment. Farm forestry activities and mills decision making witnessed following key changes during 2013-2018:

1. Mills started focussing more in close proximity to their mill for farm forestry development, especially known is about one big tobacco group with mill in Telangana, another one with presence in Odisha, and Gujarat, following the TNPL model of enriching the close proximity catchment on priority.
2. Some mills started buying wood directly from farmers, reducing/ eliminating the middle men. This was again, in authors' view, followed from TNPL model.
3. Large scale export of eucalyptus clonal plants by private nursery growers from AP to UP and Gujarat states. This also resulted in development of plantations in central UP (Raebareli-Prayagraj-Amethi-Sultanpur-Ayodhya) as new catchment. Eastern-Southern Gujarat also became a new growing belt for Eucalyptus clones in western India.
4. Nellore in AP and surrounding 100 km witnessed comparatively dry spell and massive eucalyptus farm forestry was initiated by land owners with planting material from private nurseries between Alligudem and Jangareddygudem, along Godavari river.

By the end 2017 prices stabilised. During 2018 and 2019 there were protests from farmers in Andhra Pradesh and Telangana about very low prices being paid by wood based paper mills. Mill delivered prices in the belt of Andhra Pradesh-Telangana-Odisha-Maharashtra-Gujarat-Karnataka ruled between 3500-4500 per MT for Subabool and Eucalyptus. Consequently, the prices delivered to farmers were much less and the market mechanism was not able to cover the growing cost of wood in many instances.

The flawed procurement policies resulted in change of land use by farmers and shifting away from growing pulpwood in many pockets in these states. The obvious result has been reduction of pulpwood growing area and availability of pulpwood in 2023.

Similar scenario developed in North India also with a different timeline. In the states of Punjab, Haryana, Uttarakhand, Uttar Pradesh and Madhya Pradesh shortages started about 2 years ago and have not stabilised yet. This resulted in big blow to entire wood based industry sector in North India. Large number of veneer mills have been closed. Paper mills increased focus on imported pulp while allowing usage of miscellaneous wood species (Low cost) in raw material mix as a compromise.

In September 2023, ITC paper mill in Telangana imported one ship of wood chips from Thailand at Kakinada port. We are back to it again.

The sequence of events indicate following:

1. Focus on farm forestry thru trained manpower, infrastructure of nurseries, extension activities worked well
2. Procurement policies of mills' still have a big inconsistencies for ensuring sustainability of wood supply on long terms basis in terms of quality, quantity, prices and farmers wellbeing.

Following gap areas have been identified:

1. Lack of integrated command for Farm Forestry development team and Wood sourcing team
2. Tendency to keep the prices suppressed in the vicinity of mills during easy availability years
3. Wood procurement being the responsibility of "Commercial Heads" who are not at all connected to forestry/ agriculture and who are experienced buyers on "Three quotation - Select the lowest" concept

Before providing a path forward, let us look at what would it look like for paper mills' wood cost now, and what are the options, through the lens of numbers.

How much does it cost to import wood chips now?

Table 3 Imported wood Chips prices

CUSTOMS TAR IFF HEADING (HSS CODE)			44012200	
				lb./BDMTSr
.Sr.#	Particulars	Factor	Source of Chips	
			ASEAN	NON ASEAN
3	CIF price In US$		190.00	190.00
5	Exclange rate	83.5	83.50	83.50
7	Va lue In INR		15865.00	15865.00
8	Landing dues @	1%	158.65	158.65
9	Assessable Value CIF (5 +7)		16023.65	16023.65
10	BCD Tariff on (8) @	5%	0.00	801.18
11	SWS on BCD	10%	0.00	80.12
12	Total BCD + SWS + CIF		16023.65	16904.95
13	IGST as per Nf. No.001/2017 sl.no. 1198....@	5%	801.18	801.18
14	IGST Cess as per nf. no.01/2017 sl.no. 56...@	0%	0.00	0.00
15	IGS and GST CMJ (13+14)		801.18	801.18
16	TOTAL WITH IMPORT DUTY (Rounded off)		16824.83	17706.13
At moisture equivalent when compared to domestic prices @			40%	Rs./MT
	Cost on arrval at port without IGST/ GST		I9614	10143
	Cost on arrival at port witn IGST/ GST		10095	10624

Set off is available against IGST/ GST on finished goods . Not usually considered In comparisons of wood prices

It can be seen that wood import prices have appreciated by about 8-10% only in a decade. However, the currency exchange rates have become unfavourable for wood chip imports to India, during 2013 and 2023, with 33.5% appreciation of US $, as seen below in chart 1 below.

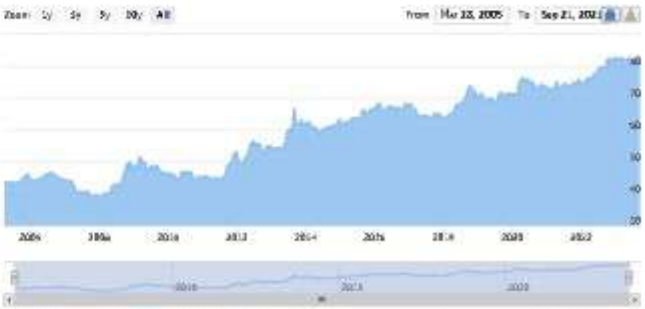

Chart 1: INR: US$ Exchange rate changes, 33.5% increase in a decadea

Source:https://www.poundsterlinglive.com/bank-of-england-spot/historical-spot exchangerates/usd/USD-to-INR

Wood logistics and transport is affected by the fuel rates changes in India.

https://www.mycarhelpline.com/index.php?option=com_easyblog&view=entry&id=808&Itemid=91

Consequently, the cost of imported wood chips, when delivered to mills in present scenario, will have following cost structure, sensitivities and comparison with domestic wood for various mills studied, as outlined in tables 4,5 and 6:

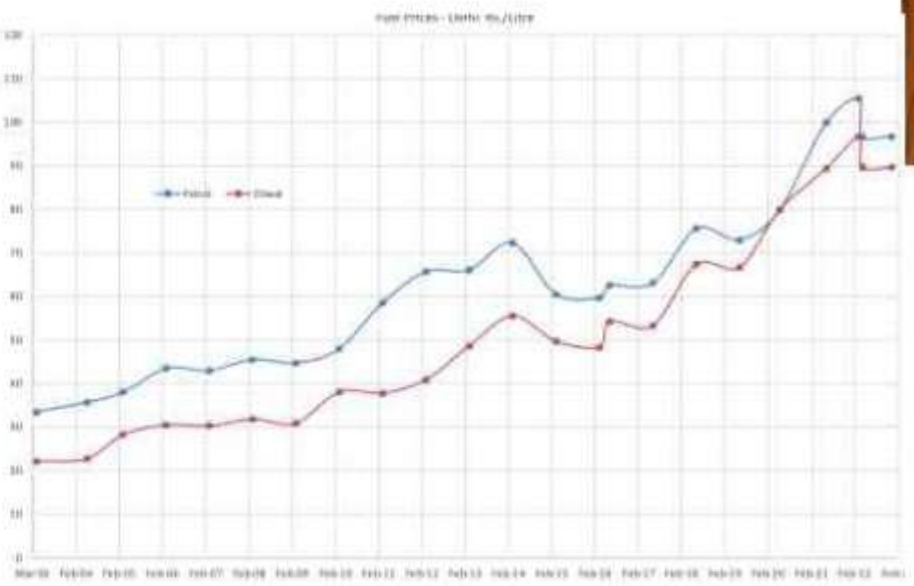

Chart 2: Fuel prices changes in India 2003 to 2023- 20 years. Increase of 84% in a decade Source:

Table 4. Wood Chip Import Scenario building for Pulp and Paper Mills

Exchange Rate ₹ 83.50 to US$ Debarked Eucalyptus / Acacia Mangium

Sr #	Particulars	Unit	Bangur APL	ITC Paper	Singhania JK Paper		Aarvantha BGPPL
a		Port	Kakinada	Kakinada	Gangavaram	Hazlra	Kakinada
b		Destination	RaJahmundry	Sarapaka	Singapur	Songarh	Ballarshah
c		Km to mill	70	230	220	115	600
d	CIF Price basis	US$/ BDMT	190	190	190	195	190
1.0	Total Duty,cess,taxes He at port	R.s./BDMT	16024	16024	16024	16445	16024
2.0	Charges for Handling,clearence, documentation,plot land rent, wharf age etc	Rs./As is MT	1200	1200	1400	1400	1200
3.0	Freight from Port to Mill	Rs./As is MT	1320	3190	3300	1870	4950
4.0	Total Hancling and Fright	R.s./As is MT	2520	4390	4700	3270	6150
5.0	Molsture %	30%	30%	30%	30%	30%	30%
6.0	Total Hancling and Fright	R.s/BDMT	3600	6270	6710	4670	8790
7.0	Mills la Rat R.s./BDMT	R.s/BDMT	19624	22294	22734	21115	24814
8.0	Mills la Rat @140% molstur eq	Rs./ MT	11774	13376	13640	12669	14888

Table 5 Sensitivity Analysis Mill Landed rate @40% equivalent Rs /MT

Sensitivities		Bangur APL	ITC Papers	Singhania JKPape		Avantha BGPPL
		Rajahmundry	Sarapaka	Singpur Road	Songarh	Ballarshah
CIF Prices Cha!:lles USSI BDMT						
190, 195 Base case		11672	13130	13388	12525	14498
180, 185		11166	12624	12882	12019	13992
195, 200		11925	13383	13641	12778	14751
Freight Increase of 10%		11774	13376	13640	12669	14888

Table 6. Estimated Domestic Prices from different sources - Rs./MT Eucalyptus/ Subabool/ Casaurina

Minimum		5500	6500	5100	7000	7000
Maximum		9500	12000	12000	13000	12000

(CIF prices at JK Unit at Songarh, being on western coast, are likely to be 5$ higher)

Some benefits of using imported wood chips are claimed to be as under. These factors have positive impacts on the fibre cost of the mills:

1. Pulp Yield benefit of ~3.5%
2. Saving in chipping cost and process losses
3. Uniform quality related pulping process efficiency benefits

It is clear from the current scenario analysis, subject to the fine tuning of analysis of cost structure, that JK Paper Unit at Songarh, Gujarat would certainly and immediately benefit from wood chip imports. Other mills may be required to soon follow suit. Probably this is the reason ITC-Sarapaka has initiated, well in advance, to experiment with imports to streamline the supply chain for bigger crisis anticipated.

Now it is a matter of further examination and fine tuning whether,

a. the mills should import wood chips sooner keeping in view the upcoming rains in south India in October-November and/ or increase in prices further ? OR
b. the mills should import pulp @650$ or so? OR
c. the mills should focus on increase in farm forestry in vicinity of mills again in a cooperative manner, jointly

It is well understood, in the Indian context, that if 25% of cultivable area is converted to fast growing hardwood cultivation (with 2 to 3 species mix) on 4-6 years rotation basis, in 50 km radius catchment of wood based mills, there would be annual wood availability of 18-25 lac MT depending on climate and soil related productivity of these plantations, in stabilised scenario after 10-12 years

With this back ground, it is clear that, domestically, wood can be grown economically. Right procurement policies can help develop wood supply sustainability. The author recommends following key procurement policies for wood based industry in India w.r.t domestic wood growers as sustainable wood buying practices. All other decisions, activities, efforts, rules, procedures and events should be aligned towards following these policies:

1. Follow one species, one price. Wood may be bought from any source between one km to thousand km, there should be one price. This would lead to increasing the farm forestry/ agroforestry in the very close proximity of mills.
2. The mills purchase price should be publicly known to all farmers and prominently displayed/ announced at mills gates or other forum, whenever changes happen.
3. Develop wood harvesting and logistics service agents, to provide efficient and effective services to the wood growing farmers. Make the list of such certified service providers available to the farmers by prominent displays, pamphlets or website links.
4. Maximise direct buying from farmers with direct payment of wood to farmers bank account. All sugar-mills follow this practice well.
5. Monthly/ Periodic review of prices: This review should work to align the prices with following criteria and decide to pay which-ever is higher

a. towards cost of cultivation + Financing cost + minimum 10% annual return
b. towards better returns than second best crop in the region.
c. towards better than what the competition is paying in the closest vicinity of the mills' catchment 6. Incentive structure to encourage the farmers to work on agroforestry and sustained productivity improvement works, and efforts.

7. Minimise the carbon foot print of wood buying transport.
8. Public recognition of wood growing and supplying farmers at socially important organisations and institutions – Clubs, Schools, Colleges, Mills annual events, and more importantly at key board meetings/ AGMs.
9. Digital tools deployment for servicing the wood growing farmers in various ways: Price announcements, wood buying, replanting, growth forecasting, yield assessments etc.
10. Prices offered to wood growers in 100 km radius should never be less than any other source for same wood species.

Conclusion:

1. Indian farmers are capable and willing to take risks for new crops and varieties including tree crops.
2. Mills procurement policies need to be aligned to long term sustainability of farm forestry and farmers' well-being. There should be only one price for one species for each mill.
3. In the current scenario wood chip imports are imperative for all mills for next 2-3 years business cycle, without much compromising the comparative competitiveness.

References :

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Latin America – Dominating Indian Teak Market

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Teak (*Tectona grandis*) is one of the world's premier hardwood timbers, accurately famous for its rich colour, fine grain and durability. It occurs naturally only in India, Myanmar, the Lao People's Democratic Republic and Thailand, and it is naturalized in Java, Indonesia, where it was probably introduced some 400 to 600 years ago.

Teak wood is well recognized in the world timber industry for its quality and appearance. The demand for planted teak has increased significantly in recent years. It is known as 'the King of the Hardwoods' and is celebrated all over the world for its incredible durability and stability. It is not only resistant to attack by fungi and insects but also known for resistance to the extremities of weather, such as sun, rain, and heat. The unique characteristic makes it the favourite species for multiple products and uses like furniture, decking, civil as well as naval constructions.

Indian Teak Imports

The world teak trade is directed towards the Indian market. India consumes almost 95% of teak logs exported from Africa and Latin America. Despite teak being produced in abundance for generations in India, growing demand and mismanagement led to frightening rate of deforestation all over the country causing ecological imbalances and harm to our environment till the landmark Supreme Court judgement in 1996 stopped all tree felling and non-forestry activities inside the forests. The path-breaking order re-defined the timber trade completely slowly making India the biggest importer of teakwood in the world.

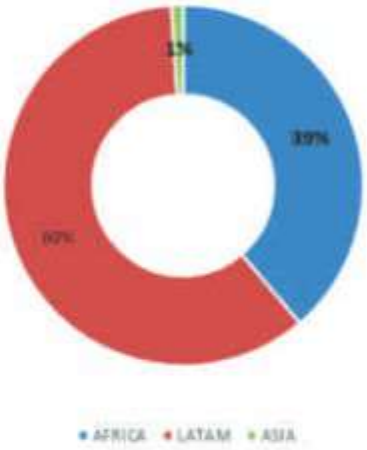
International Trade Centre data reveals that China and India have been, by far, the top two importers of tropical hardwoods and logs for quite a few years. As per Dr. P. K. Thulasidas, TEAKNET Coordinator, Kerala Forest Research Institute, *"The global teak market has been and will continue to be governed by trends in the Asian markets. Asia holds more than 90% of the world's teak resources, with India alone accounting for almost 38% of global planted teak forests. High international demand for general utility teak has broadened the traditional teak supply base from natural forests in Asia to fast-growing, small-diameter plantation logs from Africa and Latin America."*

Measurement of teak wood in our port at India

"Any fluctuation in Indian demand affects global teak trade" - Kenichi Shono, Forest Resources Officer, FAO Regional office for Asia and the Pacific (Bangkok, Thailand).

TEAK CONTAINER IMPORTS IN INDIA YOY (2018-2022)							
Origins	Region	2018	2019	2020	2021	2022	Grand Total
GHANA	AFRICA	10,660	13,928	9,576	11,967	14,417	**60,548**
ECUADOR	LATAM	9,825	13,174	7,996	15,371	12,216	**58,583**
BRAZIL	LATAM	8,772	9,375	7,647	9,459	6,876	**42,128**
PANAMA	LATAM	5,762	6,653	5,582	9,200	8,015	**35,212**
BENIN	AFRICA	4,575	4,282	3,565	5,899	5,681	**24,002**
COSTA RICA	LATAM	6,154	6,492	3,734	5,951	3,122	**25,454**
COLOMBIA	LATAM	1,567	2,309	1,993	4,355	2,421	**12,645**
TOGO	AFRICA	1,280	1,693	1,881	1,855	2,637	**9,347**
TANZANIA	AFRICA	1,961	1,997	1,259	1,794	2,125	**9,136**
GUATEMALA	LATAM	729	1,329	1,043	1,501	1,406	**6,008**
NIGERIA	AFRICA	1,981	1,591	792	804	1,005	**6,173**
IVORY COAST	AFRICA	373	352	437	786	1,314	**3,262**
SUDAN	AFRICA	1,827	1,109	589	568	867	**4,959**
NICARAGUA	LATAM	372	529	484	830	732	**2,948**
MEXICO	LATAM	79	185	232	958	550	**2,002**
MYANMAR	ASIA	962	1,022	273	112	867	**3,235**
CAMEROON	AFRICA	111	126	284	553	488	**1,562**
LIBERIA	AFRICA	37	42	327	537	422	**1,365**
EL SALVADOR	LATAM	460	288	288	317	265	**1,619**
Grand Total		**57,723**	**66,723**	**48,080**	**72,907**	**65,424**	**310,187**

TOTAL TEAK IMPORTS INDIA 2018-2022



A typical teak wood plantation site post harvest

Teak in Latin America

Teak plantations have been managed professionally in Latin and South America since the 1990s leading to a very well managed and organized 'industry' which has been leading the world teak trade flow by consistently supplying the highest volume year after year for almost a decade now. Have a look at the below map showing cumulative export of last five years from various countries all over the world to get the complete picture. Latin America and South America clearly dominates the global teak flow as visible in 'green'. Brazil, Ecuador and Panama are the leading players followed by various other countries in the region. Incidentally, Brazil also has the world's largest teak plantation which single-handedly is setting the direction of trade flow and teak economy of India, which we will discuss further in the "Brazil" section later.

The following table illustrates the 'Teak movement' wide spread in Latin and South America through systematic plantation since early 90's. It includes all big corporate farms as well as small individual farms in the region.

Table: Distribution of Teak plantations in Latin & South America

Country	Teak (Hectares)
Brazil	75,000
Ecuador	45,000
Panama	40,000
Mexico	35,000
Costa Rica	23,000
Colombia	25,000
Guatemala	25,000
Nicaragua	17,000
Others	**15,000**

Brazil has the largest land area having teak wood plantations, covering about quarter of the exports of the region only surpassed by Ecuador and followed by Panama. These three countries are the top exporters over the years accounting for almost 3/4th volume of teak export from the region over past five years.

The above table shows the number of containers imported in India from the entire region of Latin and South America for the last five years from 2018 to 2022. Exports have been rising consistently over the years only hindered by COVID-19 during FY2020 and massive increase in shipping line freights in FY2022. On an average Latin America contributes 60% of the total volume of teak imports in India which is roughly 40,000 containers per year making it approximately 8,00,000 Cbm in a year.

As visible in the table, FY2021 had a massive spike in volumes which was due to the fact that most of the companies could not export their extracted/processed wood in FY2020 due to COVID restrictions leading to a cash flow crisis along with the risk on their inventory. All those accumulated inventory got exported from various origins as soon as the port restrictions got relaxed leading to a massive surge in FY2021 which got spilled to FY2022 as well.

High sap is a common feature in all origins here

Origin	2018	2019	2020	2021	2022	Total	%share
Ecuador	9,825	13,174	7,9961	5,3711	2,2165	8,583	31%
Brazil	8,772	9,375	7,647	9,459	6,876	42,128	23%
Panama	5,762	6,653	5,582	9,200	8,0153	5,212	19%
Costa Rica	6,154	6,492	3,734	5,951	3,1222	5,454	14%
Colombia	1,567	2,309	1,993	4,355	2,4211	2,64	57%
Guatemala	729	1,329	1,043	1,501	1,406	6,00	83%
Nicaragua	372	529	484	830	732	2,948	2%
Mexico	79	185	232	958	550	2,002	1%
El Salvador	460	288	288	317	265	1,619	1%
Total	**33,720**	**40,334**	**29,000**	**47,943**	**35,602**	**186,598**	

Table: Teak volume from Latin & South America FY 2018- FY 2022

Although the ocean freight had gone up dramatically post Covid but the Indian teak market supported and absorbed it because of the huge latent demand of raw material from all over the country due to the negligible supply in the previous year. However, over time the inflated prices did not hold up in the market leading to a huge drop in demand as well as local selling prices leading to an unprecedented crisis in the teak market in 2023.

The year 2023 started slowly and the teak market turned from bad to worst with every passing month suffering consistent drop in demand as well as prices putting huge pressure on shrinking teak margins all over the supply chain making it difficult for small traders to survive. Fortunately, ocean freights during this period came down to normal/pre-Covid level but still the importers could not sustain their volume due to the massive groundstock of high value cargo purchased during FY2021-22 which was increasingly getting difficult to liquidate in the sliding market. This further added to the pessimist sentiment in the industry triggering various defaults at the origin. The situation is still unfolding as we enter the last quarter of the year but there is no sign of respite in the calendar year 2023.

Overview of the countries in Latin and South America dominating the India teak market:

Brazil

Brazil being one the largest country in the world also holds the largest privately managed farm of the world – Teak Resources Company which is 45,000 hectares. Along with this there are various other farms of individual investors making Brazil one of the key players in teak trade flow if not the most important one!

Though half way across the world with high logistics and inland transport costs the teak imports from Brazil is consistent and fueling about 14% of the teak consumption in India. In FY2022 when the container

Formation of Brazil teak ensures highest yield

freight was high across the board, Brazilian teak wood was exported in open vessels which was only possible due to the scale in which the material was extracted. Also, there are other economic factors such as investor expectation, low operation costs, and high competition which is driving the volumes here.

Mundra is the major port where Brazil wood is in demand consuming 60% 0f all Brazil origin wood as the material is consistent in formation and quality, having better yield than wood from other origins. The formation of the trees from this origin especially the clones have a stupendous yield of 81% in our sawmills here. Traditionally Mundra has been a big consumer of average quality 12-18 years old teak wood and Brazil fits the bill very well. Tuticorin and Chennai mostly consume the premium quality wood of Brazil where they get best prices too.

Mundra is the major port where Brazil wood is in demand consuming 60% 0f all Brazil origin wood as the material is consistent in formation and quality, having better yield than wood from other origins.

Table: Brazil imports to India port wise

Ports	Jan'23	Feb'23	Mar 23	Apr 23	May'23	Jun 23	Jul'23	Aug 23	Sep'23	Total
Mundra	393	587	239	306	754	745	785	579	345	4,735
Tuticorin	253	153	121	107	90	185	211	199	181	1,499
Chennai	183	105	92	96	104	56	75	103	101	915
Nhava Sheva	50	46	59	19	45	33	45	82	20	398
Nagpur	17	53	-	13	18	8	3	27	19	158
Mangalore	-	23	19	-	12	19	9	28	7	117
Vishakhapatnam	-	6	4	10	16	-	8	7	-	50
Bangalore	6	1	-	-	-	-	-	-	-	7
Kolkata	-	-	-	-	-	-	6	-	-	6
Total	**901**	**973**	**533**	**550**	**1,039**	**1,045**	**1,143**	**1,026**	**674**	**7,884**

Ecuador

Ecuador unlike Brazil is a country with many individual small-medium-big farmers and investors owning teak wood in their properties. During 1990s when the American and European funds were investing in big farmlands for teak plantation in Latin America many individual property owners followed suit and started growing teak in their small to medium farms. Notable corporates here are Reybosques and Grupo Siembra.

Ecuador teak is exported only in 'processed' form

Though there are various farms in Ecuador with good and premium quality material, most of the wood is 12-16 years old which is of normal-commercial quality. Government in Ecuador does not allow round logs to be exported to promote jobs locally so teak is exported as rough squares as visible in the above photo.

Well defined grains in Ecuador teak is unique

The volumes imported till Q3 of FY2023 was surprisingly almost same as Brazil. Again because of the normal-commercial quality like Brazil, Mundra is the biggest consumer of Ecuador teak accounting to 68% of the total Ecuadorian teak wood imported in India. This is followed by Nagpur and Nhava Sheva which are niche markets for rough squares. South India only imports the premium quality teak wood from Ecuador.

Table: Ecuador imports to India port wise

Ports	Jan'23	Feb'23	Mar 23	Apr 23	May'23	Jun 23	Jul 23	Aug 23	Sep'23	Total
Mundra	773	749	1,164	435	412	431	302	666	503	5,434
Nagpur	165	158	-	132	145	121	104	303	112	1,240
Nhava Sheva	112	63	32	107	131	57	121	110	47	782
Chennai	45	39	64	19	26	20	30	22	42	308
Mangalore	-	13	10	-	-	-	9	11	11	54
Tuticorin	3	23	2	3	-	-	2	4	5	41
Kolkata	-	6	-	-	-	-	3	5	3	18
Bangalore	-	3	-	-	4	-	-	-	-	8
Hyderabad	-	-	-	3	-	-	-	-	-	3
Total	**1,099**	**1,054**	**1,272**	**701**	**719**	**629**	**571**	**1,121**	**723**	**7,888**

Panama

Panama being the business center of Latin America and the supportive government and banking rules enabled many corporate funds to own and cultivate teak wood farms in Panama. These corporates have managed the farms well generating a consistent volume of 7000-8000 containers annually if there are no constraints in market or logistics. GKM, United Nature, Apical, 12Tree and Forest Finance are the big corporates farm consistently supplying wood to India.

Panama teak with good formation works well

Mundra and Tuticorin ports consume almost all the material of Panama with a few containers being exported to other ports as per spot demands. This country has a capacity to export about 10,000 containers however market factors in play do not allow the volume to increase beyond a certain limit every year.

Round and sound Panama teak logs

Table: Panama imports to India port wise

Ports	Jan'23	Feb'23	Mar 23	Apr'23	May'23	Jun'23	Jul'23	Aug 23	Sep'23	Total
Mundra	54	31	64	383	861	729	462	252	89	2,924
Tuticorin	202	99	146	299	462	719	241	224	88	2,479
Chennai	30	13	18	130	205	83	110	54	18	661
Nhava Sheva	14	13	24	66	100	94	51	12	5	379
Mangalore	-	-	1	4	27	22	3	-	-	57
Nagpur	4	-	-	-	11	-	19	11	4	49
Bangalore	-	-	-	-	3	-	-	-	-	3
Cochin	-	-	-	-	2	-	-	-	-	2
Total	**304**	**156**	**254**	**882**	**1,671**	**1,647**	**885**	**552**	**204**	**6,554**

Costa Rica

Costa Rica is one of the safest countries in Latin America thus attracting American and European funds and individual investors to own and manage land and use for teak cultivation. The quality of Costa Rica teak wood is considered to be better than its neighbors and thus fetches better prices too. This however is a disadvantage in a sliding market when the buyers want cheap wood to sustain and thus the export from Costa Rica has been going down consistently from 5,500 boxes to 3,500 boxes over the last 5 years.

Costa Rica teak is still considered the best substitute of African teak in long logs

The sliding volume and price pressure has affected the investors sentiments big time as they did not get the expected return from their farmlands since last few years thus demotivating them to replant teak in Costa Rica. This trend is widespread now and landowners post extraction of teak either plant pineapple, sugarcane or sell their property to real estate developers.

A golden feel in grains makes Costa Rica special

Area under teak wood management has dropped from 35,000 to 23,000 hectares over the last 10 years and still dropping. Costa Rica is slowly becoming a small player with every passing year as most of their farms are extracted and the replanting percentage is very low.

Table: Costa Rica imports to India port wise

Ports	Jan'23	Feb'23	Mar'23	Apr'23	May'23	Jun'23	Jul'23	Aug 23	Sep'23	Total
Mundra	37	135	80	211	264	221	106	106	4	1,164
Tuticorin	124	36	62	52	149	124	81	82	62	772
Nhava Sheva	34	92	13	62	102	67	129	96	8	602
Chennai	38	44	44	25	97	48	73	6	29	405
Mangalore	-	-	34	29	18	29	8	8	4	130
Nagpur	10	3	-	-	3	9	9	14	-	47
Vishakhapatnam	-	-	-	-	-	-	5	-	7	12
Total	**242**	**310**	**234**	**379**	**634**	**497**	**411**	**311**	**113**	**3,132**

Colombia

Colombia is an upcoming country in teak exports as the teak farms in the country are maturing and slowly reaching the age of extraction. Although it also suffers from a unique issue as the investors planted the teak but could not manage well due to unstable political scenario of the country. This led to slow growth and inconsistency in quality of teak wood which affected the investments big time. However most of the teak wood has thin bark and core strength because of the slow growth which increases the yield and thus the demand among the buyers.

Though the current volume at 2000 containers is low compared to the top three players but this country will start exporting double its current volume annually in the next couple of years.

Colombia teak with good heart and strength

Colombia plantations have a premium feel

Guatemala

Guatemala annual volume has never been historically more than 1500 containers of which about 70% volume is being exported by a single plantation which is a 14,000 hectares farm owned by GFP – Global Forest Partners. This farm is in the north side of Guatemala. Apart from this there are some farms of individual owners around the same region.

In the south region of Guatemala there are some big sugarcane factories who have planted teak wood as their secondary investment. They also extract teak every year though the volume is insignificant for now.

Guatemala teak square

Guatemala teak has a uniformity in formation

Nicaragua

Nicaragua has a very small share in teak exports as of now but it is growing. The plantations are mainly shared between two big companies- Novel Teak and Equiforest. The quality is mostly normal-commercial with age of 12-18 years and the exports are sporadic as the country is not stable politically. Due to the low quality and high logistics cost, around 40% of the wood is processed into sawn lumber and caters to the Nagpur market where there is a huge demand for this product.

Thick sap is consistent in Nicaragua teak

Mexico

Mexico has not been a big player of teak exports from the region however it has the presence of two of the big corporates – Proteak and Santa Genoveva who own big plantations there. One of the factors behind the low export is their ability to process the wood as final products and cater to local and western markets which gets a good margin. They do not see the need to export teak wood as round logs to India.

Normal-commercial quality of Mexico teak

Other Countries

Teak is present in almost all the countries in Latin America however they do not systematically export due to small volumes. Countries such as Honduras, El Salvador, Venezuela have teak wood however traders have not been present as the overheads will not do justice to the export numbers and hence the volume continues to stay sporadic and low . Also, the political and safety concerns dissuade traders or investors to focus on these countries. There will however be a total of approximately 750 containers annual volume from the countries mentioned in absence of any extraordinary situation.

Conclusion

Latin and South America is already contributing approximately 60% of the total teak wood imports into the Indian market and is well poised to dominate more for years to come. With time, focus will keep shifting more and more to sustainable wood consumption which will keep pushing the demand for plantation teak coming in from the region to Indian market. The current plantations across various countries in the region are still at various stages of growth so there will be no dearth of supply in the coming decade. The key will be the balance between demand and supply which has got further skewed towards over-supply post Covid hampering the trade flow by consistently squeezing the margins.

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A Case Study of a Clonal Euca Nursery Production Cluster, Alligudem (Andhra Pradesh)

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Introduction:

Eucalyptus (referred Euca hereafter) is a wonderful tree that is now integrated in many land-uses for fulfilling multiple functions in production and landscaping. The tree is grown over a major geographical area of the country except very high altitude temperate lcoations where it is not adapted to extreme cold climate. The tree is extensively grown both inside and outside forests. Currently the tree is being promoted by the most state forest departments, wood based industry (WBI), research establishments, nursery growers and even NGOs. In the state of Andhra Pradesh, Euca wood sale earns maximum revenue to the Andhra Pradesh Forest Development Corporation which plants, manages and harvests its plantations raised on government land (http://www.apfdcl.com/Pages/AboutUs/FinancialDetails.aspx). Farmers prefer growing it on their fields for wood production which is much in demand as raw material for paper pulp, panel industry and other large number of wood products. Outside forests, Euca was initially promoted in farm forestry during late 1970's by some state forest departments especially Gujarat (Patel High Density model), Punjab & Haryana. Later on ITC Ltd. starving for quality raw material for paper grade pulp, started promoting it systematically in Andhra Pradesh and some adjoining states. The use of the tree has now signficantly increased to many sectors and currently it is the life-line for most of the panel and paper industry. Its intensive culture has further expanded to different geographical locations with expanding wood based industry in the country.

Among all the natural and planted origin trees outside recorded forests, Euca constitutes 2.55% share in number (177.736 M (million)) and 1.63% share in standing volume (29.08 Mm^3) (ISFR 2021). There were more trees in lower diameter class of 10-30 cm dbh (161.778 M) than in 30-60 cm dbh (7.832 M) and >60 cm dbh class (0.033 M). Similarly, growing stock (GS) of the tree was 15.17 Mm^3, 11.19 Mm^3 and 2.72 Mm^3 in 10-30cm, 30-60 cm and >60 cm DBH class respectively in the country. Forest Survey of India, in its earlier report, mentioned 297.566 M Euca trees in the country (ISFR 2017), out of which 100.766 M (33.86%) were inside forests and 196.800 M as TOF (66.14%). Similarly, GS was 26.03 Mm^3 (45.36%) inside recorded forests and 31.35 Mm3 (54.64%) in TOF. All these Euca inventories were recorded for trees over 10 cm dbh, whereas a lot of Euca plantations are harvested young before attaining this size and hence number of trees and GS is much higher than these figures. In fact, currently, Euca is reportedly the top planted forest tree on farm land. According to an estimate, around 200 M clonal Euca plants were being planted annually around a decade back (Dhiman and Gandhi 2014) and the number is certainly much higher now.

Euca in many locations is being planted in agroforestry where the tree is complementing agricultural crop production and in some locations in farm forestry where it is competing well for economical returns with agriculture crop production. As the demand for quality clonal Euca plants is significantly increasing over the years; a greater part of it is now produced by the unorganized sector of which the Alligudem cluster has gained the significant top position. Plant supply from Alligudem is continuously happening around the year to those locations where it is planted throughout the year. Locations especially in Indo-Gangetic plains have sites/fields well prepared along with well developed irrigation system for growing agriculture crops and here Euca is planted any time as per the convenience of farmer's, his resources, time and vacation of land from existing crop production including past Euca plantations. The major supply of clonal Euca, however, take place around July-Sept. when establishing its field plantations peaks up all over especially in those locations where the planted land depends on monsoon rains for water requirement. Gujarat also get major supplies during monsoon season, though in the current year some corporate procured plants during April-May and stocked it at their satellite nurseries for maintenance till they are supplied to farmers for field planting. Locations in South Andhra Pradesh (AP) procure its plants between Oct.-Jan. when most of its plantations are established.

The success of Euca culture in many states, region and country is based on developing integrated synergies between back-end and front-end activities in the nursery productionplantation-wood processing value chain. Among different activities, quality planting stock production is basic to successful plantation programs. Till 5 decades back, Euca nursery production was restricted with mainly the state forest departments eventually started shift over to corporate sector and progressively expanded to small private nurseries in many parts of the country. Extensive expansion in Quality planting stock production outside state forest departments created a favourable ecosystem for its rapid expansion. We studied and documented one such case study of a nursery cluster of clonal Euca planting stock production in Alligudem locality of the recently carved district Allury Sitharama Raju which was earlier part of Visakhapatnam and East Godavari districts of Andhra Pradesh.

Two lead authors of this paper are associated with the Greenlam Industries Ltd. which is one of a few select global leaders in surface decor products including laminates brands, decorative veneers, engineered wood doors & frames, cladding etc. Greenlam is Asia's largest and Globally among top 3 laminate producers, besides being the largest exporter of laminates since 12 consecutive years with footprint in 100+ countries. The present study is an outcome of Greenlams's exploration of back-end and front-end synergies in Euca production-utilization value chain in South India. Greenlam, for its wood augmentation strategy, has started creating adequate wood resource on farm fields around its product manufacturing locations well ahead of commissioning its panel manufacturing plants. First phase of plantations being started during the current year planting season, will progressively expand the reach to match company's wood demand, and further create a buffer of 10-15% additional plantations for any spillover of our promoted wood to others. The company further, envisages developing strong R&D backup through collaborative and in-house research for panel wood tree resources similar to much acclaimed case studies of matchwood and paper pulp industries.

Clonal Euca nursery production system

Euca, till some decades back, was propagated using seed since the tree was known as difficult to root even with root promoting hormones. With increased knowledge on vegetative propagation especially in relation to juvenile-mature relationship in long lived trees like Euca, it has been possible to gradually develop its commercial clonal propagation technology. Scientists at Wimco Seedlings Ltd., Rudrapur, Uttarakhand first time produced clonal Euca plants using its juvenile shoot cuttings during 1986 (Chandra and Yadav 1986) and latter ITC PSPD Bhadrachalam standardized the technique for large scale clonal production (Kulkarni 2008). ITC also created ultramodern clonal multiplication facility for producing millions of clonal plants near its paper mill at, Bhadrachalam, in A.P. ITC remained the sole corporate that remained engaged with its R&D, clonal nursery production and promotion of its plantations before others witnessing its success started venturing in nursery production and plantation programmes.

The current technique of clonally multiplying Euca involves selecting a good site matched clone, create its juvenile cutting production system, take nodal or apical cuttings, plant them in root trainers filled with rooting/potting media, place root trainers inside misting chambers, maintain high humidity and tolerable temperature inside chambers, take out successfully rooted cuttings to the hardening chambers, shift plants from hardening chamber to open nursery space for acclimatization, and nurture them till they attain around 30 cm height for field planting. Clonal Euca nursery production needs appropriate environment of high humidity and moderate temperature for initiating the rooting in the cuttings. Such suitable conditions are created in assorted chambers created by many of corporate and small nursery growers.

Alligudem clonal Euca nursery production cluster

ITC has been regularly producing clonal plants of different Euca species and clones and promoting its plantations from early1990s. The demand for its planting has gradually increased and its culture expanded to new locations and states. The real craze for its planting started in the beginning of first decade of the current century, when demand for clonal Euca plants exponentially increased. It was during 2002 when some workers, supervisors and a couple of managers working in ITC clonal production visualized large potential in sale of its plants, moved out, and started their own clonal Euca nurseries. While being in ITC, they were having required skills in clonal production and also some exposure of captive cultivation and nursery propagation in government departments which helped them in taking up this activity. They instead of constructing very costly nursery infrastructure for rooting the cuttings at par with ITC system innovated with low cost polytunnels those were being used for captive cultivation of vegetables, ornamental plants and nursery production elsewhere with installed misting nozzles inside them for maintaining high humidity that

is necessary for rooting Euca cuttings. They started this activity around Alligudem in Allury Sitharama Raju District of Andhra Pradesh where the human resources with adequate technical skills for clonal nursery production (Ex-ITC) were readily available.

Alligudem site is located near the bank of Godavri river and has/had many favourable ingredients for initiating and scaling up clonal Euca nursery production that include consistent availability of good quality water around the year, water table near to ground level, good climate of moderate humidity and temperature, and sandy soil along the river which is suitable for padding the chambers internal ground space. These new nurseries started getting good response from farmers, other wood based industry and forest departments in term of high volumes of Euca plant supply and increased revenue collections. Many other locals, visualizing it as an opportunity for developing self employment in production and trade of clonal Euca plants, also started this business that helped in gradually developing Alligudem as the main hub and the largest single location for clonal Euca nursery production in the country. All nurseries here produce only clonal Euca plants as its volume is much higher than any other single player and/or location in the country

Fig.-1. A view of a clonal Euca nursery at Alligudem.

Fig.- 2. Labour shifting overstayed rooted plans inside misting chamber (Poly-tunnel).

A couple of misting poly-tunnels (referred as misting chambers) started initially has now increased to around 150 in number which are collectively producing millions of plants and supplying them to the major Euca growing locations and states in the country. Nurseries having more than 10 chambers, reportedly a dozen in number, are producing 6-8 M clonal plants per nursery annually. Others are smaller units with varying production capacity onward 8 Lakh plants per annum. According to an estimate, approximately 120 M clonal Euca plants were produced here during 2022-23., out of which major stock (around 80 M) was reportedly supplied to North India especially Uttar Pradesh followed by Gujarat (around 20 M plants). It is estimated that the current year (2023-24) production and supply of plants may exceed 150 M on account of its heavy demand from different locations. Nurseries in general take 8-9 production cycles (locally referred as charging) with an average rooting time of around one month. Rooting success is around 70% and overall plant survival percent around 50-65% of planted cuttings.

Fig.-4. Clonal Euca plants in root trainers rested on wooden stands in open space.

Jangareddygudem in Eluru District of Andhra Pradesh, around 160 Km from Alligudem, also gradually developed a small cluster for clonal Euca production during the same period. Once it had around 20 nurseries which were producing such plants and was often called as MiniAlligudem. This cluster also supplies clonal Euca to all locations similar to Alligudem. Low demand of plants during 2017 triggered many nurseries of this cluster to shift the focus to fruit plants production especially clonal guava through rooting the cuttings. The demand for Euca supply started showing recovery during the last 2-3 years and atleast four nurseries restarted clonal Euca production now. Few nurseries in this cluster are also patronized by the local paper mill at Rajahmundri for producing clonal Casuarina. High cost of production at Jangareddygudem due to higher land & labour costs and poor water quality (saline) failed to make impact equivalent to Alligudem cluster.

There are a few differences in clonal Euca production systems employed between corporate nurseries (large) and those started by small entrepreneurs (Table-1). Corporate and institutes have created large, costly and hi-tech infrastructures; whereas; small entrepreneurs innovated low-tech and low cost misting chambers capable of maintaining a minimum required conditions for rooting the stem cuttings. Unlike large corporate nurseries, those created by small entrepreneurs are of low profile in term of land resources, infrastructure & techniques, use of conventionally available construction material, employed human resources and invested costs. Cost model of these nurseries include fixed costs on assets/inventory created one time & those replaceable after sometime; and recurring costs on activities, operations & materials. Fixed costs include investment on land, working shed/store, bore well, solar system, irrigation system, transport mean, root trainers and root stands etc.; whereas, recurring costs include potting media, cutting material, fertilizers and some others; and on nursery operations like processing potting mix, filling root trainers, planting cuttings in root trainers, shifting root trainers to misting chambers, regulating irrigation, shifting root trainers outside chambers on completion of rooting, shifting root trainers kept on ground in open nursery space & chambers to avoid striking roots inside ground, making elevated wooden stands for keeping root trainers above ground for encouraging aerial root pruning, grading plants etc. Root trainers used in these nurseries are of low cost as they are made from recycled plastic and have less self-life of 4-5 years, whereas, those made from virgin plastic have long life which are not used here being costly. Labour is the single major recurring cost component in clonal Euca production. At times, there are some other costs like maintenance of infrastructure especially replacement of plastic sheet (once in around 3 years) spread on chambers and installed irrigation system, drainage improvement, plant protection, repair of tools etc. On general enquiries, entrepreneurs may mention varying figures on the production cost for negotiating higher sale value.

A classical clonal Euca production model at Alligudem includes own or lease land between 2-5 acres, misting chambers between 2-15 in number with or without hardening chamber, 2″ bore well for irrigation, 10 KW solar electrical system (currently varies from 5-15KW), root trainers, and locally made wooden billet stands for root trainers in open space, 3-4″ thick sand filling inside chamber for placing root trainers, and a team of 8-10 women and men labor force for daily nursery operations and maintenace. Some nurseries have installed sprinklers in open space of nurseries for irrigating plants, however, most of them use piped irrigation as they indicated irregular water spread through nozzle sprays. None of the nurseries maintain vegetative multiplication hedges to produce shoots for making cuttings. They procure coppice shoots from local logistic teams who collect them from harvested plantation around 60-70 Km^2 of Alligudem. The locality is one of the core areas for Euca plantations which are harvested around the year and thus coppice shoots are always available for making cuttings. In this locality, around 70% of the plantations are established using Clone ITC-316, 20% ITC-7 and 10% ITC-416. Within these 3 clones, it is easy for field teams to maintain clonal identity which they also get confirmed from plantation owners. Farmers sell the shoots at a price, current rate being Rs. 2000/acre, and personally supervise harvest of multiple shoots to keep a couple of leading and dominant shoots to form new stand of coppice origin for two subsequent rotations before establishing fresh plantations. There are numerous well connected logistic teams in the locality who primarily work for thinning out the sprouts from the stumps of harvested plantations. These logistic teams are experienced on number of technical issues like when to thin out shoots which could be used for making desired cuttings (45 -60 days old shoots), preparing nodal cuttings from that portion of shoots that give higher rooting in chambers, better handling shoots on harvest and during cutting preparation, and maintain adequate clonal control and identity of supplied cuttings/shoots. Coppice shoots on harvest are placed in large plastic containers filled with water to keep them hydrated and transported the same day for delivery to nurseries. Nurseries make cuttings and plant them the next day of harvest. A system of direct delivery of cuttings is also evolving in which harvested shoots, instead of being directly supplied to nurseries, are taken to their homes/common places for making cuttings which are then supplied the next morning and are planted by nurseries immediately on their receipt. Some teams; themselves; harvest shoots, make cuttings and get them planted in the chambers on a consolidated payment basis (Rs. 5000 to 6000/chamber).

Root trainers with planted cuttings are immediately kept on the sand beds inside chambers and regularly sprinkled with water after a set time interval to maintain high humidity (>80%). Temperature increases during day hours especially in summers when the chambers are cooled down by operating exhaust fans which ventilate the warm air out. Cuttings are kept for around 1 month inside chambers by which time the rooting is completed. In some cases, if the rooting is fast and also if

there is limitation of available space for keeping them outside, root trainers are shifted/disturbed inside chamber itself (Fig.-2) to avoid striking the roots inside the ground. Some nurseries use hardening chambers during summers when outside temperature is very high for rooted plants to directly face on immediate shifting to open nursery space. These root trainers are directly kept on the ground outside chambers for around 10-15 days and then shifted to root stands for encouraging aerial pruning of roots. Irrigation is the most important operation which is performed vigilantly and diligently every day (except rainy days) to keep plants in growing condition. Urea mixed in water is applied at 10-15 days interval to boost the growth of the plants. Another major exercise is grading of plants in which proper size plants are segregated and kept in separate root trainers and stand beds for further maintenance till they are supplied to clients.

The common size of misting chambers is around 180-200 m2 which accommodate around 60,000 to 1 Lakh plants per charge (planting) depending upon cell size and the chamber size. For example, a chamber of 180 m^2 reportedly accommodates around 60,000 root cavities of 40 cells and 90,000 of 60 cells. Most nurseries are using a mix of both vermiculite and coco-peat as rooting/potting media in varying proportion from 10:90 percent to 50:50, whereas, some use pure coco-peat. Mixing some percentage of vermiculite with coco-peat reportedly helps in better retention of moisture that ultimately requires less misting and also results in better rooting compared to sole use of coco-peat.

Costing model

Cost of production of clonal Euca plants is reported between Rs. 0.75 to Rs. 1.50/plants. This does not include depreciation of fixed infrastructure costs of land/land lease, chambers, working shed/store, hardening chamber, bore well and solar system which if included, cost of production may increase by around 70 to 80% (between Rs. 1.40 to 2.75/plant). Transportation of plants, which happens to different destination, was initially started by the local transporters. The bulk of initial supplies were to North India and the transporters from Uttar Pradesh gradually took over such supplies from local transporters. Most of them carry plants from here to the final destination; a couple of them reportedly unload some stock en-route depending upon local demand. Transportation cost varies depending on distance which currently is upto Rs. 2.25/plant to far off places like northern parts in Punjab and many locations in Uttar Pradesh, Rs. 1.25/plant to Gujarat, and Rs. 0.75 to South Andhra Pradesh and Tamil Nadu.

The fixed costs in clonal Euca production includes land cost (lease rent basis-Rs. 20- 30,000/acre/year), misting chamber (180-200 m^2) cost (Rs.1 Lakh), 2" bore well (Rs. 1 Lakh), Solar (10KW) system (Rs. 3.5 Lakh), working shed/store (Rs. 2 Lakh), and shade net house (Rs. 80,000). Other costs vary for different items those have a couple of years self-life like root trainers (Rs. 27 for 40 cells block of 63 cc and Rs. 40 for 60 cells block 50 cc) with a life span of 4-5 years, root stands made of locally procured billets (Rs. 5,000) for 2-3 years life span and miscellaneous items like tools, and for chambers etc (Rs. 20,000) for 2-3 years.

Recurring costs include coco-peat (Rs. 3,000/t), vermiculite (Rs. 12,000/t), cutting collections/making (Rs. 100/1000 cuttings), root trainer filling and planting cuttings in root trainers (Rs. 100/1000), shifting root trainers from chamber to outside hardening chamber and also inside beds to avoid striking of roots in the ground (Rs. 30/ 1000 plants), grading plants (Rs. 100/1000 plants), Irrigation (Rs. 40/1000 plants/irrigation) and loading plants in lorries for dispatch (Rs. 800/lorry of 20,000 plants)

Table-1.The comparison of clonal Euca production system between corporate and local entrepreneurs

Particulars	Organized producers	Unorganized producers
Owners	Private sector players, State forest departments, forest corporations, research institutes	Small nursery growers/ nursery entrepreneurs
Misting Chambers	Large in size, usually over 400 m^2, costly, automated to control misting, temperature and light	Small and low cost with misting through nozzle sprays, high temperature
Cutting material sourcing	Vegetative multiplication hedges	Coppice shoots from harvested trees
Cutting type	Apical and nodal cuttings	Only nodal cuttings (able to tolerate high temperature)
Root trainers	Moderate size with 30-40 cells/tray (70-100 cc)	Small size largely 40 (63 cc) or 60 (50 cc) cells/tray

Root trainers	Moderate size with 30-40 cells/tray (70-100 cc)	Small size largely 40 (63 cc) or 60 (50 cc) cells/tray
Placement of root trainers inside chambers	On root stands	Directly on river sand beds
Root stands	Metal fabricated	Made of wooden billets
Clonal diversity	High, more clones in production system	Limited, largely ITC-3 and ITC-316, with a few having ITC-413 and ITC-7 as well
Rooting success and plant percent	High rooting sometimes>90% and plant percent >80%	Low: rooting 70% and plant percent 60%
Germ-plasm garden	Maintained in the form of vegetative hedges or field trials	None, cuttings made from coppice shoots procured from harvested plantations
Volume	Collective volume low	Collective volume very high
HR Skills	High: well trained HR	Low in most nurseries

The cost of infrastructure, daily operations, human resources & labour, materials, compliances, and quality controls are undisputedly high in corporate nurseries. They could efficiently and economically operate their chambers till the sale value of plants was good enough to recover costs from their sale. Most corporate houses and government departments instead of expanding their infrastructure now prefer procuring Euca plants from these entrepreneurs for making own plantations and/or distribution to farmers at certain costs or at subsidy. With mushrooming of more and more local entrepreneurs in this activity, Euca plants are currently available at much competitive prices between Rs. 2.50 to Rs. 3/plant for bulk orders. With new wood based industrial units coming up in different locations, the demand for wood is increasing and so is the expected demand for Euca plants for new plantations.

Women empowerment

Plant nurseries are one of the preferred places which attract a large number of women workers for carrying out different operation. These operations may start from handling of propagation material to the final supply of produced plants to different locations. Women find preference over men workforce for many nursery operations, some of which are making & planting nodal cuttings, filling root trainers with rooting media, placing them inside chambers and their shifting, grading of plants in root trainers and some other activities. Some activities exclusively performed earlier by men are now efficiently executed by women workforce and the taboo that women can only perform light operations is rapidly disappearing here. Out of the total wage cost spent on nursery operations, half of it reportedly goes to women. Out of a total estimated production cost of Rs. 1.50/plant, half of it i.e., Rs. 0.75/plant and a total of Rs. 90 M amount for producing 120 M plants was paid to women work force employed during last year, which by any mean is a very high and significant contribution to women empowerment in this tribal and demographically less developed area. Such a huge impact in women empowerment is created by these small nurseries without any support from government or other financial institutions and is a huge opportunity for uplifting their living standard.

Fig.-3. Women performing different operations.
A-making cuttings from shoots, B-planting cuttings,
C-shifting root trainers inside chambers, and D-grading plants.

Evolving arrangements for trading clonal Euca

Growing nurseries and promoting plantations has imbedded in operations in many corporate workings for improving their social and environmental footprints. Costs on these and other operations are always under review for better value to the money they spent. Nursery plant availability at competent rates outside like Alligudem cluster is encouraging many corporate to shift the costly in-house nursery production to outsource mode. Some forest departments who have created costly infrastructure are not able to use them effectively & efficiently, and are also increasingly procuring Euca plants from such nurseries. Even some of them, have reduced their in-house production to check operational costs. The following trading arrangements have evolved, over the years, in this cluster.

Committed outsourced nurseries

There are a few nurseries who have developed mutual commitment with some corporate to produce and supply the Euca plants. ITC currently has arrangements with five entrepreneurs who produce clonal Euca plants to this company only. These entrepreneurs get assured supply orders, new clones from the company and also technical support. Company, however, put a rider that such nurseries will produce planting stock to the only Partner Company and dealing with others would disqualify and debar from the contract agreement. This is to secure the planting stock of newly developed clones which they share with these nurseries for mass multiplication and for making plantations in own catchment area.

Patronized outsourced nurseries

A major local paper mill at Rajahmundri has patronized selected nurseries around its catchment area to produce clonal planting stock of suitable species and advise farmers to lift plants from such nurseries. In addition to meeting the committed supply of the company, nurseries are free to sell their plants to other parties including farmers and companies. Initially, such nurseries were given some financial support to produce clonal plants that also include mother material of selected clones for multiplication. The entrepreneurs of these nurseries, in addition to their existing locations also facilitated to create new units at favorable sites in the catchment areas of the mills.

Free trade nurseries

This type constitutes a major chunk of exiting nurseries in this cluster. They are open trading nurseries where anyone at anytime approaches them to make direct supply on payment basis. Large corporate make contractual arrangements on negotiated rates, clone types and schedule of delivery. Some corporate also take some security money so that entrepreneurs do not back-out from the committed supplies. Of late, many traders mushroomed in different parts of the country that directly approach these nurseries here to supply plants at negotiated prices. We did not find a single nursery which is exclusively involved in trading without production. However, plant traders from other locations and states handle a large volume of Euca plants from here for trading purposes. Government departments and forest corporations procure plants through open tenders. Many of the entrepreneurs / nurseries here have developed a good network for participating in these tenders and getting supply orders at competitive rates.

There have been efforts to replicate this model in other locations and states that has not met with desired results. Language and culture barriers limit the local entrepreneurs to move to other locations. Some efforts made by the local entrepreneurs to start such nurseries in Uttar Pradesh, could not succeed. This cluster has well developed logistic support for some specialized activities, like making the cuttings from coppice shoots of harvested plantations, making low cost chambers, irrigation systems, low cost root trainers, low cost coco-peat etc. Further, the large scale plantations of only 3 clones and the easy availability of their cuttings in this locality matured this system well integrated with local logistics and resources. In some locations like, Uttar Pradesh, multiple clones are used in field plantation, which makes it a little difficult to keep clonal control. In Andhra Pradesh, the bulk of Euca is currently for paper pulp with some portion of trees being diverted for poles (ballies). The management prescription for these plantations is harvesting the first crop at 4-5 years with additional two subsequent coppice rotations thereafter before uprooting the old stumps and replanting new plantations. In North India, the tree is grown on highly productive farm fields; farmers prefer to harvest trees, remove stumps and make fresh plantations inside agriculture fields. Some boundary plantations are allowed to coppice and managed to take additional coppice harvest. The easy availability of coppice shoots for making cuttings around Alligudem cluster is again a critical issue for making it successful elsewhere.

Negative exposures

Market forces

Tree culture on farm land for wood production is mainly market driven. Any fluctuation in wood prices

tends to change farmer's interest to remain engaged with tree culture. In case the market for wood prices is upbeat, the expansion in tree culture continues to expand. Past experience of market trends of poplar culture in North India establishes that whenever wood prices drop in the open market, farmers divert their land use to agriculture crops and vice versa. This is also happening with Euca in South India now. AP witnessed two peaks of high-end wood prices i.e., during 2005-06 and again during 2014-15 and two slumps during 2010-11 and again during 2017-18. Tree culture followed the same trend as that of wood prices. In the current scenario, wood prices started increasing 2018 onward and so was the case of corresponding increase in making Euca plantations. Local nursery entrepreneurs from Alligudem are of the view that there was sale of around 80 M during 2021, 120 M during 2022 from this nursery cluster and the current year supply is estimated to be around 150 M.

Slump periods in wood prices, tree culture and planting stock production are a real test of entrepreneurship for remaining engaged in related activities of tree culture including nursery production. In organized sector, such setbacks have institutional support for absorbing short term losses due to market uncertainties. Unsold nursery stock during slump is the biggest monetary loss to the nursery entrepreneurs; they try to sell them at throw away prices even at the cost of production. During the distress years they try to recalibrate production system to reduced demand or may shift production to other species as Jangareddygudem cluster did around 2017 when they started fruit plant production in their nurseries. Many prefer to abandon nursery activity and wait for the opportune market conditions to restart it. The rising uptrend 2018 onward is likely to continue for a longer period this time because of vast expansion of wood based industry all around for which increased demand for Euca is likely to exist for some time hereafter.

Labor issues

Clonal Euca plant production is labour intensive especially as most of the activities are manually performed. Availability of the efficient workforce throughout the year is very essential for the success of this venture. Currently, labour engaged in the locality is both native to locality and from Chhatisgarh. There have been issues with retaining labour around the year especially that comes from Chhatisgarh. Once the labour goes home may be during festival season or social functions, their return in time seldom happen. Non availability of labour even for a small period seriously affects nursery production and its viability. Continued availability of trained labour, is a critical issue in the success of this kind of labour intensive activity.

Issues with QPM

Use of the root trainers for producing clonal Euca plants is the necessity. Rooting nodal cuttings is extremely important step in producing Euca quality planting material (QPMs) for which there is no available alternate from root trainers. Though this cluster ably innovated in the potting media by replacing bulk of costly vermiculite to low cost coco-peat, they could not find alternate to root trainers which fits in well for clonal nursery production in the present context. The major advantage of root trainer plants is that their root system get embedded in the cavity and make an effective root plug in which root does not get outside exposure and remain well protected. Such plants if planted in active stage are able to survive in field plantations. Moisture availability and nutrient status in farm fields is better than stressed sites as such these plants start growing early. Plants grown in these root trainers need much higher attention and regular care. Shifting root trainers from one cavity to another during grading, results in distortion of roots which may lead to poor performance on field planting. Overstay of these root trainers on the ground surface makes their main root system penetrate inside ground and such plants develop poor fine root system.

One of the negative exposures of these plants is that these nurseries apply heavy doses of N fertilizer by mixing it in water, sometimes, at quick intervals of 10 days to boost the height growth of plants and to make them quickly saleable. Plants with high N content becomes sensitive to stress they specially witness during long distance transport which sometime span for 7-10 days to North India. Such plants also fail to tolerate extreme of weather conditions immediately at planted sites.

Hostile rains

Monsoons, which at times are heavy, cause a lot of damage to nurseries in this cluster. Small plants many a time get washed away with running water. When the rains continues over a few days, infection of Cylindrocladium leaf blight (CLB) starts which sometimes causes heavy damage to their inventory. They spray fungicides to control the damage yet the losses are heavy at times. Rains also affect supply chain that leads to increased built up of stock in nurseries, cost of maintenance and reduction in the returns to the entrepreneurs.

Other factors

This is a remote locality with hardly any support system of general amenities. Visitors from other locations find it difficult to get day to day needs as one finds a very few outlets for tea, food and other articles.

One good thing about evolution of this cluster is that there was no interference from any government agency and thus nursery growers have been freely doing this business. Unlike horticulture, forest nurseries do not require registration with any authority and this was a major factor in ease of doing business here. Many academicians and professionals including foresters generally advocate registration of these nurseries with competent authorities. In such a case, many of these entrepreneurs may get debarred as they may not have adequate qualifications to get their nurseries registered. This is besides a fact that many foresters are procuring clonal Euca plants form here for their plantation schemes. Any such effort on the name of registration will have significant impact on Euca and other tree culture in the country, besides these entrepreneurs will have to find some other activity to develop their life support system.

These nurseries maintain a delicate balance between cost of production and sale price. Bulk sales at even low price are accepted norm for dealing with fewer suppliers and get reasonable earning by volume sale. Income from sale of self produced plants is treated as agriculture income and hence tax free, however, the income from trade is taxable under the existing regulations. The sale price of the plants for casual low volume supplier is generally high. The current sale price is around Rs. 2.50 to 3/plant which may firm up if the demand increases or may ease out if demands fall. A large number of corporate houses repeatedly visits Alligudem and making contractual arrangements for procuring Euca plants with selected nurseries this year indicating increased demand and if that happen the prices of the plants may firm up.

Conclusion

Alligudem cluster of clonal Euca nurseries has very ably demonstrated that small entrepreneurs can innovate very well to develop business lines without any outside support if there exists some potential opportunity around their locality. Such activities need to have a trigger which was initially provided by ITC for developing clonal nurseries in this locality. This great effort has itself created a large network of logistic teams throughout the value chain right from collection of coppice shoots from harvested plantations to making cuttings their supply to nurseries, supply chain of consumable of potting media, infrastructure, transport integrated with plantation activities in different locations of the country. This is a low cost model innovated by the locals and worth emulating by others. Potential activities like this do have a lot of potential in providing jobs at rural and tribal locations and to create a real impact in rural transformation and Greening India.

Institute of Wood Science and Technology, Bangalore
Publications for Sale

IWST PUBLICATIONS FOR SALE

BOOKS

Sl. No.	Name of the Books	Language	Rate
1.	Gem of Peninsular India Sandalwood	English	1,500
2.	Endemic Possession of Eastern Ghats: Red sanders	English	150
3.	Biodeterioration of Timber and its Prevention in Indian Coastal Waters - 3rd Progress Report (1982-2005)	English	250
4.	Anatomy and Properties of Lesser Known Timbers of North-East with particular reference to Nagaland	English	175

PROCEEDINGS / ABSTRACTS

Sl. No.	Name of the Books	Language	Rate
1.	Forestry, Forest Products and Coastal Population	English	200
2.	Wood Preservation in India: Challenges, Opportunities and strategies	English	250
3.	Conservation, Restoration and Sustainable Management of Mangrove Forests in India	English	250
4.	Intellectual Property in Forestry issues	English	250
5.	Bamboo Reserve Management & Advances in Utilization Options	English	200
6.	Indian Sandal wood. Compendium Abstracts of Research carried out English	400	
7.	Abstracts of the Published Research Papers (1998-2007)	English	Free

TECHNICAL BULLETINS /BROCHURES

Sl. No.	Name of the Technical Bulletin	Language	Rate
1.	Sandalwood	English/Kannada	100
2.	Sandalwood Tree (Pests, Diseases and their Management)	English	80
3.	A Guide to some important timbers in South Indian markets	English	150
4.	Arbuscular Mycorrhizal (AM) fungi as biofertilizer in forestry	English	30
5.	Teak Heartwood Borer. AlcterogystiaCadambae (moore) and its management	English	50
6.	Whitefly pests in Forestry and their management	English	30
7.	Wood Polymer Composite: New age Material	English	50
8.	Protection of Wood from Weathering	English	80
9.	Flower Gall Inducer of PongamiaPinnata and its management	English	60
10.	Cultivation prospects of edible bamboo shoots in South India	English	100
11.	Ficus Tree in Semi-arid. Agro Ecosystem of Karnataka	English	150
12.	Bamboos of India	English	200
13.	GuaduaanguistifoliaKunth: A Vegetable Steel Bamboo Species	English	150
14.	Dendorocalamusstocksii (Munro): A Potential Multipurpose Species for Peninsular India	English	150
15.	DendorocalamusBrandisii (Munro): An ideal Bamboo Species for Domestication in Humid Tropics	English	150
16.	Micro propagation of Bamboo Species	English	150
17	Disease Alert on Eruption of Sandal Spike Disease in Conservation and Cultivation of Indian Sandalwood	English	100
18	Important Insect Pests in Mangroves of Maharashtra and their Management	English	100
19	Genuine Mahagony – Cultivation, Management and Uses	English	100
20	Meliadubia Malabar Neem	English	100
21	Phytoplasma: Thrust for developing effective management strategies	English	100
22	Sandal oil: Adulteration and detection techniques	English	100
23	Bamboo Lumber: A sustainable alternative to solid wood	English	100
24	Utilization Potential of Palmyra Palm Wood (Borassusflabellifer L.)	English	100

Activities of Haryana Forest Development Corporation Limited (HFDC)

HFDC and Objectives:

Haryana Forest Development Corporation (HFDC) Limited (Company No. 05-30749) was established in December 1989 under the Companies Act 1956 mainly for the promotion and development of tree plantation on non-forest lands by providing suitable price to tree growers for their forest produce. The main objectives of the Corporation are:

- To assure reasonable prices to the farmers for their standing trees and other forest produce.
- To generate employment opportunities in rural areas.
- To increase financial status of farming and labour community.
- To promote development of forest based and allied industries.
- To stabilize timber and fuel wood prices in open market.
- To protect the forest producer from exploitation of the middlemen and safeguard the interest of the consumers by undertaking proper and scientific exploitation of the forest resources of the State and if necessary, outside it, in order to obtain maximum financial return thereof.
- To transfer related technology to farmers.
- Tree felling and wood extraction from Government forests earmarked to the Haryana Forest Development Corporation Limited, development of forests and raising plantations.

Besides, there are other activities ancillary or incidental to the attainment of the main objects of the Corporation.

HFDC has also been engaged in felling, conversion and sale of trees from earmarked forest areas since 1995-96. Later the Corporation diversified its activities and started manufacturing polythene bags for nursery purposes, barbed wire for fencing, furniture and wooden crates. HFDC is also engaged in carrying out projects related to arboriculture and landscaping, plantation with various organizations like Ministry of Defence, Government of India; National Building Construction Corporation Ltd.., RITES; Indian Railways; National Highways Authority of India; Forest Department, Govt. of NCR of Delhi and Indian Institute of Technology, New Delhi and throughout the country. These works have been undertaken by the Corporation on contractual or nomination basis.

HFDC has been declared as approved source by the Haryana Government for supply of barbed wire, wooden crates, furniture timber and its allied products.

The Corporate office of the Corporation is located at Panchkula. The Managing Director of HFDC is an officer of the Indian Forest Service in the rank of Principal Chief Conservator of Forests (PCCF). He is assisted at the headquarters by an Addl. Managing Director, an officer in the rank of Addl. PCCF, one General Manager, an officer in the rank of Divisional Forest Officer (DFO) and associated staff. There are three Regional Offices of the Corporation located at Ambala, Karnal & Gurugram namely offices of Chief General Managers, headed by officers in the rank of Addl. PCCF. There are nine offices of General Managers located at Ambala, Kurukshetra, Yamunanagar, Karnal, Sirsa, Hisar, Rohtak, Rewari and Gurgaon headed by officers in the rank of DFOs. The General Managers are assisted by Managers in the rank of Forest Rangers, Deputy Managers in the rank of Foresters and Assistant Managers in the rank of Forest Guards.

Cadre strength of the Corporation:

Against the maximum sanctioned cadre of 227 officers/officials, a total of 62 officers/officials only are deputed to HFDC from Forest Department. 7 officials are working against sanctioned cadre of 10 officials of HFDC. 73 officials have been engaged through Haryana Kaushal Rojgar Nigam (HKRN). As such a total No. of 142 officers/officials are working in HFDC. The Corporation has not engaged any employee drawing remuneration in excess of the limits laid down under section 217 (2A) of the Companies Act, 1956 read with the Companies (Particulars of Employees) Rules, 1975.

Board of Directors and other office bearers:

The management of the Company is vested in a Board of Directors having not less than two and not more than 12 Directors. As on today, the Company has Six Directors including a Chairman and a Managing Director.

The Board of Directors of HFDC is presently constituted as under:

Sr. No.	Name of Directors	Designation
1	**Sh. Dharampal Gonder, MLA** Hon'ble Chairman, Haryana Forest Development Corporation, Panchkula	**Chairman**
2	**Sh. Vineet Garg, IAS,** Addl. Chief Secretary to Government, Haryana Environment, Forests & Wildlife Department, Chandigarh	**Director**
3	**Sh. Jagdish Chander, IFS** Principal Chief Conservator of Forests (HoFF), Forest Department, Panchkula.	**Director**
4	**Sh. T.P. Singh, IFS** Secretary to Government, Forests & Wildlife Department, Haryana.	**Director**
5	**Smt. Kiran Lekha Walia** Chief Financial Advisor, Finance Department, Chandigarh	**Director**
6	**Sh. Vineet Kumar Garg, IFS,** PCCF-cum-Managing Director, Haryana Forest Development Corporation, Panchkula	**Managing Director**

Equity and its distribution:

The equity of HFDC, since its inception, consists of 2003 shares with a value of each share being Rs 1000. The details of equity and profit distribution over the past five years is given below:

Sr. No.	Entities (in No.)	No. of Shares share (in Rs.)	Value of each (in Rs.)	Total Value	%age
1.	Govt. of Haryana	2000	1000	2000000	99.85
2.	ACS to Govt. of Haryana, Environment, Forests & Wildlife Department	1	1000	1000	0.05
3.	Secretary, Forests	1	1000	1000	0.05
4.	Managing Director, HFDC	1	1000	1000	0.05
	Total	2003		2003000	100

Equity distribution for past years:

Year	Profit (After Tax) (Rs. In Lakhs)	Shareholder name	Equity paid @30% of the Total Share Capital (Rs. In lakhs)
2017-18	61.73	Government of Haryana	6.09
2018-19	275.62		6.09
2019-20	243.73		6.09
2020-21	750.20		6.09
2021-22	905.42		6.09

Financial Position of HFDC:

The details of assets, liabilities and Profit/Loss of the Corporation for the last five years is depicted below:

Year	Asset Rs. In Lakhs)			Liability (Before (After Tax)			Turnover	Profit Before Tax	Profit After Tax	CSR
	Non-current Asset	Current Asset	Total	Non-current Liability	Current Liability	Total	(Rs. In Lakhs)	(Rs. In Lakhs)	(Rs. In Lakhs)	(Rs. In Lakhs)
1	2	3	4=(2+3)	5	6	7=(5+6)	8	9	10	11
2017-18	1330.70	6015.54	7346.24	71.28	2357.23	2428.51	3769.15	84.17	61.73	-
2018-19	1429.38	7374.82	8804.20	66.52	3578.96	3645.48	7851.08	381.69	275.62	-
2019-20	1432.78	9245.25	10678.03	83.44	5192.12	5275.56	6840.86	337.98	243.73	-
2020-21	1381.84	11112.25	12494.09	83.95	6323.84	6407.79	8540.11	1058.25	750.20	-
2021-22	1392.56	12608.54	14001.10	61.81	6959.59	7021.40	10068.25	1277.59	905.42	11.88

Major activities of HFDC:

A. Wood Harvesting from forest and non-forest areas:

Prime activity of HFDC is felling of trees including Green trees for widening of roads/other developmental projects and dead & dry and green fallen trees from Government forest lands as per approved Working Plans. Though HFDC does not own any forest areas for carrying out plantations, it has been assigned the mandate of carrying out wood harvesting in the allotted forest areas as per the prescriptions of Working Plans and/or sanction of fellings in forest diversion cases under Forest Conservation Act, 1980. Apart from the traditional forest areas, the Corporation also carries out wood harvesting from non-forest areas such as plantations on private and institutional lands. These fellings on non-forest areas are carried out only when the Corporation enters into an agreement of purchase of trees on the basis of minimum assured price. The details of felling done by HFDC during last five years is as below:

Sr. No.	Year	Dead & dry volume felled		Green Volume felled		Total Volume felled (in CUM)
		Volume (in CUM)	Percentage%	Volume (in CUM)	Percentage%	
1	2	3	4 = (3/7)*100	5	6 = (5/7)*100	7 = 3+5
	2018-19	59415	41	86664	59	146079
	2	2019-20	64685	53	56423	47121107
3	2020-21	61125	41	89715	59	150840
4	2021-22	61195	44	79321	56	140515
5	2022-23	49799	39	78772	61	128572
	Total	**296218**	**43**	**390895**	**57**	**687114**

B. Furniture Manufacturing:

HFDC has five Furniture Manufacturing Units located at Yamunanagar, Panchkula, Kurukshetra, Karnal and Rewari. These units are responsible for wood working and manufacturing all types of wooden furniture items. HFDC regularly supplies the furniture articles to government departments, institutions and general public with an assured wood quality.

Expenditure/ Income Statement for last five years											
2018-19		2019-20		2020-21		2021-22		2022-23		Total	
Exp.	Income	Exp.	Income	Exp.	Income	Exp.	Income	Exp.	Income	Exp.	Income
1247.36	1289	943.56	1033.96	858.48	1076.15	1030.56	1266.67	1132.36	1635.19	5212.32	6300.97

C. Manufacturing of Polythene Bags:

The Corporation also undertakes manufacturing of polythene bags which are being used in the nurseries of Forest Department for raising of plants. HFDC has three such units located at Kurukshetra, Rewari and Hisar. The details of expenditure and income of polybag manufacturing units for the last five years is given below.

Expenditure/ Income Statement for last five years												
Name of Unit	2018-19		2019-20		2020-21		2021-22		2022-23		Total	
	Exp.	Income	Exp.	Income	Exp.	Income	Exp.	Income	Exp.	Income	Exp.	Income
Total	229	336.16	243.5	354.02	249.9	401.48	719.1	886.95	466.6	623.45	1908.6	2602.1

D.Barbed Wire and Chain Link Manufacturing:

Barbed wire and chain links are being used by Forest Department for fencing operations in the plantations to ensure effective protection. While the Corporation has been manufacturing barbed wire since last many years, it has recently started manufacturing of chain link at its unit located at Yamunanagar. The units located at Ambala and Hisar carry out manufacturing of barbed wire. The details of income and expenditure on this activity is given in the table below:

Expenditure/ Income Statement for last five years												
2018-19		2019-20		2020-21		2021-22		2022-23		Total	
Exp.	Income	Exp.	Income	Exp.	Income	Exp.	Income	Exp.	Income	Exp.	Income
124.4	95.11	104.7	108.04	295.6	253.15	123.2	300.29	126.7	99.4	774.6	855.99

Diversification:

The Corporation has been undertaking the activities which are enshrined in the Memorandum of Association and additional activities as assigned by the State Government from time to time. Tree felling and wood extraction from Government forests earmarked to the Company, development of forests and raising of plantations are the major activities of the Company. Besides the conventional activities, the Company has diversified its activities within and outside Haryana state such as:

1. Government of Haryana has declared HFDC as approved source for supply of wooden furniture, firewood & Crates.
2. The Company has supplied the nursery bags and barbed wire mainly to the Forest Department for raising of seedlings and plantations.
3. Wooden crates have been supplied to various Government agencies such as Food & Supplies Department, Haryana Warehousing Corporation (HWC), CONFED, HAFED and Haryana Agro Industries Corporation.
4. Various projects like arboriculture, landscaping and plantations have been executed for Ministry of Defence, Northern Railway, NHAI, NBCC and Delhi Forest Department.

Unique achievements:

HFDC has started e-auction platform "www.hfdceauction.co.in" for sale of timber harvested from forest and non-forest areas. This activity was started in the year 2021. Over a period of two and half years, the Corporation has received good response from the bidders. The e-Auction platform of the Corporation is robust, user friendly and transparent system of e-Trade of timber where the bidders are assured of seamless and reliable service. The Corporation has been able to increase its revenue significantly and the total revenue from sale of timber through e-Auction for the years 2021-22 and 2022-23 was Rs. 111.46 Crores.

Activities of Himachal Pradesh State Forest Development Corporation Limited (HPSFDCL)

CIN: U0200IHP1974SGC003413

(A Government of Himachal Pradesh Undertaking)

Registered Office: Van Nigam Bhawan, S.D.A. Commercial Complex, Kasumpti-171009, Shimla, Himachal Pradesh

H.P. State Forest Development Corporation (herein after referred to as HPSFDCL) was incorporated under the Companies Act and came into existence on 25th March, 1974 for carrying out the mandate of scientific harvesting and marketing of forest products in accordance with working plan prescriptions without the involvement of contractors.The authorized share capital of the Corporation is Rs. 50 crores. The 100% shares of the Corporation are with the State Government as such the HPSFDC is wholly owned by the Government of Himachal Pradesh and is a Public Sector Undertaking. The HPSFDC is the agency authorized by the Government of HP to engage in timber and resin extraction in the State of HP and as per the provision of HP Forest Produce (Regulation of Trade) Act, 1982 the HPSFDCL has a monopoly status to deal in aforesaid forest produce in the State. Theprimary business activities of the HPSFDCL includes resin extraction, resin processing, sale of rosin, timber harvesting and sale, extraction and sale of fuel-wood, pulpwood, khair–wood and bamboo. As subsidiary activities, it also runs timber treatment plants, wood based unit and ecotourism sites.

Corporation was created with the following major objectives:

- To carry out extraction and marketing of timber and resin/rosin on scientific lines by adopting suitable modern techniques.
- To eliminate the Contractor's Agency in respect of works of timber extraction and resin tapping.
- To obviate the chances of illicit felling of trees, illicit tapping of resin and other mal-practices.
- To work the forests on commercial lines by re-cycling of funds and by raising funds from financial institutions as and when need arose.
- The extracted timber is used in building works, manufacturing of furniture, ply board and wood wool.
- The resin after processing in the R&T Factories is used in medicines, paints, boot polish. Phenyl and turpentine oil is also manufactured from the resin.

Management set up:

The Apex Body of the Corporation is the General Body (GB), headed by the State Forest Minister. The GB meets once a year and approves the balance sheet of the previous year and the work plan for the next year. The executive body of the Corporation is the Board of Directors (BOD), chaired by the State Forest Minister with Secretary (Forests), Secretary (Finance), PCCF (HoFF) as ex-officio members, Managing Director HPSFDC as member secretary and 9 nominated members. The BOD meets once every quarter and considers and approves various financial, operational and policy matters. Day to day management of the HPSFDC is entrusted to Managing Director who is supported by Executive Director, Directors, Divisional Managers, General Managers and front line personals.

Core activities:

➢ **Resin Extraction, Processing and Marketing:**

Resin extraction work was transferred to the Corporation in the year 1975-76. The Forest Corporation switched over to the system of "Rill Method" in a phased manner from the traditional **"Cup and Lip"** method, which was damaging the trees. Emphasis is being laid on the quality of tapping. It is being ensured that the blazes are of standard size and no illicit or over tapping is done. All the work is got done through **Labour Supply Mates on tender basis,** under constant supervision of the Forest Corporation staff. The work is carried out by professionally trained labour.

The enumeration is done during January and the enumeration lists are made available to the HPSFDC by the HPFD during February. However, to save time, the **HPSFDC starts tender process proactively during the month of January,** on the basis of existing lot wise blazes. The lot wise yield per section is fixed on the basis of average of last three years yield obtained and the upset price is approved accordingly, based on sanctioned schedule of rates. All out efforts are made to ensure that the tender process is completed before **15th of February so that the crop setting starts by 15thof February.** The detail of resin blazes received during 2018 to 2022 for resin tapping are as under:

Year (Iapping blazes)	Nos. of Resin blazes	Resin Extracted in Qlts.	Yield obtained/ 1000 (Qtls.)
2018	1483355	58355	39.34
2019	1415257	57080	40.33
2020	1389174	50939	36.62
2021	1405728	60802	43.25
2022	1416075	61520	43.00

The Rosin and Turpentine Factories at Nahan and Bilaspur with a total installed capacity of 1,11,000 quintals per annum (37,000 quintals in Nahan& 74,000 quintals in Bilaspur) were transferred to the Corporation in 1974. All the resin obtained by Corporation is processed in these factories to produce rosin, turpentine oil and other subsidiary products. Rosin Grade Full Name Pale(ISI) X Extra White WW Water White WG Window Glass N Nancy Medium (ISI) M Mary K Kitty H Harry Dark D Dark B Black The detail of Rosin, Turpentine Oil and its subsidiary products sold is as under:

Rosin	Grade	Full Name
Pale (ISI)	X	Extra White
	WW	Water White
	WG	Window Glass
	N	Nancy
Medium (ISI)	M	Mary
	K	Kitty
	H	Harry
Dark	D	Dark
	B	Black

Year	Rosin		Turpentine Oil		Subsidiary products	Misc. Sale	Total Sale
	Qty. (Qtls.)	Amount. (Rs. in Cr.)	Qty. (in Ltrs.)	Amount (Rs. in Cr.)	Amount (Rs. in Cr.)	Amount. (Rs. in Cr.)	Amount. (Rs. in Cr.)
2018-19	47706.15	31.64	859536	10.46	0.48	0.43	43.01
2019-20	49178.00	28.13	406328	6.09	0.77	0.29	35.28
2020-21	43384.00	35.75	1364151	16.09	0.65	0	52.49
2021-22	41914.00	45.64	1181961	15.66	0.30	0.41	62.01
2022-23	39488.00	43.57	1021736	13.01	0.67	1.24	58.50

The rosin and T. Oil is sold after fixation of rates by the Designated Committee.

➢ **Timber Extraction and Marketing:**

The marking in the salvage trees are done jointly by the field staff of H.P. Forest Department and HPSFDCL. in Low Lying Area, the marking lists are handed over to HPSFDCL by 15th September and in High Lying Area by 15th December for further exploitation.

The detail of volume handed over to HPSFDC Ltd. is as under: -

After extraction of timber, it is sent to Himkashth Sale Depots at Mantaruwala (Paonta Sahib), BaddiNear Chandigarh, Sawarghat, Dhanotu, Shamshi near Kullu,Udaipur (Chamba), Nurpur and

Bhadroya (near Pathankot) for sale. Auctions are conducted every month by the respective Directors.

The detail of timber sold during last 5 years is as under:

	Qty. Sold (M3)	Net Sale Amount (Rs.in crores)	Average Sale Rate/M3.
2018-19	85961.169	141.95	6571
2019-20	80670.902	135.53	16800
2020-21	71198.422	116.41	16350
2021-22	85513.635	138.15	16156
2022-23 (Feb/2023)	68352.517	139.11	20352

Besides timber and resin, HPSFDC also extracts khair, pulpwood and fuelwood Bamboo and Charcoal from Government forests and sale through Road/Retail Sale Depots. The detail of timber sold during last 5 years is as under:-

Besides timber and resin, HPSFDC also extracts khair, pulpwood and fuelwood Bamboo and Charcoal from Government forests and sale through Road/Retail Sale Depots. The detail of timber sold during last 5 years is as under:

Year	Khair		Timber (sale value in lakh)	pulpwood, F/wood (sale value in lakh)	Bamboo (sale value in lakh)	Charcoal (sale value in lakh)
	Volume in m3	SaleValue (in lakh)				
2018-19	2707.14	1418.13	491.41	354.66	0.14	29.66
2019-20	3019.91	1668.93	387.05	376.47	5.66	24.08
2020-21	3210.00	2223.00	150.12	347.12	49.45	20.31
2021-22	2941.04	1626.00	332.01	551.20	41.32	8.59
2022-23 (Feb/2023)	2702.87	1522.69	542.44	492.35	0.01	11.88

In addition to above, Private timber of nationalized species is also harvested and sold through auctions in the above Himkashth Sale Depots. The detail of timber sold during last 5 years is as under:

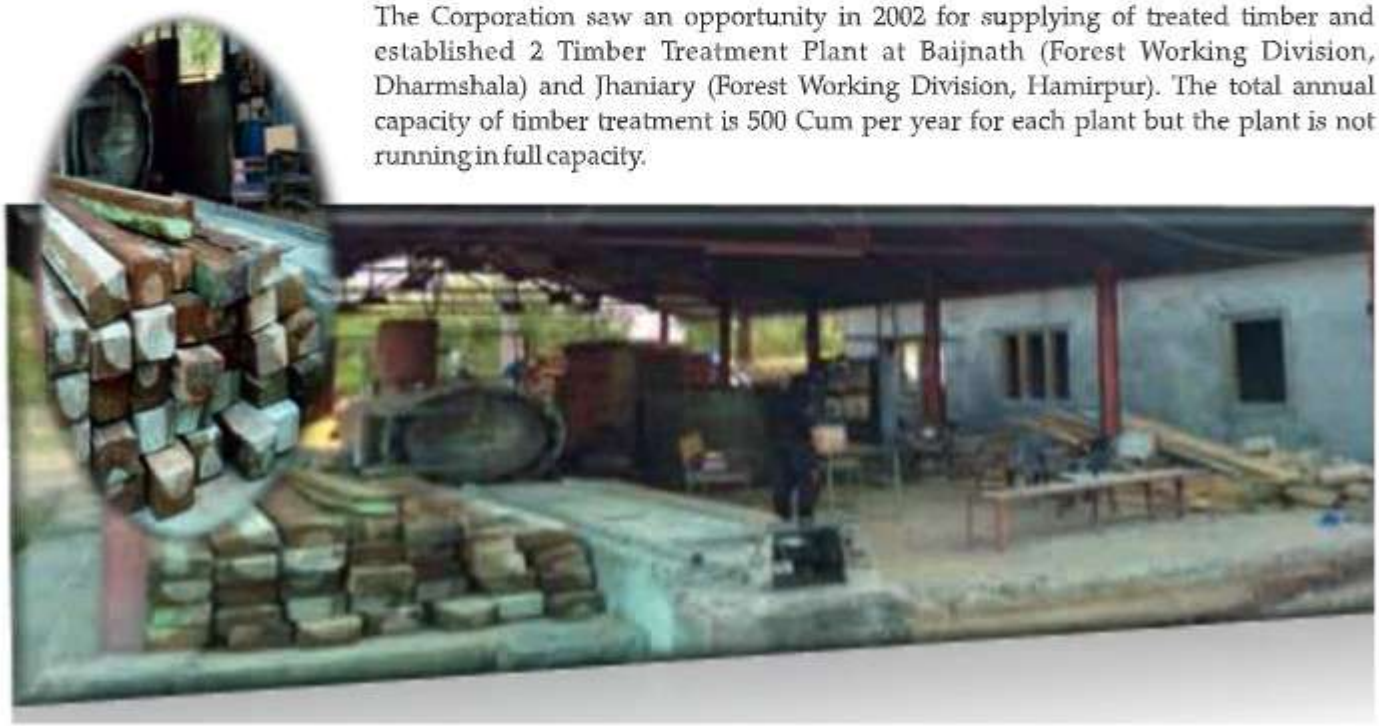
Year	Qty. Sold (M3)	Net Sale Amount (Rs.in crores)	Average Sale Rate/M3.
2018-19	15828.732	25.57	16181
2019-20	12195.852	20.79	17047
2020-21	12332.997	22.36	18132
2021-22	19508.608	38.33	19647
2022-23 (Feb/2023)	17018.855	41.49	24379

In lieu of harvesting the Pvt. Lots, the HPSFDC Ltd. charge handling charges on net sale of forest produce @ 15% from 01/04/2023.

The royalty rates are approved by the Pricing Committee every year on the basis of average sale rate obtained in Himkashth Sale Depots in the preceding year.

➢ OTHER ACTIVITES: TIMBER TREATMENT PLANT

The Corporation saw an opportunity in 2002 for supplying of treated timber and established 2 Timber Treatment Plant at Baijnath (Forest Working Division, Dharmshala) and Jhaniary (Forest Working Division, Hamirpur). The total annual capacity of timber treatment is 500 Cum per year for each plant but the plant is not running in full capacity.



The detail of Timber treated is as under:

Year	Name of Plant	Pvt. Timber treated (M3)	Govt.Timber Treated (M3)	Total (M3)
2018-19	Baijnath	31.446	24.365	55.811
	Hamirpur	69.870	107.279	177.149
2019-20	Baijnath	32.647	0.912	33.559
	Hamirpur	45.812	135.99	181.802
2020-21	Baijnath	0	0	0
	Hamirpur	74.455	3.27	3.27
2021-22	Baijnath	64.090	0	64.090
	Hamirpur	74.655	46.791	121.416
2022-23	Baijnath	15.475	0	15.475
	Hamirpur (Feb/2023)	47.701	35.475	83.180

Supply of Fuel Wood to Tribal Areas:

The HPSFDCL is supplying fuel wood to the Tribal Areas as per the decision taken by the Govt. The sale of fuelwood in the tribal area is done by the HP FD. The total demand and supplies made during last 5 years and current year are as under:

Year	Qty. Supplied (In Qtls.)	Amount (In crores)
2018-19	76054	5.57
2019-20	73698	5.39
2020-21	86974	6.37
2021-22	88185	6.46
2022-23 (Feb/2023)	76525	5.60

Sale of furniture items from Shamshi Unit, FWD, Kullu.

The HPSFDC is selling furniture and other wooden items from Joinery unit at Shamshi of FWD, Kullu. The detail is as under:

Supply of Godrej Furniture through HPSFDCL:

The HPSFDCL is an agency for supply of products of M/s Godrej Interio to various indenting Government Departments. HPSFDCL is generating income @5% from the total sale amount up to 2020-21 and after that @ 8.5. The detail is as under: -

Financial status: The Corporation began with a net annual turnover of 2.53 crore in 1974-75 and touched 244.13 crore in 2021-22.

Steps initiated for improvement in recent past:

The Corporation has taken several steps to improve efficiency and profitability. A brief of important initiatives undertaken in the recent past is given as under:

I) HPSFDC adjusted (instead of retrenchment)1021 surplus daily wagers in other Government Departments owing to reduced workload and heavy salary burden.

ii) The outturn norms of timber were rationalized to reduce wastage and improve yield. The scheme for incentivizing higher out turn percentage was also brought out.

iii) To rationalize organization, cut costs and improve efficiency HPSFDC has frequently undertaken merger, abolition and reorganization of its field units based on availability of work. iv) The post of Director Marketing,Director Finance and Director Legal have been abolished to trim down the top heavy management. Some posts of Divisional Managers have been downgraded based on volume of business.

v) To cut short delays and to encourage timely completion of timber lots by the Labour Supply Mates, a scheme providing for incentives to the LSMs as well as to the staff of the Corporation for early completion of lots and for better performance has been was launched.

vi) To improve transparency and to increase competitiveness amongst the bidders **e-tendering** has been introduced for timber and resin works through out the State.

vii) To obviate chances of misclassification and incorrect grading of timber in Sale depots, the old grading and classification system have been revisited and rationalized.

viii) To bring transparency and reduce cost, **e-auction** has been introduced for sale of Khair, Pulpwood and fuel-wood. ix) Timely decision and aggressive marketing resulted in obtaining better sale rates of timber.

Activities of Karnataka Cashew Development Corporation (KCDC) Ltd.

Sri. Prakash S Netalkar, IFS

Chief Conservator of Forests &
Managing Director, KCDC Ltd. Mangaluru

&

Sri. Appanna C Poonacha,
Ex-General Manager (NABARD)
Project Consultant

E-mail: kcdcltd@gmail.com

Cashew

Background

Cashew (Anacardium occidentale), a native of Brazil, was introduced in other parts of the world starting from the 16th century mainly with the intention of afforestation and soil conservation. From its humble beginning as a crop intended to check soil erosion, cashew has come out as a major foreign exchange earner in maost of the countries. Cashew is primarily grown in the continents of Asia, Africa and South America. Asiatic zones mainly include India, Vietnam and Indonesia as the major cashew producing countries followed by Philippines, Malaysia, Thailand and Sri-Lanka. African countries producing cashew are Côte d'Ivoire, Nigeria, Tanzania, Mozambique, Kenya, Benin, Guinea-Bissau, Ghana, Senegal and Madagascar. Latin American countries producing cashew consist of Brazil, Columbia, Costa Rica, Honduras and Salvador.

Till 80's, raw cashew nut production witnessed slow and steady growth. From 90's, global raw cashew nut production has seen a tremendous growth. The huge production increase has been mainly contributed by Vietnam, the newly emerged raw cashew nut producer in the recent times. Since 1990, Vietnam cashew industry has seen massive growth with respect to domestic cashew nut production and processing.

India is the largest producer of raw cashew nut in the world with 1.01 million ha area under cultivation and 0.75 million tons production in 2013. The area under RCN has been increasing consistently year-after-year. From 1961, cashew cultivation area in India has increased at a growth rate of 3.04 per cent (CAGR).

Africa produces 42% of the estimated 2.6 million tons of raw cashews every year. Of this, it exports 90% to the rest of the world, retaining the rest for domestic produce.

In India Kerala, Goa and Karnataka states are the traditional RCN producers and processors for a long time in India. Later the RCN cultivation expanded towards other states like Maharashtra, Andhra Pradesh, Odisha and Tamil Nadu.

India is among the largest cashew producing countries in the world. The country is the largest producer and processor of cashews in the world. The cultivation of cashew in India covers a total of 0.7 million hectares of area and the country produces over 0.4 million metric tonnes (MT) annually.

India Cashew Market Size was US$ 807.41 Million in 2020, according to a recent research analysis.

The approximate raw cashew nut requirement of the country by 2050 is estimated to be 4-5 million metric tons or more.

Some of the top cashew nut producing states in India are: Maharashtra, Andhra Pradesh, Orissa, Karnataka, Kerala and Tamil Nadu.

Cashew in Karnataka

Cashew is grown mostly in interior villages of Karnataka and following table shows the area and production.

Sl. No.	District	Area -ha	Production - MT
1.	Kolar	2646	1674
2.	Shivamogga	9153	6377
3.	Belgaum	6273	6433
4.	Uttara Kannada	5896	7177
5.	Dakshina Kannada	43478	31973

Apart from being an important commercial crop with low key investment per unit area it also generates immense local employment.

The processing industries are also largely in small scale sector and they too generate substantial employment. It is necessary that substantial investment is made to those agencies/institutions/corporations who play the role of direct raw material contributors like KCDC as cashew is considered to be a thrust area among horticultural crops under National Horticulture Mission.

Karnataka Cashew Development Corporation (KCDC) Ltd., Mangaluru

The Genesis...

Karnataka Cashew Development Corporation Ltd., was incorporated on 14th February 1978 under the Companies Act, for Scientifically Managing the cashew plantations raised hitherto by Karnataka Forest Department promoting the development of cashew plantations in the State. The authorized share capital of KCDC is Rs.1000Lakhs and the subscribed share capital is Rs.759.03 lakhs, of which Rs.44 lakhs is held by Government of India in the form of 4400 equity shares of Rs. 1,000/- each and the remaining Rs.715.03 lakhs are held by Government of Karnataka in the form of 71503 equity shares of Rs.1,000/- each. The Government of Karnataka has transferred 25,629.66 ha. of land of which 12721.47 ha. of land is held as equity and 12908.19 ha. of land is held on lease.These areas are distributed in the three divisions in the following Districts:

Division	Dakshina Kannada	Udupi	Uttara Kannada	Shivamogga	Total
Puttur	9130.04	1287.23	-	-	10417.27
Kundapura	-	6116.12	-	2064.25	8180.37
Kumta		-	-	7032.02	7032.02
	9130.04	7403.35	7032.02	2064.25	25629.66

The KCDC has been raising and managing cashew plantations for last several decades in degraded forest lands and Government land of coastal region and in some Upper ghat patches of Karnataka.

Being one of the largest Cashew plantation units in the world in terms of area, every effort is drawn to make the corporation inch towards making it one of the largest producers too. The objective is to see that every major raw cashew producer like KCDC in the country evolves its own model and strategy to add quality volume and value to raw cashew and in the process generate employment and wealth for the nation.

The approach envisages taking into account a holistic long-term strategic view for encouraging scientific, environment friendly, drudgery/labour reducing, efficiency enhancing, energy saving, remunerative and time saving planned development of cashew farming activity while focusing on organized marketing of the farm produce on a continuous and remunerative platform on a long-term basis.

Structure of KCDC Ltd.:

The Karnataka Cashew Development Corporation Ltd. is governed by Board of Directors both from the State Government and Central Government as detailed below.

Directors representing the Government of Karnataka:

1. Sri.B. Maniraj Shetty, Chairman.
2. Sri.Prakash S Netalkar, IFS, Chief Conservator of Forests & Managing Director.
3. Sri. Rajkishore Singh, IFS, PCCF (HoFF), Karnataka Forest Department.
4. Dr.Sanjay S. Bijjur, IFS, Principal Secretary to Government, FEE Department, Government of Karnataka.
5. Smt.C.Hemalatha, Deputy Secretary, Department of Public Enterprises, Government of Karnataka.

Directors representing Government of India:

1. Dr. N. K. Patle, Director. Deputy Commissioner (Hort.), Ministry of Agriculture & Farmers Welfare,Krishi Bhavan,NEW DELHI.
2. Dr.Venkatesh N. Hubballi, Director.Directorate of Cashewnut & Cocoa Development, Kera Bhavan,KOCHI
3. Sri. Avinash T.J., Director. Chikmagaluru
4. Dr. Sunil, Director.Coordinator, Cashew Technology Centre, University of Agriculture & Horticulture Sciences, Navile, Shimogga

The above Directors meet quarterly for the Board Meeting at Head Office Mangaluru and discuss and take important decisions on the working and administrative issues of the Corporation. The proceeding of the Board Meetings is being sent to the Government of Karnataka and the Accountant General office for necessary information.

The Managing Director has 3 Divisions manage by the Divisional Manager of the rank of Dy. Conservator of Forests and have Divisional Officers at Puttur in Dakshina Kannada District, Kundapura in Udupi District and Kumta in Uttara Kannada District below the Divisional Manager are the Plantation Superintendents followed by Supervisors and plantations watchers who

monitor the field and take care of plantations from encroachments, fire, illegal felling of trees, etc. They maintain the plantations with at most care and see that the yield cashew trees are increased.

Aims and objectives

Aim

Revival of cashew plantations under Karnataka Cashew Development Corporation for higher productivity & better returns in the long run.

Objectives

The objectives of the corporation are listed below:

- Enhance productivity by removing senile andold plantation and replanting with High yielding varieties of cashew grafts.
- Managing the plantations by adopting latest technologies released by research institutions.
- Putting the KCDC land to the best use for optimum utilization.
- Restoring waste lands to productive use by adopting agronomic practices.
- Effective soil and moisture conservation in the high rainfall areas.
- To establish cashew nursery for expanding cashew cultivation for improving livelihood of people and arresting land degradation
- To create awareness programme for farmers

Core activity Focus

The Karnataka Cashew Development Corporation Ltd. Has been actively involved in increasing production of cashew by raising new cashew plantations of high yielding varieties in the Forest lands (leased or on equity from Govt.) and maintenance of its older cashew plantations. The Corporation also promotes cashew plantations on farm lands by producing grafts of high yielding variety which if in excess over in-house demand, sells it to farmers.

The crop management is done in a scientific manner by Karnataka Cashew Development Corporation Ltd. This is being done with expertise and analysis from implementation to execution & evaluation by various Government of India agencies like (a) Directorate of Cashewnut & Cocoa Development, Cochin, (b) Directorate of Cashew Research (Formerly, National Research Centre for Cashew (NRCC), Puttur (c) Zonal Research Centre, Brahmawar, (d) Agricultural Research Station, Ullal. The KCDC is greatly benefited by the regular interactions in experience sharing and expertise of these Scientific Institutions from time to time.

Presently KCDC is holding the possession of 25,629 hectares of total cashew/forest area. The cashew plantations spread over forest areas are subdued owing to high density of weed growth between plants area, removal of which itself a gigantic task and is both time consuming and involves a high degree of expenditure that too on a continuous basis. This excess weed growth which at present continues to be is highly discouraging or interfering aspect in KCDC's Cashew plantation crop areas, resulting in poor growth of trees and also hindrance in day to day up keep of operations at the field. As a result, these plantations are gradually losing their potential of Cashewnut production because more and more trees are turning senile every year. Earlier attempts have been made to maintain the yield potential of these plantations by planting cashew grafts of high yielding varieties (HYV) in the available gaps in the existing plantation areas to the extent of 12,780 hectares from the year 1992 to 2018. But this pace of gap planting of high yielding variety is not sufficient to maintain the yield potential of total areas under possession of KCDC.

This Corporation conducts the annual sale of right to collect the Cashewnut and apple collection through the process of e-tender cum e-auction through the e-Platform of e-Governance Department of Karnataka State. Sales are conducted at the respective divisions for the cashew units falling in their jurisdiction. For the purpose of conducting the sales all the plantations are grouped into sale units comprising of one or more than one plantation. There is total 489 such units distributed among 3 divisions of Corporation. The headquarters of the Divisions are situated in Puttur, Kundapura, and Kumta.

Further it is observed that the plantations which are having sufficient number of trees but their extent is very less and more over they are also not maintained annually because of non-availability of funds with KCDC.

Past and Recent planting programmes & Progress

High yielding Variety cashew plantations have been raised in 13,915.80 hectares with the help of Directorate of Cashew and Cocoa Development Board, Kochi & RKVY grants since 1992.

During 2018-19, KCDC raised 500 ha. of new cashew plantations under the financial assistance of RKVY-RAFTAAR Scheme by planting high yielding varieties of grafts at 200 plants per ha. and the results are promising. RKVY Scheme has really shown impact on the cashew

growth of 4 districts of coastal Karnataka and has developed interest in the local farmers to grow high yielding varieties of cashew seedlings and improve the economic status and increasing the availability of raw materials to the local industry.

Replanting KCDC plantations with these high yielding varieties are indeed is the need of the hour as the Corporation had earlier only older cashew plantations of seed origin

Types of plantations and species planted:

Karnataka Cashew Development Corporation Ltd. has been raising high yielding varieties of cashew plants since 1982 with the help ofDirectorate of Cashewnut& Cocoa Development Board, Kochi and Rastriya Krishi Vikas Yojana grants from Ministry of Agriculture, Government of India and State Government.

Replanting KCDC plantations with these high yielding varieties are indeed is the need of the hour as the Corporation had earlier only older cashew plantations of seed origin and as such recording poor yields over the years of ageing. The seedlings required for these plantations were initially brought from Directorate of Cashewnut & Cocoa Development Board, Kochi approved nurseries of Maharashtra.Since last 5 years, the seedlings are raised in the corporation nurseries by our own staff with the guidance of DCCD Kochi and local Cashew Research Institute. They were accredited every year upon thorough inspection of DCCD Kochi and certificates were issued towards the quality of seedlings. The species raised in our plantations are -

(a) Bhaskar(e) Ullal-II

(b) engurla IV (f) Ullal-III

(c) Vengurla VII(g) H130

Cashew grafts raised at Valalu Nursery of Puttur Taluk

Six-month-old planted seedling

Rejuvenation of cashew plantation

(d) Ullal-I

Pictures of Nursery and various works at KCDC plantations.

The plantations raised by our corporation since last 10 years are given below.

Year	Name of the District			Total
	Uttara Kannad	Udupi	Dakshina Kannada	
2012	240	150	110	500
2013	225	30	245	500
2014	250	250	500	1000
2015	200	0	350	550
2016	181	100	132	350
2017	100	25	125	250
2018	220	130	150	500
2019	125	120	160	405
2020	70	56	104	230
2021	105	75	70	250
2022	45	-	105	150
Total	1698	936	2051	4685

These high yielding varieties of cashew plantations and maintained for 3 years by the Corporation. This has resulted in increase of yield in plantations plus adding to the overall quantity of the yield available to the local cashew industries along the coast. However, as a number of cashew industries along the coast is more than 200 including small and large factories, the quantity available is insufficient and a major portion of the requirement of raw Cashewnut (RCN) is hence continued to be met through imports.

Present & Future Strategy

KCDC still has more than 11000 ha. of gap areas for raising new cashew plantations and we propose to take replanting/new planting of cashew plantations every year in the uncovered area. We wish to take up the planting step by step subject to the availability of funds. Hence, KCDC is proposing to take up development involving a total area of 22625 hectares of Cashew plantation area during 2023-28 under its different divisions.

The specific areas along with the GPS readings will be given after planting activities are over. Further the areas proposed for planting during 2023 and 2028 is not covered under areas in any of the existing schemes, hence for the purpose of reviving the production/ yield potential of these plantation assets, following proposals are made as per the requirement of plantations for restoring production potential of these areas.

Details/ Particulars	Year of Implementation, Description and area
	Uprooting the old and deceased and Low Yielding Cashew Trees with Heavy weed growth and Replanting with High yielding Variety of Cashew Plants and Maintenance for 5 years.
	Cashew New Planting/Replanting –Raising of Cashew Plantation and Maintenance for 5 years.
	Intensive Cashew Cultivation for 5 years
Maintenance Activity	Maintenance of Existing Cashew Plantation
Rejuvenation activity	Cashew Rejuvenation –Rejuvenation of older Cashew Plantation.
Raising of Cashew grafts in KCDC nursery.	Raising of cashew grafts in KCDC Nurseries accredited by the DCCD, Kochi. Raising of High yielding variety cashew grafts for support of entire in-house exercise of planting programme of KCDC over years
Purchase of tools & Equipment	Purchase of a set of tools & equipment for easy carrying out of the plantation maintenance programme throughout the tenure of the project period.
Administrative Expenses Supervision / Administrative cost/ Including conduct of training programmes, seminars, meets etc.,	Administrative expenses- Overhead Charges-Institutional handling, supervision, administration, Interaction, Awareness, Workshops, seminars, exposure visits & national project interface in cashew exposure and other related expenses.

Notable events and Achievements of KCDC

I. International & National level Seminars, and workshops and interactive meets

A. International Cashew workshop –Organiser KCDC

"Recent development in cashew processing and raw nut handling by growers and traders"

Karnataka Cashew Development Corporation Ltd. organized a day's Workshop on Cashew titled " Recent developments in cashew processing and raw nut handling by growers and traders" in BIRD Campus of NABARD, Mangaluru, Dakshina Kannada, Karnataka, India. About 45 participants were present.

The workshop was inaugurated by Dr. N.K. Patle, Director, KCDC Ltd. and Deputy Commissioner (Hort.), Ministry of Agriculture & Farmers Welfare, GOI in presence of Dr. Venkatesh N. Hubballi, Director, KCDC Ltd. and Director, DCCD Kochi, Sri.Prakash S. Netalkar, IFS Managing Director, KCDC Ltd, Dr. GangadharNayak Director, DCR, Puttur, Sri.K.Lakshminarayanan, Jt.Director, BIRD, Mr. Firoze Kapadia, Grp Chief Financial Officer, AL Sayegh Grp Malasia& delegates.

The above international level event ensured to create a platform for producers and processors to come together to address their issues collectively. KCDC is confident of organizing such events in future too to sort out the various issues that arise from time to time in both producers' level and at the processors level.

B. Karnataka Cashew Development Corporation (KCDC)

Interactive & Motivation meet - 05-12-2019

"Cashew Plantation up keep & other related aspects"

Karnataka Cashew Development Corporation (KCDC), Mangaluru under the guidance and leadership of its Managing Director Sri. Prakash S. Netalkar, IFS, successfully conducted the Interactive & Motivation meet "Cashew Plantations upkeep and other related aspects" on 5th December, 2019 at their Farmers Training Centre (KCDC Premises) Mangaluru.

The event commenced with invocation by Sri. Raviraj, Plantation Superintendent, Kundapur. Sri. Sripathi S., Accounts Officer, KCDC Ltd., welcomed the participants. Sri.B.L. Hegde, Office Manager, KCDC donned the role of Chief Anchor for the event.

Inaugural address was given by, Guest of Honor Sri. H.R. Nayak, Deputy Director, Horticulture, Mangaluru, who spoke in brief about the genesis of RKVY programme under which KCDC sought financial support for revival of their existing cashew plantations. He further mentioned about the present programme (under RKVY scheme) and its focus and future steps to be taken by KCDC for further enhancement of yields and revenue generation.

Sri. Prakash S. Netalkar, Managing Director, KCDC, Mangaluru, in his address explained to the house regarding the background and necessity that arose finally leading to organizing an interactive session of this nature amongst its staff and employees to be taken up from time to time. He opined that such interactive meet would definitely send a positive vibe amongst its employees and will have a direct beneficial effect on their work output. He further emphasized the importance of financial support extended under RKVY programme to KCDC especially for its plantations revival and rejuvenation programmes. Would continue to seek support under the said programme for taking up various activities in KCDC plantations that ultimately result in increased yields and better revenue returns in years to come, he added.

Dr. Yadu Kumar, Senior Scientist (Rtd), DCR, Puttur, made a presentation (Cashew Plantation Cultural Practices -Scientific & Modern practice tools) showcasing the latest cultural practices and new strides

in the field of cashew cultivation apart from modern practices relating to soil and water conservation, nutrient management, improved cultural practices etc., Emphasizing on the importance of better cultural practices on a continuous basis, he stressed the need for focusing on activities like mulch and earthing-up of soil to preserve soil moisture, soil nutrients and soil flora and fauna apart from control of insects and pests through IPM. He made a passing remark regarding securing plantation areas and suggested some changes in the present auction system of raw cashew nuts (RCN).

In the interactive session "Re-look at Man, time and material management at Cashew Plantations", Sri. Appanna C.P -Ex G.M.-NABARD - Agri Consultant & Project Specialist, reminded the house regarding KCDCs position at No.1 place as one of the largest Cashew Plantation Globally. He requested the participants that after their return to the respective work place/ respective plantations they should re-work their daily schedule by putting extra efforts to step up per unit's production level of the plantations to bring it on par with National Cashew Yield level per unit area.

Workshop/training conducted by KCDC with the help of NABARD Bengaluru

C. Regional Level Workshop on Cashew–Organiser KCDC

Workshop/training conducted by KCDC with the help of NABARD Bengaluru

"Latest trends in Cashew cultivation and its adoption by cultivators coupled with improvised approaches in orchard training/ pruning/ post-harvest handling"

Karnataka Cashew Development Corporation (KCDC) Mangalore organized a day's workshop titled "Latest trends in Cashew cultivation and its adoption by cultivators coupled with improvised approaches in orchard training/ pruning/ post-harvest handling" for farmers on 21 September 2022 at KCDC's Farmers Training Conference Hall, Abbakkanagar, 1stMain, Kottara, Mangalore, Dakshina Kannada, Karnataka, India.

The objective of the workshop was to give an opportunity to Cashew farmers and KCDC field staff who will have an insight into the latest emerging trends related to crop cultivation and its possible adoption. It also keeps them abreast with the latest approaches in training/ pruning/ post-harvest handling in their orchards, so as to empower them to fine tune themselves in advanced crop technologies and also learn more about improved post-harvest handling of Cashew farm produce before its onward sale to processors for a remunerative price.

Major topics to be discussed during the workshop were:

- Crop Cultivation - Latest trends/innovations/ improvements
- Training & pruning approaches in Cashew with more focus on Innovative methods, labour and time reducing methods
- Post-Harvest handling of crop produce at the farm level-new dimensions
- Cashew crop scenario, Costs of cultivation in Cashew, Economics and Cashew Crop's relevance in comparison to other crops

Further, the main subject and topics discussed at the workshop are directly relevant and are present requirement/ need of the hour in cashew crop which has to be to addressed periodically from time to time to keep pace with farm output of quality standards which if maintained will fetch a remunerative price to its growers.

Any improvisation/better/improvised practices adoption in farming approach for cashew is always welcome as the crop is indeed a major earner in our country's exchequer and shortage or deficit of raw cashew nut (RCN) within the country (local) continues to pose a huge challenge to research organisations and the like. Such approaches to update/ motivate/ encourage farmers on a regular basis is indeed need of the hour. Hence the subject and timing both are appropriate.

D. Cashew Grafts supplied to other States:

In August 2022 actively participated in the coordinating the exercise relating to loading & unloading of Karnataka Cashew Development Corporation's in-house nursery Cashew grafts to Nurseries of Government of Madhya Pradesh in Balaghat, Chitwada&Sivani districts. KCDC in this maiden Interstate venture (Involving sale and dispatch a record quantity / number of cashew grafts in a single load)successfully loaded and dispatched nearly 16000 Cashew grafts from their Keravase (Moodabidri) nursery to Madhya Pradesh Government on 5th August 2022. This is a national record for shifting such a large number of Cashew grafts in one go. Highlight of the exercise was that there were almost "nil" loss of plants during transit which was a period of 5 days and the host of events involved with this mammoth task was all carried out by Team KCDC only.

This is in line with their continuous endeavour to support and encourage new cashew plantations in hitherto unexplored area. Kudos to team KCDC for actively participating and supporting the cause for bringing additional area under cashew thereby fulfilling nation's longstanding drive for cashew crop extension to bridge the gap in RCN production.

Pictures of the nursery & exercise

Kerevase nursery of Karkala taluk

Volalu nursery of Puttur taluk

Shifting of live plants to the Districts of Madya Pradesh State

E. Creation of water resources

In coastal Districts as the rain fall is heavy it is very necessary to check the flow of rain water going to the sea by digging of water ponds, contour trenches, etc. Hence the corporation has taken steps towards water conservation by digging above structures within the plantations of the corporation so that the water flow from hill slopes is checked and accumulated in ponds and trenches. This will increase the availability of water o the cashew plants as well as the local villagers downwards the plantations. Photos of structures are shown below.

Creation of water pond at Honnavara Unit of Uttara Kannada District under RKVY RAFTAAR during 2020-21

Local villagers have shown interest in these works and appreciate the efforts of the Corporation in conservation of water by expressing that water level in their well has increased during summer season.

F. Training/ Study tour of farmers and filed staff

A. Farmer's study tour to Kerala

While carrying out the activities of KCDC in development and maintenance of HYV grafted cashew plantations, it is very essential to address the farmers and local community by way of conducting study tours to farmers outside the state of Karnataka and within the State. KCDC has conducted a study tour to farmers in coordination with the Directorate of Cashew and Cocoa Development at Cochin to cashew research station at Madakkatara, Thrissur, Kerala State and also visited the Directorate of Cashew and Cocoa Development at Cochin. The farmers gained the knowledge in processing the cashew apples and how to prepare the value-added items like juice, candy, jam, pickle etc. and gained expertise knowledge in raising of cashew plantations, nursery & treatment of borer attack, etc.

Address by Dr.Venkatesh N Hubballi, Director, DCCD at DCCD, Kochi during farmers study tour to Kerala under RKVY Project 2019-20.

B. Farmer's study tour to Goa

Address by Dr.Venkatesh N Hubballi, Director, DCCD at DCCD, Kochi during farmers study tour to Kerala under RKVY Project 2019-20.

II. Important Events-Meetings-Interactions-Visits

A. Inauguration

Inauguration of farmers training centre building constructed unader RKVY Scheme during the year 2019-20 on 15-10-2019

B. Field Visits/Inspections

Field inspection by Dr.Venkatesh N Hubballi, Director, DCCD, Kochi, GOI and Pr. Scientist, DCR, Puttur for raising of new cahsew plantations under RKVY Area Expansion Sub-Scheme during 2018-19

Field Visits/Inspections

Shri Sandeep Dave, IAS, Addl. Chief Secretary, FEE Dept., Shri Sanjai Mohan, IFS, PCCF (HOFF) and Shri Kishore Singh, IFS, PCCF (Dev)., visited the cashew grafts nursery site raised under RKVY Scheme on 17-06-2021 at Kundapura

Accounts & Audit:

Accounts are maintained for all expenditures as per A.G. guidelines. M/s Shabbir & Ganesh, Chartered Accountant, Udupi, was appointed for conducting internal audit of accounts for the year 2021-22 to comply with Companies (Auditor's Report) order and M/s. A.K.Gopinath Shenoy & Co, Chartered Accountants, Mangalore, was appointed as Statutory Auditors for the audit of accounts for the financial year ended 31-03-2022 by the Comptroller and Auditor General of India.

The audit of accounts of KCDC Ltd. is then updated by above auditors within the time frame of the companies act and annual administrative report for the year 2021-22 as on 31-03-2022 is sent to the State Government and Central Government well in time. Further Accountant General audit is also completed during 2021-22 and to the satisfactory of the corporation.

Conclusion

The financial support and continued backing under Government Schemes like RKVY, NHM and DCCD have helped KCDC in maintenance of their cashew plantations to some extent and also have helped the corporation in introducing new plantation blocks under high yielding varieties of cashew plants over the years. Further, after meeting the in-house requirements of the seedling grafts, the seedlings raised by KCDC are also distributed to the farmers which has motivated them to raise cashew plantations in and around the vicinity of KCDC plantations. Further, demonstration plants and field trips have motivated the farmers of Mysore & Mandya region and an area of 320 ha. plantations is raised with Vengurla-IV variety with the help of DCCD Kochi which have started yielding the cashew nuts.

Thus, it is apparent from the various actions as narrated above that apart from KCDC continuing to maintain its own plantation through multiprong approaches, in the process it has also ensured to motivate local farmers to take up cashew plantations so as to increase the yield of cashew nuts in their fields too, ultimately resulting in making Karnataka less dependent on imported cashew nuts and in the process slowly but steadily save the precious foreign exchange to the Government exchequer.

Activities of Forest Development Corporation of Maharashtra Limited

Vikas Gupta
Managing Director
Email : mdfdcmltd@gmail.com

Introduction:

1. Prior to the creation of the Forest Development Corporation in the State of Maharashtra, Forest Development Board was established by the Government of Maharashtra in 1969 for converting large blocks of low valued mixed forests into valuable stands. Considering the experience of the Forest Development Board and the recommendations of the National Commission for Agriculture, Forest Development Board was metamorphosed into the Forest Development Corporation of Maharashtra Limited ("FDCM"). FDCM was incorporated under the Companies Act, 1956 on 16th February 1974, as a wholly owned Government of Maharashtra Enterprises. FDCM is one of the rare examples of successful forest plantation ventures in our country.

2. The FDCM has lived up to the mandate assigned to it and established valuable teak plantations. With over five decades of experience in raising teak plantations, harvesting based on time-tested silvicultural practices and marketing of timber and other forest produce, FDCM is a trailblazer in production forestry. It ranks among the best-managed State Public Sector Companies in the country with a track record of consistently making profits and paying dividends to the Government. The Company's contribution in generating rural employment is also noteworthy.

Objectives

3. The paramount objectives of the Company as enshrined in its Memorandum of Association are summarized as follows:

I. To develop land in the State of Maharashtra acquired by the Company by purchase, lease or otherwise for forest resources by raising thereon plantations of economically important species like teak, bamboo, khair, semal and such other suitable species as the Company may think fit.

ii. To plant, grow, cultivate, produce and raise plantations of all kinds or varieties of forest plants, trees and crops and natural products of any kind and other agricultural crops and to buy, sell, export, import, process, distribute or otherwise deal in all kinds of forest plants, forest produce, trees, crops, natural products, agricultural and silvicultural cash crops.

iii. To maintain, conserve, protect and preserve plants, crops, trees raised or come up naturally on the lands leased to or owned by the Company.

iv. To undertake maintenance, preservation, protection and development of the existing fauna.

v. To carry on business of felling, converting, dragging, hauling, marketing, processing, standardizing, grading, sorting, distributing and selling the forest products naturally or otherwise grown or raised on the lands leased or owned by the Company.

vi. To carry on business of timber and lumber merchants, lumber yard and saw mill shingle mill and pulp and paper mill proprietors, and to buy, sell prepare for market, process import, export and otherwise deal in timber, piles and poles, lumber and wood of all kinds.

vii. To manufacture and deal in articles of all kinds in the manufacturer of which timber or wood or any other forest produce is used.

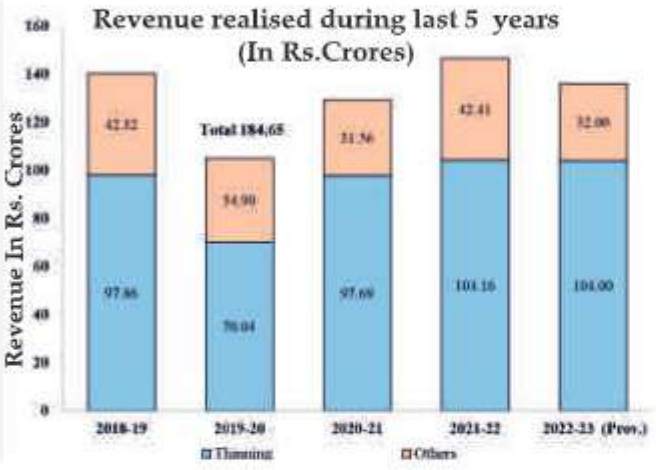
viii. To carry on the business of logging and lumbering, purchasing, acquiring and leasing timber berths, and so far as may be deemed expedient the business of general merchants in any other business which may seem to the Company capable of being conveniently carried on in connection with any of the above or calculated directly or indirectly to render profitable or to enhance the value of the Company's property or rights of the time being.

ix. To carry on business as manufacturers of and dealers in plywood, pulpwood, matchwood, hardwood, wood blocks for flooring and other

purposes, boxes, windows, doors, wood pulps, wood wool, masts, spars, derricks, sleepers, tool handless, paneling, woodwork, furniture and articles of all description wholly or partly made from wood or forest produce, the waste products or by-products of wood or forest produce.

4. The present Authorized Share Capital of the Company is 330 crores. And the Paid-up equity Capital is Rs. 323 crores.

5. The graphical representation of annual revenue earned through harvesting, thinning and other silvicultural operations is depicted as under.



6. As per the provisions of the Companies Act 2013, read with the Articles of Association of the Company, the power to appoint Directors on the Board of the Company is vested with Hon'ble Governor of Maharashtra. Experts and eminent person from the forestry profession and Government Officers are appointed on the Board of Directors of FDCM. At present, Hon'ble Minister (Forests) is the ex-officio chairperson with the Principal Secretary (Forests), the PCCF (HoFF) and the Deputy Secretary (Forests) are the ex-officio Directors of the Company. Except for the few senior level posts namely, the Managing Director, Chief General Managers, General Manager and Regional Managers, who are the IFS officers, the FDCM has its own sanctioned staff of about 1680 posts.

Area of Operations

7. Ever since the inception the FDCM, the Government of Maharashtra has leased out forest land across the State to it on certain terms and conditions, few of which are highlighted as under-

I. The FDCM shall utilize the leased lands for the purpose of raising plantations of economically important species like teak, Bamboo etc.

ii. The FDCM shall be at liberty to construct the roads, Buildings structures either of temporary or permanent nature, ancillary to its works on the lands leased to it.

iii. The Government shall not entertain any request for grants of forest lands for Agriculture or any other use and shall not sublet or allot lands leased to it for Agriculture or any other purpose without prior approval of the FDCM.

iv. The forest lands have been transferred to the FDCM in the form of pattas without transfer of ownership for Development, Management and Exploitations on the scientific lines.

v. The Government of Maharashtra will have no lien or rights over produce obtained from the crop to be grown in the transferred areas.

vi. The FDCM shall be free to sell, process or utilized in any manner the forest produce obtained by it from the transferred areas and retain the sell produce and other income there from for its own use.

8. At present, the extent of forest areas leased out to the FDCM extends over 3.43 lakh ha, which for the administrative reasons is divided into three Regions namely, Chandrapur, Nagpur and Nashik. The above three Regions are further sub-divided into 12 Forest Project Divisions and 1 Depot Division.

Delegation and Sub-delegation of Administrative and Financial Powers

9. The Articles of Association and Memorandum of Association are the bye-laws framed in furtherance of the Companies Act, whereby the Managing Director has been delegated administrative and financial powers by the Board of Directors for the day-to-day management of the Company. The Articles of Association also contain provisions, whereby the Managing Director has been authorized to sub-delegate such of his powers as he deems fit, to other officers of the Companies subordinate to him. Accordingly, the Managing Director, from time to time has sub-delegated his certain powers to subordinate officials.

Statutory Powers under the Indian Forest Act 1927 and the Wild Life (Protection) Act 1972

10. While leasing out forest areas to the FDCM, one of the conditions stipulated by the State Government

is that the Corporation shall be responsible for the protection and the conservation of forest lands under its administrative control. Accordingly, soon after the incorporation of the FDCM, the Government of Maharashtra empowered and invested the FDCM officials with the statutory powers under the Indian Forest Act, 1927, which have been revised and further modified from time to time and updated on 21.05.2013, so that they can discharge their functions as forest-officers within the meaning of the said Act.

11. Similarly, the State Government has appointed the field functionaries of the FDCM as the Wild Life Wardens and has also authorized them wherever necessary, with statutory powers under Wild Life (Protection) Act, 1972. Further, the Chief Wildlife Warden has also delegated his powers under section 5 of the Wild Life (Protection) Act, 1972 to the FDCM officials vide notification dated 25.07.2013. With such investment, authorization and delegation of statutory powers, the field functionaries in the FDCM exercise the same powers as that of the forest officers of the State Forest Department, with regards to the protection and conservation of forests and law enforcement under the said legislations.

Mode of Working in the Past

12. Almost entire forests assigned to the FDCM are dry deciduous in nature, with teak as the principal species. Being strictly shade intolerant, teak species requires bright sunshine for its vigorous growth. This implies that, if any undesired growth in the form of shade tolerant and inferior species is not cleared to make the conducive conditions for the principal species, i.e. teak *(Tectona grandis)* and its associates, the latter is bound to be suppressed by the former.

13. Apart from the aforesaid scientific reasons, Teak is one of the most time-tested sources of superior timber in the world. Teakwood can withstand the vagaries of nature due to its closely packed grains and high content of natural oil exuded by the tree, which makes it termite-proof and water-resistant. This is what gives teak its unmatched durability and makes it the most favored material for construction purposes. The Great Marathas and the British could build their empires on the strengths of their naval power, which was itself based on ships made of teak. Apt to say, ***"age cannot wither it, nor custom stale its infinite variety"*****.....**

14. Teak is a versatile timber with a unique combination of strength, durability, workability, and great aesthetic appeal. It is a naturally beautiful timber with its typically straight grain and pleasing golden brown color. Among all the teak varieties of the world, the Central Indian teak (also known as the CP Teak) is the finest, due to its superior quality and alluring visual appeal. Furniture made of the CP teak can last for hundreds of years, thereby making it an important carbon sink.

15. With aforesaid consideration, after the formation of the Forest Development Board in 1969, and later the FDCM, Teak plantations to the tune of 1,24,355 ha. were raised by clear felling the forests during the period 1970-87. After the moratorium on clear felling imposed in 1987, FDCM was entrusted with the task of afforestation of degraded forests as well as forest waste lands during 1988-91. Total area tackled under the said Massive Afforestation Programme during this period was 2,35,608 ha. Teak/Bamboo plantations were raised under the World Bank aided Maharashtra Forestry Project during 1992 to 2000 over 1,20,905 ha.

Cardinal Principles of Production Forestry Followed by the FDCM

16. In the words of W.E. D'arcy, the author of the treatise, titled as 'Forest Working-Plans in India'—

"The Timber growing is one of the few kinds of creative processes in which both product and productive machinery are the same thing. The wood of the stem cannot be removed without destroying the machinery (Growing Stock) that produced it. A clear distinction must, therefore, be drawn between the trees that must be left to produce more wood and the surplus trees that can be regarded as product and harvested."

17. Similarly, David M. Smith, in his masterpiece named as 'The Practice of Silviculture' quotes—

"Paradoxical and repugnant to certain influential segments of public opinion, useful forests are created and maintained chiefly by the destruction of judiciously chosen parts of them. One of the characteristics of life is death, if there were no death, there would be no space for new life."

18. Sticking to the philosophy cited above, the paramount consideration of forest management for the FDCM is that, in furtherance of robust economy and to attain self-sufficiency, it is

essential that the country has sufficient stock of standing quality-timber of all sizes in the form of growing trees at every point of time. Therefore, the FDCM considers that the Forests must be managed and maintained in such a manner, that it's manager should always be equipped to meet sudden demand of quality-timber of all sizes, arising out of unforeseen exigencies.

19. With above considerations, the FDCM has been managing its forests, following the cardinal principles listed out as under—

I. To ensure maximum Current Annual Increment.

ii. To ensure that the said maximum CAI is accumulated on the main stems of the vigorously growing trees of principal species, and not on the deceased, suppressed and malformed ones.

iii. While ensuring (i) and (ii) above, to further ensure that the productivity of the site is not deteriorated in future.

Entire working of forests managed by the FDCM is on the touchstones of the above-mentioned cardinal principles.

New approach in tackling irregular, uneven-aged forests

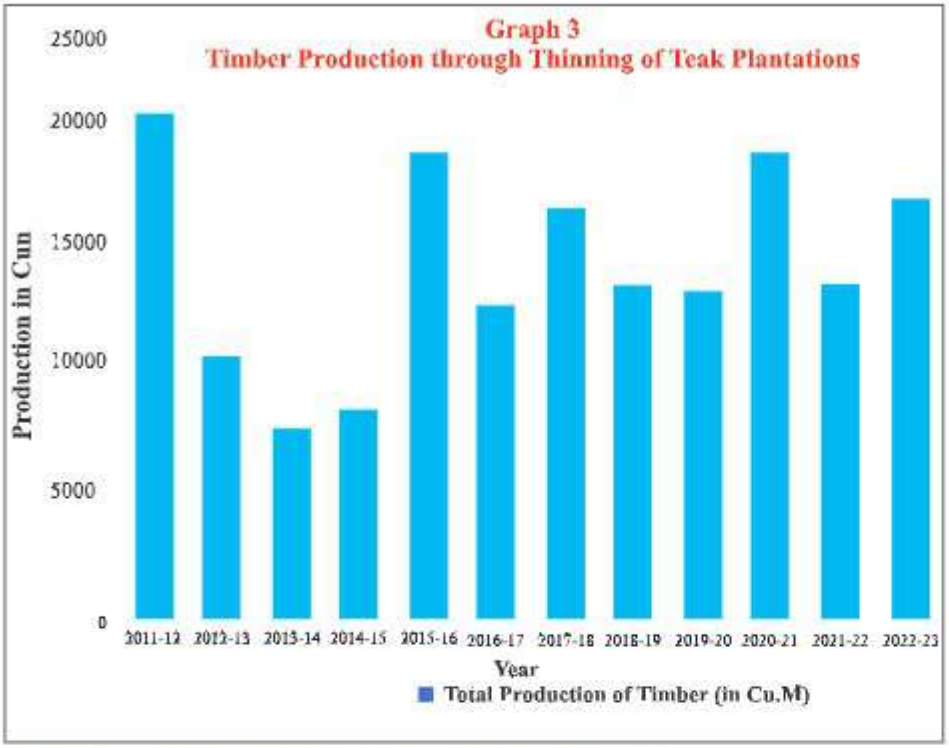
20. Vast tracts of forests managed by the FDCM fall in the category of irregular, un-even aged forests of varied composition, making their scientific management, challenging, and intriguing. The FDCM took up this challenge and came up with the unique Silvicultural System named as, **Conversion to Uniform System with Supplemental Artificial Regeneration of Genetically Superior Stock**, more commonly known as the Over-wood Removal (OWR) System. After several rounds of deliberations at the highest level in the Ministry, this silvicultural system was accorded approval by the MoEF in the year 2001. Since then, it has been adopted in FDCM as well as in few of the Forest Divisions in the Maharashtra Forest Department. This system is based on the objective criteria of Critical Crop Girth, which shall be discussed in the succeeding paragraphs. Pure teak plantations under the aforesaid silvicultural system have been taken up since the year 2002 and about 35000 ha. forests has been tackled accordingly. Year-wise production from harvesting is shown below.

Graph 2

Timber Production from Harvesting

The Thinning Regime Developed by the FDCM

21. Majority of the forest areas managed by the FDCM are dry deciduous, predominated by the shade intolerant teak and its associate species. As mentioned in the preceding paragraphs, prior to the years 1987 and after 2002, the forests have been managed under the even aged system. This necessitates the introduction of sound thinning regime, aimed at manipulation of stands to obtain the optimal CAI on judiciously selected trees of principal species. With this objective, the FDCM has developed its own thinning regime. These guidelines are enforced since the year 1999. About 33% of the Revenue is realized through the thinning operations in the FDCM. The timber-production from thinning is shown as below.



Management Practices in respect of Irregular Uneven Aged forests: The Critical Crop Girth

22. The even aged teak stands are managed with the help of Yield Tables and Stand Tables. However, under the practical situation, forests officers do encounter with crops, which are mostly of Irregular and Uneven Aged type with one or more girth classes either completely missing or largely suppressed. Often, crops themselves have varied degree of compositions with shade-tolerant species, malformed, crooked, dead, diseased and dying trees and coppices.

Before Thinning

After Thinning

23. To meet this challenge, unique silvicultural system named as **"Conversion to Uniform System with Supplemental Artificial Regeneration of Genetically Superior Stock"**, also known as the Over wood Removal (OWR) System has been devised by the FDCM. Under this system, irregular and uneven aged forest areas are divided into grids having areas 100m X 100m. To ensure the objectivity for harvesting, a parameter, known as the **Critical Crop Girth** is used to determine the suitability of a particular grid for its harvest. The forest area is harvested grid-by-grid, if and only if average crop growth of a given section is found to be more than the Critical Crop Girth corresponding to the site quality and crop-composition to which particular grid belongs to.

Teak Plantations under the OWR System

Critical Crop Girth

24. As stated earlier, the productivity of a site can only be maintained, if the crop is mature or over mature; it would deteriorate, and the deterioration shall be in proportion to its immaturity. Keeping this phenomenon in mind, such values of Crop-Girth have been worked out in respect of sites of various quality-classes having different sets of composition of species which can be considered as an indicator of maturity of that crop. In other words, a forest on a site of given quality class having crop-girth equal to or exceeding the value of such a Crop-Girth, if felled under clear felling system, would ensure respectively maintenance or improvement in productivity of the site; and the forest having crop-girth less than the said value of Crop-Girth, if felled, the productivity of the site shall go down resulting into the failure of new reproduction to grow on the lines the previous crop (clear felled crop) had grown. Such a value of crop-girth is termed as **"Critical Crop Girth"** in respect of that site quality class and that composition of species in the forest.

25. The **Critical Crop Girth** (CCG) is a function of productivity of site (that is to say, Site Quality with respect to the principal species) and growth pattern of the species present in the crop. It may be defined as a value of crop-girth, called Critical Crop Girth, in respect of a forest, such that, if the actual crop-girth of the forest taken up for reproduction under the clear-felling system, is less than the said value of Critical Crop Girth as applicable to that site and composition of species, the productivity of the site shall deteriorate, and this deterioration shall be in direct proportion to the difference between the two crop-girths. In other words, the productivity of a forest site shall be maintained/improved, if and only if, the crop-girth of the forest intended to be replaced with new reproduction is equal to or more than the value of the CCG.

26. To further elucidate on this point, if "g" is the actual crop-girth of a forest and "G" is the Critical Crop Girth for that site and the composition of species, then the productivity of the site shall be maintained while replacing the crop with new reproduction under clear felling system, if only if $g \geq G$; and if $g < G$, then the deterioration of site shall take place in due course and the extent of deterioration shall be directly proportional to G minus g. That is to say, more the deffrence

between the value of the CCG (G) and the actual crop-girth (g) of the forest in question, more would be the deterioration in the productivity of the site.

27. Based on thorough field exercise and observations, FDCM has worked out the Critical Crop Girth for different teak site qualities and crop compositions, chart of which is reproduced below—

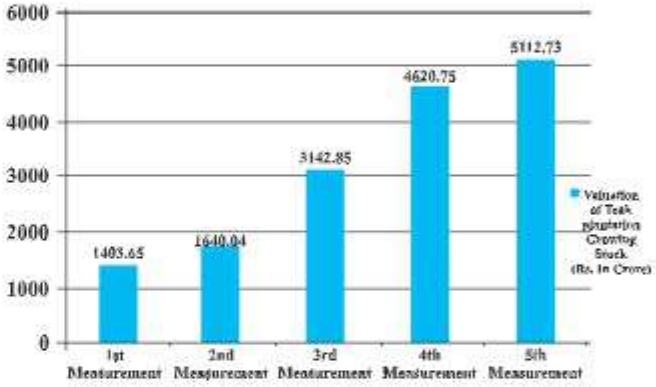
Top height in meters	All India Teak Site Quality		Top height in meters
40	SITE QUALITY I, I/III		40
39			39
38			38
37	CCG in cms.	Proportion of Teak, Ain, Bija, Haldu & Kalam	37
36			36
35			35
34			34
33			33
32	110 95 80	Above 40% 20% to 40% less than 20%	32
31			31
30			30
29			29
28			28
27			27
27	SITE QUALITY II, II/III		27
26	CCG in cms.	Proportion of Teak, Ain, Bija, Haldu	26
25			25
24			24
23	85 75 65	Above 40% 20% to 40% less than 20%	23
22			22
21			21
21	SITE QUALITY up to III		21
20	CCG in cms.	Proportion of Teak, Ain, Bija, Haldu	20
19			19
18			18
17	70 60 50	Above 40% 20% to 40% less than 20%	17
16			16
15			15
14			14
13			13
12			12
11			11
10			10
9			9
8			8
7			7
6			6
5			5

Plantation Inventory

28. For effective managing of growing stock and other dynamics of the crop, particularly teak plantations, a Plantations Inventory Unit was established in 1993 under World Bank aided Maharashtra Forestry Project with the mandate to carry out inventorization of the existing teak plantations and to assess the productivity of the teak plantations, so as to estimate the total growing stock and its monetary value.

29. So far, inventory measurements conducted at the regular interval of 5 years from 1995-96 till 2019-20 revealed that the market value of the growing stock of teak plantations is worth about Rs. 5100 crores.

Bar Graph of Growing Stock Market Value at Different Time Zone (Per Hectare)



30. FDCM has developed expertise in production of quality Teak Root Shoots in its various Nurseries spread across the State. FDCM is using its Nursery stock for raising its own production. Apart from that, the teak root shoots produced by the FDCM are in regular demand by the Teak bearing States.

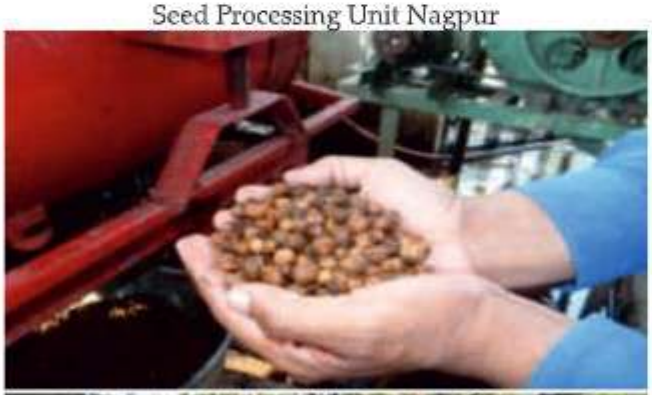

Chulband Nursery District Gondia

Quality Teak Seeds Collection, processing and marketing

31. The quality of seeds is the paramount requirement for successful raising of teak plantations. Sticking to this basic principle, the FDCM has identified and developed its own Teak Seed Stands (SS) and Seed Producing Areas (SPA) in the forest areas assigned to it to ensure that seeds used in the raising teak plantation is collected from the identified sources only. Specific provisions and methodology have been embodied in the Management Plan itself for maintenance of Seed Stands (SS) and Seed Producing Areas (SPA) so that this vital aspect of teak plantation management is adequately taken care of. Dedicated staff has been deployed for seed collection from the aforesaid identified sources from where collected seeds are sent to the seed processing units.

32. Mere collection of teak seeds from the identified sources is not adequate unless it is processed before its use in Nursery. To achieve this objective, dedicated Seed Units are in place at Nagpur and Ballarshah (Chandrapur) where the collected seeds pass through different stages of processing after which they are stored following the strict protocol. Apart from internal use of treated seeds in the FDCM itself, they are in great demand in the adjoining States like Andhra Pradesh, Telangana, Madhya Pradesh and Chattisgirh.

Seed Processing Unit Nagpur



Publications

I-Yield and Stand Tables for Teak

33. Ever since its inception in 1974, the FDCM is not only raising and maintaining the teak plantations created by it but is also instrumental in taking care of teak plantations raised in the past by the Forest Department, prior to the creation of the FDCM. Thinning is one of the most vital tending operations in the management of teak plantations and therefore for determining the correct measures of thinning in various teak site qualities and ages, yield and stand tables are the most important and vital tools.

34. Yield and Stand Tables for Teak were first published by the Forest Research Institute of Dehardun in 1959 in the FPS system. These tables were later converted into metric system by Shri. M. Y. Sawoni and Shri. R. D. Gadkari published by the FDCM in 1977. With this, came the change in spacing of teak plantations from 6 feet X 6 feet to 2m X 2m, thus bringing down the per hectare requirement of plants at the time of planting from 2990 to 2500. Later, in the year 2003, the next edition of Yield and Stand Table was published which was made more user friendly with the class interval of 5 cm.

35. Yield-Tables, which are available at present, are technically applicable for pure Even Aged stands of Teak. However, as stated in preceding paragraphs, under practical situations, instead of pure even-aged teak stands, forest-officers do encounter with crops, which mostly are of Irregular and Uneven Aged type, with one or more girth-classes either completely missing or suppressed. Quite frequently, crops themselves have varied degree of composition with shade-tolerant species, malformed, crooked, deceased, dying and dead trees and coppices. Under such

circumstances, it becomes imperative that basic reading material should be readily available, which can be applied with uniformity and without subjectivity and personal bias in field situation.

36. To overcome these difficulties, the FDCM has come up with the revised Edition of Yield Tables providing the Balanced Structure Table which can reasonably be applied to the Uneven-Aged Forests in determining the population of trees in different girth classes in various site qualities, corresponding basal areas and volume. These Balanced Structure Table have been verified from the Yield Table applicable to the Even Aged Stands and are very much helpful in the field for the management of irregular, Uneven-Aged forests which are encountered under the practical situation. The revised Edition has been published in September, 2021.

II Local Volume Tables for Teak and its Associates

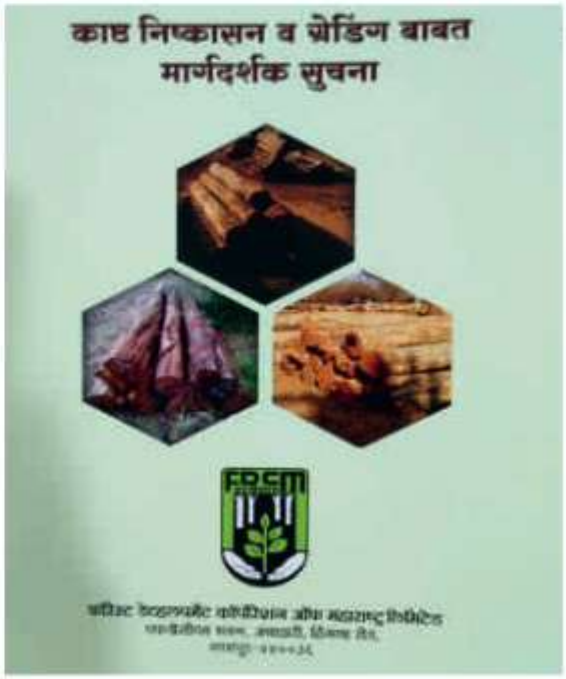
37. In various judgments following the order dated 12.12.1996 in the landmark Godavarman case, Hon'ble Supreme Court has mandated that felling must be commensurate with the regeneration. Accordingly, seeking permission for annual felling and regeneration involves furnishing precise figures about the extent of exploitation in the ensuing year.

38. Areas under the administrative control of the FDCM are primarily teak forests having ain, *(Terminalia tomentosa)*, haldu *(Adina curdifolia)* bija *(Pterocaorpus marsupium)* and dhawda *(Anogeissus latifolia)* etc. as its main associates. So far as teak is concerned, the anticipation of annual yield is based on the Local Volume Tables prepared by the FDCM in 2003. Local Volume Table straightway gives the site-quality wise volume of stem timber and small woods as per the girth classes. However, in absence of any authentic data in respect of associate species, the same Local Volume Table is used on the assumption that the growth pattern of the associates, would by and large, be similar to that of teak.

39. To achieve the reasonable accuracy in assessing the Yield from associated species of teak, the FDCM has recently taken up the task of preparing Local Volume Tables for the major associates of teak. The Local Volume Table are expected to be ready very soon.

III Grading Rules

40. Auctioning of timber is one of the major commercial activities undertaken by the FDCM. Howsoever, scientific and technical methods of timber harvesting are applied, the harvested timber cannot withstand the test of market forces unless it is presented and offered in the manner acceptable to the prospective buyers. The FDCM has devised its own Grading Rules, which are scrupulously followed while grading the timber for the purpose of auction. These Grading Rules have been duly published in vernacular (marathi) and have been made available to the Depot staff.



IV Growth and Yield Statistics of Common Indian Timber Species

41. With the re-arranging of the subject matter of 'forests' from State List to Concurrent List, a significant change was introduced through the 42nd Constitutional amendment of 1976, whereby the Union Government came to gain a greater say in forestry matters. Following the myriad directions of the Apex Court in the landmark Godavarman case, the Central Government mandated that approval to Working Plans should be obtained from the Core Committee of the MoEF. The National Working Plan Code 2014 (earlier 2004) sets the guiding principles for obtaining approval for Working Plans. All these developments have certainly helped in streaming forest management, but at the same time, made the job of forest-officers more daunting.

42. It is therefore imperative that the forest-officials are equipped with authentic and reliable data, with the help of which they would be able to predict various growth parameter, including yield with reasonable degree of accuracy. Search for published literature in this connection led to the serendipitous discovery of a precious gem in the form of a compilation of desired data for Common Indian Timber Species. Published by the Directorate of Forest Education, Forest Research Institute & Colleges Dehradun, this Compilation in two Volumes, dating back to the year 1967 and 1970 respectively.

43. Volume I covers Timber Species of Himalayan Region and Volume II gives details about species of the Plains. The Preface of the said Publication mentions that it is a compilation from numerous publications, including general volume and yield tables published by the Forest Research Institute & Colleges Dehradun during 40 years prior to 1967, several working plans, and volume or out-turn tables of species of local importance published by the State Forest Departments.

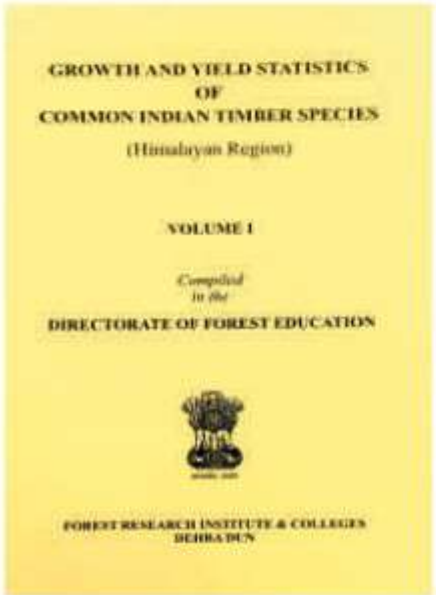
44. The FDCM in collaboration with the Maharashtra CAMPA took this opportunity and privilege to reprint the above mentioned publication in its original form. This is our humble tribute to the hard work, commitment and perseverance, dedication and professional competence of the foresters of the bygone years who have passed of such a valuable legacy to the posterity. These reprints have been circulated among the premier forestry institutions across the country.

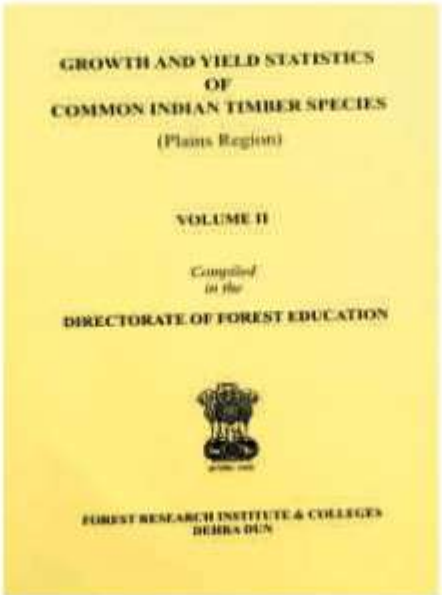
E-auction

45. The FDCM has been carrying out ground auctions of timber ever since its inception. Prior to this, the Forest Department has been traditionally conducting the ground auctions. However, in furtherance of the e-Governance policy of the State Government and to ensure more transparency in the system, the FDCM has introduced e-auction for the forest produce since 2017. This innovation has facilitated the customers and users to participate in auction without physical presence. Presently NIC is the Authorized Service Provider for the FDCM.

Sawn Timber Trade

46. The unique characteristics of teak and its high price in the market have led to the ingress of several imitation products in the market, whereby low-quality timber is passed off on as teak after chemical treatment and polishing. Even when the product is genuine, the string of middlemen operating between the producers and the end-consumers, result in escalation of price beyond the reach of the ordinary consumer. This prompted FDCM to venture into the production and marketing of sawn timber (lumber), to give the end-consumers access to high-quality timber at competitive prices.





Sawn Timber Production Unit Ballarshah Chandrapur

47. The State Government has been kind enough to handover the Saw Mill Units at Allapalli to the FDCM, where the production of quality Sawn Timber from the timber harvested from the forests. During the last, one and half years, FDCM has been able to market Sawn Timber not only to the common customers but has also succeeded in making available quality Teak to the prestigious projects at National level like the Central Vista, and Shri Ram Temple Trust at Ayodhya. Through the said value addition, the FDCM is hopeful for playing vital role in making available the genuine timber at competitive prices.

Shri Sudhir Mungantiwar, Hon'ble Minister (Forests) marking the occasion of dispatching first consignment sawn teak timber for the Ram Temple Project.

Profit Earning Since 1987

48. FDCM is one of the few State Forest Corporations which have been earning profits on perpetual basis. The FDCM has been earning profits continuously since the year 1987-88 and has been contributing accordingly to fulfill its commitments under the CSR activities as well as paying annual dividends to the State Government regularly.

Directors of Company submitting Dividend Cheque to Hon'ble CM and Dy. CM

The Corporate Social Responsibility (CSR)

49. As per section 135(1) of the Companies Act, 2013, every Company having net worth of Rs. 500 Crore or more, or turnover of Rs. 1000 crore or more or a net profit of Rs. 5.00 crores or more during the immediately preceding financial year shall constitute a Corporate Social Responsibility Committee of the Board. As per sub section (5) of the Section 135, the Board of every company referred to in sub section (1), shall ensure that the Company spends in very financial year, at least two percent of the average net profits of the Company made during the three immediately preceding financial year in pursuance of its Corporate Social Responsibility Policy. In furtherance of the aforesaid statutory provisions the FDCM has contributed following amounts towards the CSR activities.

Year	Amount (in Rs lakh)
2018-19	203.90
2019-20	254.62
2020-21	212.00
2021-22	198.50
2022-23	192.00

Contribution in enhancing the protected Areas Network in the State

50. Common perception among the masses is that the forests assigned to the FDCM are solely managed from the commercial point of view in total disregard to conservation and protection of wildlife habitats. However, ground realities testify that the regular working of forests on the basis of sound principles of silviculture practice not only optimize the growing stock and current annual increment but also automatically take care of improvement of wildlife habitat. As stated in preceding paragraphs, the silvicultural practices implemented by the FDCM for the management of the principal species, namely teak and its associates require the significant opening of canopy to allow sunshine to assist regeneration

and growth also facilitates development of grasslands, which attract the herbivore. The increase in herbivore population in turn, ensures the availability of necessary prey-base for the carnivores, thus restoring the food chain to its normalcy. As a clear manifestation of this phenomenon, as much as about one lakh hectares of forest areas under the management of FDCM for more than four decades have been declared as Sanctuary and National Parks over last decade by the State Government.

Turnkey Plantation

51. As a measure of diversification of its activities, the FDCM has been taking up Turnkey plantations on the areas provided by various Government and Semi Government agencies like Municipal Corporations, National Highways, Public Works Department, Western Coalfield Limited, NTPC etc.

Turn-key Plantations taken up by the FDCM

52. FDCM is also instrumental in developing and maintaining of garden at Rajbhavan premises at Nagpur.

Rajbhawan Garden at Nagpur being maintained by the FDCM

53. The Government of Maharashtra has declared the State Eco-tourism policy in the year 2007. In furtherance of the said Eco-tourism policy, the State Government has handed over certain Government Rest Houses and Tourism facilities in and around forests to the FDCM to be operated in tune with the guidelines issued by the Central Government and State Government from time to time. Accordingly, the FDCM has fulfilled its commitments and obligations.

Eco-tourism Complexes maintained by the FDCM

Eco-Tourism Complex, Bor, Wardha

Eco-Tourism Complex, Pitezari, Gondia

The Balasaheb Thackeray Gorewada International Zoological Park, Nagpur

54. One of the India's largest Zoos, the Balasaheb Thackeray Gorewada International Zoological Park at Nagpur is **a jewel in its crown**, being conceived, developed and managed by FDCM. In 2011, the State Government assigned the task of development, operation and management through the FDCM. The implementation to the policy decisions taken in the year 2011, could only be done during 2017-2019. The incorporation of the Joint Venture Company with the association of the Private Investor, namely the EsselWorld Leisure Private Ltd. happened in 2018. Following this, the execution of the first major component of the Zoo, namely the **Indian Safari** was expedited and completed during 2018-2019.

55. Following the exit of the private partner, the Zoo is now operated by the FDCM through its wholly owned subsidiary company. The Zoo has been inaugurated by the Hon'ble Chief Minister of Maharashtra on 26th January 2021. Spread over an area of about 564 ha, the Zoo is a marvelous testimony of the ex-situ wildlife conservation. It has already secured a permanent place among the major tourist centers in Vidarbha Region.

56. A unique attraction in the form of **Walking Trail** shall be starting very soon. Besides that, the execution of the next major component of the zoo, namely the **African Safari** is expected to commence shortly.

Gorewada Zoo and Safari, Nagpur

Employees Welfare Measures

57. No organization can thrive, unless the human resource at its disposal is properly taken care of. At present, the FDCM is having a working staff of about 1000 personnel in administrative, supervisory and executive capacities. The FDCM has taken following measures for its staff in the recent past-

I. Applicability of 7th pay Commission

The Government of Maharashtra has been kind

enough to implement the recommendation of 7th Pay Commission to the FDCM staff with effect from 1st July, 2021.

ii. Incentives

FDCM has introduced a novel scheme of rewarding its employees with incentives which are categorized in three classes, namely Organizational, Group and Individual. Under first category, all employees of the FDCM are rewarded with annual incentives which are linked to their pay scales. The latter two categories are performance linked incentives. Incentives in these categories are given based on the performance of the Group of employees and the individual employees. Annual budgetary allocation to the tune of Rs. 7.00 crores is earmarked for this purpose and employees are being benefitted with this unique scheme for last 3-4 years.

iii. Group Medical Insurance Policy

Like their counterpart in the State Government, the FDCM employees are also entitled for the medical reimbursement for themselves and their families. However, the reimbursement as per the Government Policy is restricted only to certain diseases of serious nature. Under practical circumstances many of the diseases are not covered under the Government Policy. Therefore, in order to tackle these issues, FDCM has introduced Group Medical Insurance Policy through the National Insurance Company. The sum assured is Rs. 3 lakhs per member, which includes the employees themselves, their spouses, children and parents. The annual premium is paid by the FDCM to the Insurance Company. This scheme has been introduced from 2021-22 and since then all employees and their families have been immensely benefitted with this scheme.

iv. Assistance through Banking Sector

Banking Sector has improved its facilities over the last few years and managed such facilities which were unexplored in the FDCM till date. To take care of the requirements of its employees, FDCM has entered into MoU with various Banks offering great number of facilities linked with the salary account of the concerned employees. Under such scheme the Banks are offering the life insurance cover up to Rs. 50 lakhs, besides many other benefits.

v. Ex-gratia Assistance

As stated in the preceding paras, the field functionaries of the FDCM are invested with powers under the Indian Forest Act, 1927 and Wild Life (Protection) Act, 1972. These field functionaries are also discharging their functions while handling man-animal conflict situations. Under such circumstances, these field functionaries are susceptible for eventualities and therefore, the FDCM has adopted the Government Resolution, whereby the employees are entitled for financial assistance of Rs. 25 lakh in case of death and up to Rs. 3.60 lakhs in case of permanent disabilities. Apart from this, the FDCM also offers ex-gratia assistance of Rs. 5.00 lakh to the next of kin of the deceased employees.

vi. Training for Enhancement of Professional Skills

In order to equip its officials and employees with necessary professional skills and in order to improve upon their professional competence, the FDCM has prepared training modules for them in respect of various subjects. Such trainings are being regularly conducted at State Training Academies. Experienced trainers in different area engaged for conducting such trainings.

vii. Sports

In order to take care of the physical health of its employees and to inculcate spirit of healthy competition among them, the FDCM has resumed the Sport activities both at the Regional Level as well as State Level.

Shri Sudhir Mungantiwar, Hon'ble Minister (Forests) gracing the FDCM Sports Meet 2023

viii. Equipping of Field Functionaries

The FDCM has been equipping its field functionaries by providing vehicles and person kits, to ensure that they discharge their protection related functions efficiently and fearlessly.

Hon'ble Minister (Forests) and Chairman FDCM handing over new vehicles and field kits

Activities of Telangana State Forest Development Corporation Limited (TSFDC)

Introduction:

The Telangana Forest Development Corporation Ltd. was established on 14.05.2015 under the Companies Act, 2013 and the entire bifurcation process has completed including transfer of Rs.75 Crores from the residual state in the year 2021.

Functions of TSFDC:

- Raising and maintenance of plantations of Eucalyptus, Bamboo, Teak, Cashewnut, Subabul & Casuarina Plantations.
- Production of Clonal Seedlings for planting and sale to farmers.
- Supply of Eucalyptus Pulpwood to wood based industries.
- Sale of Long Bamboo, Bamboo Industrial cuts and Cashew.
- Acting as consultant for Afforestation works.
- Acting as Facilitators to Government for Beedi Leaf Trade & DET scheme.
- Development of Eco-Tourism activities.

TSFDC Corporation Area:

The Management plan for the Corporation area is approved by the MoEF & CC for the years 2021-2025.

Sl No	Division	Area with TSFDC	Eucalyptus	Bamboo	Cashew	Teak	Other species	Total Plantations area
1	Paloncha	5946.61	4206	1230	46.00	66	4	5552
2	Kothagudem	7414.68	4043.59	2234.3	59.00	82.87	0	6419.76
3	Sathupally	5573.71	2148.66	2463.48	0	0	0	4612.14
4	Kaghaznagar	4713.79	4115.39	0	0	25.04	0	4140.43
5	Warangal	2965.59	2167.16	206.55	0	0	0	2373.71
6	Ranga Reddy	4195.74	3753.46	103.49	0	41.95	63.50	3962.4
7	Medak	2141.27	2025.41	0	0	0	0	2025.41
	Total	32951.39	22459.67	6237.82	105.00	215.8	67.50	29085.85

Vintage Trees Plantation:

Conversion of Matured Eucalyptus Plantations with in the proposed Regional Ring Road is taken up for planting of Sandal wood, Rose wood, Red sanders, Kusum, Mahogany, Teak since 2021 onwards. The inter planting within row is taken up at every one meter distance with Casuarina and Seethaphal. The row to Row distance is 3 mts apart to facilitate ploughing. The last two years progress is as follows.

Sl No	Species	2021		2022		2023	
		Area in Ha	Plants planted	Area in Ha	Plants planted	Area in Ha	Plants to be planted
1	Seethaphal	-	142883	-	197641	-	46015
2	Sandal wood	34.22	28551	103.94	77105	22.24	16660
3	Red Sandal	12.21	10982	35.43	29257	-	-
4	Teak	78.17	97090	60.24	58266	13.00	10829
5	RoseWood	22.90	19168	63.56	51649	22.00	18526
6	Panasa	6.57	2654	-	-	1.00	400
7	Bambusa Tulda	4.00	1066	11.75	470	-	-
8	Narepi	1.09	916	-	-	-	-
9	Regu	0.50	570	-	-	-	-
10	Amla	0.90	1147	-	-	-	-
11	Casuarina	-	321803	-	367005	-	92030
12	Kusum	-	-	3.74	3116	-	-
13	Mahaghani	-	-	-	-	3.00	2499
	Total	160.56	626832	278.66	788739	61.24	186959


Casuarina Plantation


Sandal Wood Plantation


Red Sandal


Seethaphal


Rose Wood

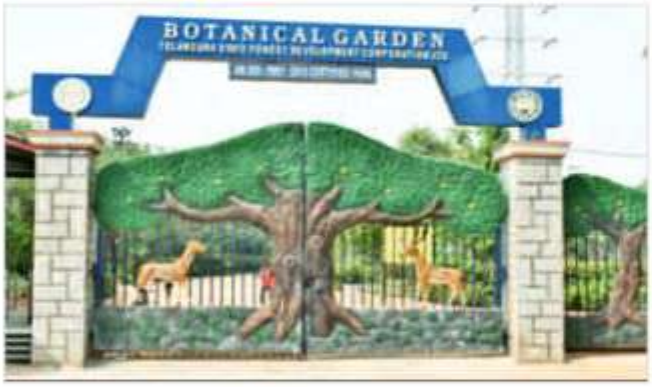

Teak Plantation

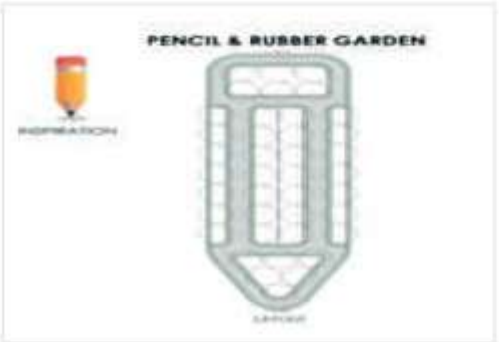
Botanical Garden Transformation:

Kothaguda Reserve Forest with an area of 274 Acres is being maintained by TSFDC and is used by the people of Hyderabad as a nature park and retreat, which is popularly known as Botanical Garden. It is a favorite spot for walkers, especially seniors who come to take their morning strolls. A large number of visitors come to the Botanical Garden and enjoy the beauty and tranquility it provides. Keeping the need of visitors, required amenities & activities have been taken up in the park. In the process of this transformation the following two pledges are taken up in the park.

A. Plant every time a new species in the visitors zone and not to repeat the existing plant species so as to improve the biodiversity

B. In order to introduce the plants to the visitors and school children it is proposed to have Vruksha Parichayam program by developing Theme parks, Ecosystems, Plant evolution and Animal Kingdom.





Environmental Education:

Environmental Education is imparted to school children through exercise books, Nature class room, Nature walk and demonstrations of various models on plants, Wildlife etc., including screening of short film shows in Environment Education Centre. All these interventions resulted in increase of (4) times foot fall of School Children from 18,804 in the year 2021-22 to 61,759 in the year 2022-23. Every year on 2nd October, the TSFDC is conducts the Run for Peace in association with Walkers Association of the Botanical Garden, wherein thousands of people participate in the event.

School Children @ Cactus Garden

Run for Peace 2022

Snake show

A large number of visitors come to the Botanical Garden and enjoy the beauty and tranquility it provides.

Virtual Safari:

There is a proposal to develop Virtual Safari & Virtual Eco-Theme Park in AR-VR Technology in an area of 106 Acres in Night Safari area which is adjacent to the Botanical Garden in Kothaguda RF, Kondapur. AR-VR and AVR technology is becoming increasingly popular and has tremendous potential to revolutionize the entertainment industry. The TSFDC utilizes this technology in order to showcase the unique culture of tribal people and enable them to gain a more intimate experience with nature, Environment, wildlife. Initial works like renovation of existing Building, Entrance Arch etc., are under progress. After completion of the above works, TSFDC will implement the project duly inviting the tenders.

Pala Pitta Cycling Park:

Exclusively dedicated for cycling Developed and maintained by TSFDC and this facility is operated by Hyderabad Bicycling Club with over 500 Bicycles. Spread over 20 hectares area in Kothaguda Reserve forest block and located in the most happening place in Hyderabad named after the Telangana State Bird the Palapitta the Indian Roller or Blue Jay. The park is typical of Deccan plateau with rocks and water bodies and scrub vegetation. There is abundant sighting of Peacocks in the park which is our National bird. Recently TSFDC has removed all Eucalyptus and Subabul plants and replaced them with native vegetation.

FOREST CERTIFICATION:

TSFDC is awarded with Forest Stewardship Council certificate recently. This is a very a prestigious certificate issued to organization managing Forest in way it preserves Biological diversity and benefits the lives of the local people and workers, while ensuring it's sustained economic viability. FSC-Certified Forest are managed to Environmental, Social, Economic standards. This has increased the market demand for the Wood produced from the Corporation area and fetching better price.

Eco-Tourism Corpus Fund:

- ✓ TSFDC has taken up financing the Eco-Tourism projects of the Forest Department with interest on the repayment basis by creating an Eco-Tourism corpus fund. The following are the details
- ✓ .Amrabad Tiger Reserve with Rs.108.00 Lakhs
- ✓ Kawal Tiger Reserve with Rs.67.50 Lakhs
- ✓ Eco-Tourism Center at Turkan Cheruvu, Dimmadurthi Range of Nirmal District with Rs.145.65 Lakhs
- ✓ Adelly Nandanavanam, Nirmal Range of Nirmal District with Rs.102.60 Lakhs

Doubling of Income:

During the year 2022-23 the revenue of TSFDC is almost doubled when compare to the previous years.

Sl. No	Particulars	Amount (Rs. in Lakhs)			
		2019-20	2020-21	2021-22	2022-23
1	Sale of Eucalyptus Pulpwood	5723	6562	5363	11761
2	Sale of Bamboo	1046	1049	894	1332
3	Others and Misc. income	279	221	281	354
4	Interest income	1357	1355	1340	1057
	Total	8405	9187	7878	14504

During the year 2022-23 the harvesting of Eucalyptus Pulpwood is 2.74 lakh metric tons. Further a record high price of Rs.6015/- per ton is fetched for the Eucalyptus Pulpwood during the year 2023. The previous price for the Eucalyptus Pulpwood was Rs. 4515/- per ton in the year 2022.

``The Bamboo harvest also touched a record high of 30 lakh long Bamboo during the year 2022-23 when compare to the average harvest of 23 lakh Long Bamboo in the past years.

`The revenue in 2022-23 is increased by 90% over the last year and in 2023-24 it will further increase by another 30% due to the price increase and demand for the FSC certified produce from corporation areas.

Timber & Bamboo Depot @ Sathupalli

Urban Forest Parks:

The following Urban Forest Parks are developed and managed by the TSFDC.

- ✓ VeduruVanam – Thumukunta
- ✓ Vana Drushyam – LalgadiMalakpet
- ✓ Chandana Vanam– Gowdelly
- ✓ Forestrek park – Chilkur
- ✓ Botanical Garden - Kothaguda

Veduru Vanam – Thumukunta

Vana Drushyam– LalgadiMalakpet

Chandana Vanam – Gowdelly

Forestrek park – Chilkur

Corporate Social Responsibility (csr):

CSR funding mobilized for the TSFDC initiatives from:

HDFC– 86.50 lakh.	SBI– 10.00 Lakh
Canara– 10.00 Lakh	Micron– 25.00 Lakh

Under TSFDC's CSR fund, TVS scooters are given to (60) physically challenged persons with a cost of Rs.65.40 Lakhs through Telangana Vikalangula Co-operative Corporation (TVCC), Government of Telangana.

During the Covid-19, TSFDC have supplied the fuel wood to the crematorium in municipal areas on humanity grounds.

RO Plant @ Botanical Garden by Micron

Scooters distributed under TSFDC-CSR fund

Teak Thinning:

Teak thinning operations started first time since planting in two decades.

Before Teak thinning

After Teak thinning

Study Tours:

Study tours are organized for all the staff in Corporation from Plantation watcher to Divisional Manager to study the best practices successful models of Plantations & Nurseries and also to visited the Paper Mills. This is the first time the TSFDC has taken up such Educational tour programme for the Carders.

Study Tour of Plantation Watchers

Beedi Leaf Net Revenue Transfer:

Process of net surplus revenue transfer to the Beedi leaf collectors, began online directly from Corporation account to beneficiary account. This has been pending since 2016 and now pending payments are being released to the tune of Rs.300 crores. From the year 2023 season even the beedi leaf collection remuneration is also transferred online to the beneficiaries.

Introduction Of New Hybrid Clones:

New hybrid Eucalyptus clones like EC x ED, EC x EU are introduced duly replacing the Clone No.7 in order to reduce the rotation age and better yield. To promote mechnisation in harvest in future 3x3 mt spacing is adopted

New hybrid clones EC x ED, EC x EU

Eco-tourism Projects Under Corporation:

TSFDC have already developed (3) Eco-Tourism projects under PPP model in nearby National Parks & Wild life areas and are operated by Concessionaries as detailed below.

1. JLTC, Shamirpet Eco-Tourism project (Aranya Resorts)
2. Mrugavani National Park, Chilkur, (Mrugavani Resorts)
3. Mahavir Nischalvan Eco-Tourism Centre, Vanasthalipuram, (Ananya Resorts)

Further Eco-tourism projects are under implementation at Back waters of Nagarjuna Sagar @ Gajubidem and another project is in pipeline at backwater of Sriramsagar in Nizambad District.

JTLC Shamirpet ETP (Aranya Resorts)

Mrugavani National Park ETP (Mrugavani Resorts)

Mahavir Nischalvan Eco-Tourism Center (Ananya Resorts)

Gajubidem ETP – Vizag Colony

Women Open Gym @ Botanical Garden

Sri Ram Sagar Nandipet Eco-Tourism Project

New Infrastructure:

TSFDC during the year 2022-23 has taken development of new infrastructure after gap of more than four decades. All the existing Office buildings of Divisional Managers at various places in the State are in dilapidated condition. New (17) No of Office & Residential buildings for Divisional Managers & Plantation Managers are under construction at (4) locations.

Head Office: Currently the Head Office of TSFDC is operating from the temporary structures and Bamboo house in Botanical garden in Kothaguda Reserve Forest. The permission accorded by the Government of India for construction of Forest & Eco-Tourism Development office (Head office building) in an area of 1.5 Acres in Kothaguda Forest subject to use of eco-friendly material in construction and making it a green building and is being constructed.

TSFDC Office: Bamboo House

Construction of Divisional office Building

Appreciating Forest Certification to TSFDC
by Hon'ble Minister Sri. Allola Indrakaran Reddy and Hon'ble Chairman Sri.Vanteru Prathap Reddy

Contact:
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Principal Chief Conservator of Forests & Vice Chairman & Managing Director, TSFDC.
E-Mail: vcmd.tsfdcl@mail.com | Off: 040-2339 2652.
Website: www.fdc.telangana.gov.in

Activities of West Bengal Forest Development Corporation Ltd.

Timber Harvesting and Disposal of Forest Produce:

The West Bengal Forest Development Corporation Limited has introduced West Bengal Forest Produce Management System for disposal of forest produce harvested from the forest areas spread across the state of West Bengal through E-Auctions. These E-Auctions are being conducted using the official website (www.wbfpms.com). Before participating in the auction, the bidders need to register themselves in the bidder registration platform. Registrations are of two types – single and corporate. A bidder can use Auto Bid option for bidding and set the price limit. The bidders can make the payment online and generate the invoice instantly.

Financial Year	Felling Area (Ha)	Total Sale Value (in Cr.)
2017-18	5510.45	208.00
2018-19	5710.58	205.44
2019-20	5683.22	172.80
2020-21	5462.90	157.57
2021-22	4995.82	178.38
2022-23	4982.13	258.11

Fig: Carriage of Timber from Coupe to Depot

Supply of Mining Timber:

As per agreement with coal mining companies like - ECL, BCCL, MCL, TATA Steel etc. every year cogging sleepers and poles are being supplied to mining companies at a pre-approved rate as per requirement placed by the mining companies.

Fig: Stacking of logs at Depot

Sale of Quantity (pcs)			
Felling Year	Sale of Cogging Sleeper	Sale of Pole	Total Sale Value (Cr.)
2019-20	4,29,087	54,990	8.60
2020-21	3,06,071	13,650	5.35
2021-22	2,65,661	9,571	4.52

However, with the advancement of technology in the mining sector requirement of mining timber is decreasing over the year.

Fig: Stacking of logs at Depot

Financial Year	Govt. Royalty	JFMC Share
2019-20	69.09	44.04
2020-21	64.83	33.32
2021-22	77.92	42.24
2022-23	79.60	52.41

Eco-Tourism Centres:

The West Bengal Forest Development Corporation Limited is one of the leading forest corporations in the country in Eco-tourism. The State is endowed with rich biodiversity and natural heritage. To provide scope for the tourists to appreciate the wilderness and wildlife amidst natural surroundings, several wilderness destinations, also known as eco-tourism centres, are being promoted.

WBFDCL manages 247 room inventories in 34 Eco-Tourism Centres dotting 12 natural landscapes –Buxa, Jaldapara, Gorumara, Neora Valley, Darjeeling, Mahananda, Kalimpong, Jaldhaka, Garpanchokot, Mukutmanipur, Jhargram and Beach. About 50,000 tourists visit these eco-tourism centres annually.

Present locations of Eco-Tourism Centres of WBFDCL:

Mukutmanipur, Susunia, Bolpur NIC, Jhargram, Hatibari, Lodhasuli, Tajpur, Garhpanchokot, Lava, Lolegaon, Mongpong, Gorubathan, Samsing, Suntalekhola River Camp, Suntalekhola, Jholung River Camp, Mouchuki Camp,Paren, Sailabas , Lepchajagat, Takdah, Chatakpur, Garchumuk, Malangi, Mendabari, Rasikbill, Murti (Banani), Lataguri, Neora Jungle Camp, Dhupjhora, Kalipur, Murti Tent, Hornbill, Rhino Camp.

Fig: Mongpong Nature Resort

Fig: Lava Nature Resort

Wilderness Camping Site:

The West Bengal Forest Development Corporation Limited promotes love for nature and environmental education. A close interaction with nature and stay in the Wilderness enable one to rediscover one's roots and link to the nature and wilderness. Forest Corporation developes Wilderness Camps with basic amenities, for people to stay in the nature camping sites.

Wilderness camps have been developed at—

North Bengal: Mongpong, Suntalekhola, Murti, and Lava.

South Bengal: Hatibari, Tajpur and Kolkata Banabitan). Tourists can visit the online booking platform **(www.wbfdc.net)** to book, modify and cancel wilderness camp bookings.

(Outside View)

(Inside View)

Fig: Wilderness Camp at Suntalekhola Nature Resort

Joinery & Carpentry Unit:

The West Bengal Forest Development Corporation Limited harvests around 14,000 cmt. Timber every year, the largest primary producer in the State.

The WBFDCL is running 4 Joinery and Carpentry Units at Siliguri, Raiganj, Saltlake and Durgapur. WBFDCL generally supplies furniture to all State Government Departments, Corporations, various Government Institutions and public, according to the budget and taste of the customer.

The furniture is made of Teak, Sal, Mahogany, Jarul, Akashmani etc. based on the buyer's choice.

Fig: Proposed Design of Ropeway Cabins

Fig: Brochure of Joinery and Carpentry Unit

Darjeeling Ropeway:

The Darjeeling Rangeet Ropeway is being modernized with the latest technology and décor. The land and existing buildings at upper and lower station are being renovated to include facilities like Food Courts, visitors' amenities and Multimedia Theatre. The Ropeway and Cabins are being redesigned – latest technology and new décor & furbishing of cabins will increase the capacity and the comfort. Online and Mobile Booking Facilities will be created for seamless booking and accessibility facilities.

Fig: Proposed Design of Darjeeling Rangeet Valley Ropeway Upper Station

Mouban Honey:

WBFDCL collects Sundarban honey from Joint Forest Management Committee members, processes and packages it for sale under brand "MOUBAN" since 1980s. FSSAI License No. 12822013000820 has also been issued to WBFDCL. It aids livelihood of the villagers and contributes to strengthening tiger conservation in Sundarbans.

The Mouban Honey is sold in attractive bottles of 250 ml and 500 ml through the Retail Sales Centres of the WBFDCL. It is also available at the reception centres of the Eco-tourism Resorts of the WBFDCL and the headquarters of various Forest Divisions in West Bengal.

Fig: Mouban Honey

Zoological Parks:

In collaboration with the West Bengal Zoo Authority, the Forest Corporation is developing food courts at different zoological parks across the state, especially at Alipore Zoo, Kolkata and North Bengal Safari Park, Siliguri.

Fig: Proposed Design of the Cafeteria at North Bengal Safari Park

Green Projects Wing:

Through Green Projects Wing, Corporation has created a professional branch to conceptualize, design and execute landscape gardens all over the state.

Some of the well-known projects are 'Bhorer Alo' at Gazaldoba, Eco-Park in New Town, Soujanya Complex in Murti and Jaldapara Tourism Projects.

Esteemed customers include Departments of Tourism, Irrigation, Youth & Sports, Law, PWD, WEBEL, Hooghly River Bridge Commissioner, WBIDCL, WBSIDCL, W.B. Pollution Control Board and also Coal India, Eastern Coal Fields, NHAI and Damodar Valley Corporation.

Banabitan:

Banabitan in Salt Lake, Kolkata is being developed as wilderness landscape, a jungle in the midst of city. Development features include Creeper Garden, Rose Garden, Unique Tree Park, Jaldapara Park and Boating. A Lotus Pond is also being created over 4 acres.

Fig: Creeper Garden and Signage at Banabitan Park, Salt Lake.

Major Achievements Accomplished During Last Ten Years

Transformation from Physical Auction to e-Auction:

E-Auctioning of timber produces was introduced by The West Bengal Forest Development Corporation Limited in 2017 to simplify the manual auction process. W.B.F.D.C.L has more than 700 registered timber merchants to date from all over India on its e-Auction Portal (www.wbfpms.com). Since its start, W.B.F.D.C.L has completed more than 6000 Actions to date, and

more than1.80 lakh lots were sold through the e-auction portal (www.wbfpms.com) generating a sale value of more than 1000 Crore.

Fig: Steps involved in e-Auction process

Online reservation of Eco-Tourism Centres:

The West Bengal Forest Development Corporation Limited website (www.wbfdc.net) allows citizens to book their stay in these eco-resorts since 2014. Citizens can visit the Nature Resorts Online Booking Platform to book, modify and cancel eco-resort bookings.

The online book facility has made the process easy and user-friendly. Moreover, features such as free cancellations, hassle free check-in facilities, personal tour managers, and corporate event management facilities have managed to attract more tourists to these pristine destinations.

Financial Year	Revenue (Cr.)
2017-18	3.82
2018-19	4.64
2019-20	5.03
2020-21	3.06
2021-22	3.44
2022-23	5.06

Fig: Dashboard of Booking Website (www.wbfdc.net)

Online Reservation of Safari Booking:

The West Bengal Forest Development Corporation Limited website (www.wbfdc.net) allows tourists to book seats of Elephant and Jeep Safari at Jaldapara and Gorumara National Park. The online book facility has made the process easy and user-friendly.

Revamping of Banking & Account System:

Financial discipline is the foundation for any Corporation. An efficient competent accounting system is required for proper commercial decisions. The previous banking account system of the Corporation has been revamped - multiple Current Accounts in several banks – Divisional Managers and Range Managers (more than 90) have been closed and a single bank has been selected with 'mother-child system' with all accounts linked to the Head Office Current Account. The zero balance account of the divisions has reduced unnecessary blocking of fund in Current Account and help in better management of resources.

A new Account Code has been introduced based on current operational realities of Corporation and has been integrated with new Account Software. The whole 'account system' has been migrated to live mode in the FY year 2022-23 - one of the first kind in the state.

In the next stage, both banking and accounting systems will be integrated creating Financial Management System (FMS) - at par with international practices.

SKOCH Award:

The West Bengal Forest Development Corporation Limited along with State Forest Department has managed to bag the SKOCH Award in the PLATINUM category for its revolutionary project – "Joint Forest Management – A people's movement" in 2022. Joint Forest Management in West Bengal is the first project in India that allowed the direct involvement of forest fringe populations in the management as well as protection of forest. Uniqueness of this project are:

- People's active participation the at Grass-root level in forest management
- Sale of forest produce through a transparent MIS platform of e-auction.
- Use of technology in the management process, such as GIS based coupe marking, mechanized harvesting etc.
- DBT of usufruct benefits directly to the bank accounts through ECS.

Fig: Prestigious SKOCH Award, 2022

Value Additions Done To The Existing Activities

- **Manufacturing of Wooden Handicrafts:**

Kolkata Forest Corporation Division has taken the initiation to manufacture wooden handicrafts from the wastage of Joinery and Carpentry unit under Marketing Range. It is usually also available at the reception centres of the Eco-tourism Resorts of the WBFDCL and the headquarters of various Forest Divisions in West Bengal.

Fig: Handicrafts of WBFDCL

- **Eucalyptus Oil:**

WBFDCL has taken the initiation to sell eucalyptus oil. The eucalyptus oil is sold in attractive 50 ml bottles through the headquarters of WBFDCL.

Fig. Eucalyptus Oil of WBFDCL

- **GI Registration of Sundarban Honey:**

Process of GI for Sundarban Honey is under process in collaboration with Patent Information Centre under Department of Science & Technology and Biotechnology.

- **Zoological Gardens:**

Renovation of Heritage Cafe, development of Kiosks and Food Court at Alipore Zoo and renovation of Food Court at North Bengal Safari Park are under construction and will be opened for public soon. These will attract more tourists and open new sources of revenue for WBFDCL too.

- **Nature-Education at Banabitan Park:**

Recently WBFDCL has started a new initiative regarding organization of nature study tour and group activities. School children, college students, teachers, parents and individuals of all ages can avail this opportunity for nature-education, picnic, day visit, mini excursion and nature trail in this beautiful park. Group booking ad guide facilities are also available.

- **G20- Summit Meeting:**

WBFDCL recently undertook the emergency plantation along four stretches from Airport to Milan Mela Prangan all along the EM-Bypass in Kolkata during the G20 Summit Meeting which was attended by Dignitaries from 33 Countries. Beautification of roadsides by a variety of Flower Species and Royal Palms was done which was widely appreciated.

PRESS NOTE OF WORKSHOP

With our stepping into the **25th Silver Jubilee Year** it's our privilege to announce the first & new initiative organised by the industry professionals & enthusiastic members of Bengal **Timber Importers Association (BTIA)** in collaboration with **The Federation OF All-India Timber Merchants Saw Millers And Allied Industries** a successful Workshop on "**Timber Preservation and Seasoning**".

The event took place on **7th October 2023** at the factory site of **Silvertoss Industries Private Limited near Baidyabati in Kolkata** which attracted all interested & diverse group of participants eager to gain insights into the latest techniques and technologies in timber preservation and seasoning.

We were honoured to have expert scientists from **Forest Research Institute (FRI) - Dehradun Dr. Shailendra Kumar, Scientist-D, Forest Products Division & Ms. Riya Tudu Solanki, Scientist – D from ICFRE – IWST, Field Station, Kolkata.**

The One Day Seminar & Workshop was focussed on technical subject of Preservation & Seasoning of Timber which aimed to enhance knowledge and awareness about sustainable practices in timber processing and utilization.

Key Workshop Highlights:

- **Expert-Led Sessions:** Industry experts with profound knowledge & experience shared their expertise, covering topics such as timber treatment methods, seasoning processes leading to sustainable practices.
- **Interactive Discussions:** Engaging presentations, panel discussions and Q&A sessions allowed attendees to interact with the experts and delve deeper into relevant topics.
- **Networking:** The workshop facilitated networking opportunities, enabling participants to connect with other industry peers and establish valuable professional relationships in the timber fraternity.

Value Added Composite Products from Waste Resources

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Packing plays a valuable, often resource conserving role in the modern distribution of food, beverages and other goods. In today's world, the choice of packed food and beverages are increasing enormously. In this article the packaging of the tetra pack materials have been explored for transforming into composites. The beverages tetra packs are generally dumped after consuming the liquid. As the tetra packs contain liquid content almost in less quantities after the disposal this is enough for the mosquitos to breed and causes large health problems. There is a need to learn how the package once used can be recycled to create products that minimize environmental degradation and make economic sense both in terms of production and purchase

Keeping this in view, this institute had taken up a work to explore the utilization of this waste tetra packs for value addition. This project involved producing the useful products from the tetra pack waste which can be a substitute for the boards for application in furniture and construction. The process parameters for making composites using tetra packs particles by incorporating resins and without resins have been optimized. The strength properties of all the panels made using tetra pack waste confirms to the required physical and mechanical properties of Indian Standards IS 3087-(2005) "Particle boards of wood and other ligno cellulosic materials (medium density) for general purposes -Specification". The comparison for both type of boards has been made as the sizing of the material of tetra packs cannot be defined through sieve. Utilization of the tetra packs waste for value added composite products finds wide application in furniture and construction industry.

INTRODUCTION:

One of the most significant components, that threatens the future of the world are solid wastes. Unfortunately growing population and technological developments has resulted in an increase in solid wastes. In addition, the changes in consumption habits affect the composition of the waste.

Tetra Pack Aseptic is a commercial packaging material that is used to keep foods without spoiling and it consists of layers of carton, polyethylene (PE) and aluminium (Al). Carton layers provide stiffness, polyethylene layers provide durability and aluminium layers provide strength to the food against the effects of light and oxygen. Tetra Pack was founded by Ruben Rausing and Erik Wallenberg in 1951 in the Swedish city of Lund. As of January 2013, the company Tetra Pack has supplied approximately 173, 234 million packages so that 77,307 million litres of milk, juice, nectar and other products could be delivered to consumers around the world.

It is currently estimated that 2/3 of the food produced in the World is to be packed with Tetra Pack packages. Tetra Pack Aseptic, is the most commonly used subset of packaging materials and the first production was in 1969. Approximately 184 billion units Tetra Pack packaging materials were produced in 2015, and it is estimated that 24.5% was recovered. By the year 2020, it is aimed that the recycling of Tetra Pack packages will be reached to 40%. The recycling of waste Tetra Pack packages or similar types of other packaging materials provide to minimize the environmental impact of these waste materials. It is important in terms of the use of alternative raw materials.

Due to the significant and harmful effect of the global warming on our communities, health, and climate, the usage of sustainable, bio-based and green materials became an imperative. On the other hand, the utilization of waste and biomass resources for developing new bio based composite materials is attracting much attention for the environmental and socio economics.

Recycling saves energy, reduces raw material extraction and combats climate change. The vast majority of studies have found that recycling is better for the environment rather than incinerating or land filling it.

Tetra Pack packages are primarily paper-based and fully recyclable. A number of Life Cycle Analysis (LCA) studies have assessed the greenhouse gas emissions from different packaging formats (including glass

bottles, PET and HDPE containers, Tetra Pack cartons, metal cans and stand-up pouches) and the Tetra Pack carton is generally attributed with the lowest environmental impact. The Tetra Pack package is primarily made of paperboard (75%), which has a low carbon footprint, as its main raw material – wood fibre, if well managed, is renewable.

Raw Material and Chipping:

Waste tetra packs collected from hostel and local juice Shops have been used for the study. The Tetra packs are cut into roughly 10mm pieces . The particles are dried in oven to optimize the moisture content to 2-4%. The oven dried materials are taken for mat forming directly for controlled panel while for the other boards the materials were blended with various resins. The percentages of resin are varied. Conventional Phenol formaldehyde and Urea formaldehyde resins were used in minimal percentages. The tetra pack composites can be made with and without resin. Minimal percentage of resin were incorporated to study the variation in the physical and mechanical properties of the panels. The tetra pack particles were placed into a mat forming box as indicated in Figure 1 with base dimensions of 330mm × 330mm. Aluminum/ SS plates spread with BOPP film were placed on either sides of the mat furnish. Prepressing and compression of the fibers were done by pressing a matching wooden plate on the fiber mat in the forming box by applying pressure manually as shown in Figure 1. BOPP film which can withstand 160° C is used on top and below the tetra pack particles mat. The entire assembly was hot pressed with requisite temperature and pressure.

Figure 1. Tetra pack material in mat forming box

Figure 2. Pre pressed mat of tetra pack material

Initially the pressure is given higher so as to create a high surface density of the board. The core density was then formed by reducing the applied pressure to 12 -16 kg/ cm^3 and later the hot press temperature was cooled to below 100° C before downloading the board. The final product of tetra pack composite is as given in **Figure 3.**

Figure 3. Tetra pack composite

The strength properties of all the panels made using tetra pack waste confirms to the requirement of IS 3087-(2005)- Specification for Particle Boards of wood and other ligno cellulosics materials (Medium Density) for general purpose" for flat pressed single layered board /Grade 1 and Grade 2 Medium Density Particle board. The panels bonded with resin yields superior properties when compared to the control panel (without resin). However, for tetra pack composites the density requirement is higher than that specified in IS 3087-2005 to achieve the desired strength properties **(Table 3).** This is due to the inherent characteristics of the tetra pack waste materials.

The Tetra Pack package is primarily made of paperboard (75%), which has a low carbon footprint, as its main raw material – wood fibre, if well managed, is renewable.

Table 1. Physical and Mechanical Properties of Composites from Tetra Pack Wastes

Sl. No	Property	Prescribed value in IS 3087-2005 Single layer flat pressed	Tetra pack waste	Tetra pack Waste + 3% PF Resin	Tetra pack Waste + 5 % PF Resin	Tetra pack Waste + 3% MUF Resin	Tetra pack Waste + 3% UF Resin
1	Density kg/m^3	500-900	988	1032	996	889	974
2	Water absorption 2 hours 24 hours	 25 (40*) 50(80*)	 21.47 25.55	 24.42 25.85	 22.36 24.15	 26.14 27.86	 23.43 26.23
3	Swelling I) Length ii) Width iii) Thickness	 0-5% 0-5% 10%	 0.26 0.24 2.03	 0.18 0.14 4.3	 0.14 0.08 4.1	 0.19 0.1 3.94	 0.38 0.3 4.1
4	Modulus of rupture N/mm^2	11	3.67	16.11	15.11	11.83	13.33
5	Modulus of elasticity N/mm^2	2000	1124	1441	1391	1230	1359
6	Internal bond strength N/mm^2	0.8(SL) 0.3* 0.45**	0.34	0.608	0.84	0.43	0.5
7	Screw withdrawal test , Edge N/mm^2	850(700*)	1140	1280	1560	1890	1321

* Denotes value for Grade 2 multilayered panels requirement as per specification

** Denotes value for Grade 1 multilayered panels requirement as per specification

PF – Phenol Formaldehyde
MUF – Melamine Urea Formaldehyde
UF –Urea formaldehyde
SL – Single layered

CONCLUSIONS

From the research findings, the conclusion drawn is that tetra pack waste material can be effectively utilized for converting into value added products viz., Tetra pack waste composite.

Utilization of the tetra packs waste for value added composite products finds wide application in furniture and construction industry. The waterproof characteristics of this composites make this board suitable for applications in humid conditions. This composites can serve as an alternative for wood particle boards in various end use applications based on the formulation adopted for composite making. Considering the adhesive cost being employed for wood particle board (10%) and comparing with the resin employed in this study i.e., 3% -6%, it has been found that the composites made using tetra pack waste are cheaper by 40 -70% than the existing particle boards in the market w.r.t adhesive cost excluding the savings in energy and other processing costs.

References : Contact author at sujathad@icfre.org

Bamboo Mat Based Roofing System

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Introduction:

Utilization potential of bamboo and its composites in housing and construction has seen a major research focus in recent years in various international and national research organizations. In India also studies were carried out at erstwhile IPIRTI (Indian Plywood Industries Research and Training Institute (IPIRTI)) to develop roofing system from green/ecofriendly material Bamboo. As corrugated sheets are more ideal for roofing application, attempts were made to develop Bamboo Mat Corrugated Sheet (BMCS). Extensive studies were carried out on the profile of corrugated sheets and ultimately sinusoidal wave pattern profile having definite pitch to depth ratio was standardized. To cover the roof top and corners a compatible green/eco-friendly material was required, accordingly Bamboo mat ridge cap (BMRC) was designed and developed. Extensive trials were carried out for the manufacture of BMCS and BMRC using herringbone pattern woven bamboo mats and phenol formaldehyde resin. Sheets were subjected to rigorous test for evaluating bond integrity, performance tests like load bearing capacity, water permeability test, resistance to boiling water, fire resistance and weatherability. BMCS and BMRC were found to possess excellent load bearing capacity and meets the requirements as per IS 15476: 2004 (Indian Standard Bamboo Mat Corrugated Sheets — Specification) .The study on the energy audits for the manufacture of one ton of BMCS revealed that the combined total energy consumption was 22784 MJ, while for Aluminium, Galvanized iron and fibre reinforced plastic corrugated sheets energy consumption is 32,541.7MJ 89,408 MJ and 77,190MJ respectively .The Net Carbon dioxide released during the production of BMCS & BMRC per ton is found to be 1.308 tons and that of steel being 3.8 tons and for Aluminium and plastic is 1.5 tons and 3.0 tons respectively. The carbon dioxide released during the production of BMCS & BMRCS is found to be less compared to the other existing roofing materials.

BMCS roofing sheet has enhanced characteristics like toughness, resilience and ductility. Apart from this BMCS is environment friendly, energy efficient and possesses good fire resistance.

Bamboo Mat Corrugated Sheet (BMCS) is a roofing sheet made out of bamboo mat and will be green alternative to Asbestos Cement Corrugated Sheets (ACCS), Galvanized Iron Corrugated Sheets (GICS), and Fibre reinforced plastic (FRP) roofing sheets.

Manufacture of BMCS and BMRC

The hand woven mats were coated with PF resin incorporated with suitable preservative chemical using a resin applicator. Resin coated mats were stabilized by stacking for about 2 hours. Stabilized mats were dried to about 8% moisture content. These bamboo mats were assembled in 4 layers and hot pressed in specially designed press with corrugated platens having definite pitch to depth ratio (Figure 1). Process flow followed for the manufacturing of BMCS and BMRC (Figure 2). Process parameters have been worked out with regards to resin/adhesive formulation and resin application, stabilization of resin coated/treated mats, drying schedules of resin coated/treated mats. Hot press temperature and specific pressure to be employed, and time of hot pressing have been worked out. BMCS and BMRC manufactured at IPIRTI and Industrial units were subjected for evaluation as per the requirements of IS:15476-2004.Resistance to decay and insects were tested as per IS: 13958-1994.Thermal Conductivity test were carried out as per IS 3346-1980.

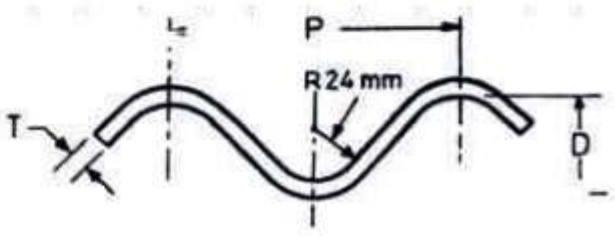

Fig.1 : Pitch and Depth of BMCS

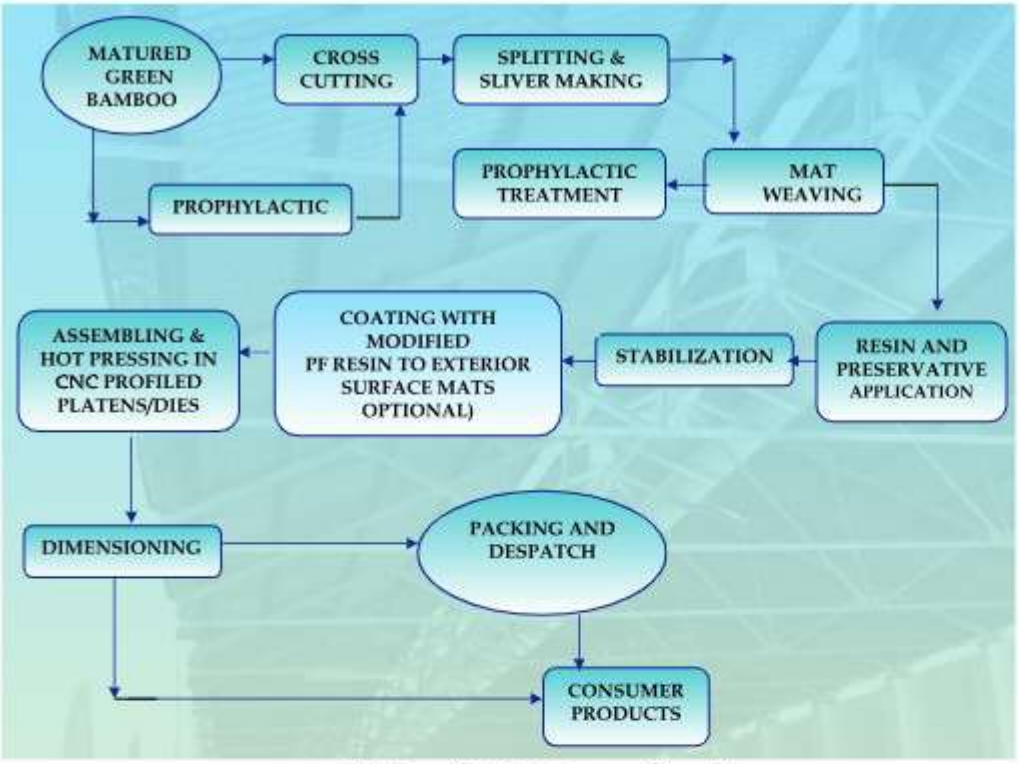

Fig. 2 : BMCS and BMRC - Process Flow Chart

Testing of BMCS and BMRC

A. Bond Quality: 30cm x 15cm pieces of BMCS were subjected to knife/peel tests in both dry and wet after subjecting to cyclic boil-dry tests 3 cycles comprising of 3 hours immersed in boiling water and dried to 12% moisture content.

B. Resistance to Decay and Insects: BMCS and BMRC samples were subjected to graveyard test (buried in active termite mounds) and borer resistant tests (exposing the test specimens with infected borer samples).

C. Water Permeability test: Standard size BMCS were mounted on a platform over which suitable metal frame to suit the corrugated profile were placed on BMCS and junction sealed with a putty, filled it with water to a height of 75mm above the crown level and observed for water leakage/seepage. Each cycle comprising of water filling up for 24 hours followed by removal of water and air-drying for 48 hours under sun.

D. Load Bearing Capacity test: Load bearing capacity of BMCS and BMRC was studied in comparison with some of the existing roofing materials like ACCS, CGI Sheets and Aluminum Corrugated Sheets. The comparative result is as shown in Table -1

E. Thermal Conductivity: Thermal conductivity of BMCS was determined by measuring the thermal conductivity of flat BMB made by employing the process parameters for making BMCS.

F.Thermal comforts: Inside temperature of the room covered with Asbestos roofing sheets were compared with that of BMCS covered roof.

G.Accelerated ageing tests: In order to assess the durability and correlate with conventional exposure tests; 10cm x 15cm specimens were immersed in boiling water for 3 hours followed by immersion in cold water to cool to ambient temperature and finally drying at 60-65°C for a period of 20 hours. This constitutes one cycle. Repeated these cycles for 3 times and finally examined for visual delamination of sheets, forceful separation of mats or slivers using knife. Sheets were exposed to high relative (902%) humidity coupled with high temperature of 40°C and high temperature 50°C and very low relative humidity of 15-20% in the presence of U.V Light.

BMCS and BMRC manufactured using Phenol formaldehyde resin was tested and evaluated as per the IS: 15476-2004. Test results indicate that load bearing capacity of BMCS is comparable with those of ACCS & CGI Sheets. It has been found that BMCS was much superior to Aluminum Corrugated Sheets (Table 1). Moreover, BMCS were found to be highly resilient compared to GI Sheets & Aluminum Sheets. Whereas ACCS were found to be highly brittle requiring special care during transportation as well as use as roofing sheets.

Thermal Conductivity of Bamboo Mat Board (BMB) and ACCS were compared with a view to correlate with BMCS and ACCS. Thermal Conductivity was found to be 0.2241 W/mk and of ACCS 0.3977 W/mk (Table 2). This was considerably lower compared to ACCS and GI sheets. Thus BMCS roofed houses will provide better thermal comforts compared to houses having ACCS or GI sheet roofs. It was noticed that there was 5°C less temperature in BMCS covered room, indicating that BMCS was more comfortable for the occupants of the room compared to that of Asbestos covered room.

The result of properties of BMCS shows that the manufactured sheets meets the requirements as per IS 15476:2004 (Table 3).The values of load bearing capacity in both dry & wet was found to be much higher than the requirement. Impermeability tests did not show any sign of water droplets. Water absorption test after 24 hr. of dipping the samples in water indicated a decrease in absorption of water. Flame penetration and rate of burning test were observed to be much higher than the requirement as all the layers were coated with the resin. Bond quality test shows that the sheets were found to be intact without any sign of delamination or weakness even after cyclic boil-dry tests indicating good bonding. The sheets were found to be resistant to termites and to borer infestation as the sheets subjected to high humidity were found to be resistant to mold/fungus. There was no leakage/seepage of water even after three cycles of water permeability tests.

Table-1: Properties of corrugated sheets

	Thickness mm	Width mm	Max. Load N	Load bearing capacity N/mm	Weight of sheet (1.8 m x 0.9 m) Kg
BMCS (4 – LAYERS)	3.7	400	1907	4.77	6.18
G. I. SHEET	0.6	400	1937	4.84	6.6
ALUMINIUM SHEET	0.6	405	669	1.67	2.48
ACCS	6	330	1800	5.45	13.6

Table-2: Thermal properties of BMCS compared with other materials

Material	Thermal conductivity W/mk
BMCS	0.2241
ACCS	0.3977

Table-3: Properties of Bamboo Mat Corrugated Sheets as per IS 15476:2004

Sl. No.	Properties	Result Obtained	Requirement as per IS 15476:2004
1	Density g/cm^3	0.75 – 0.8	0.75
2	Load bearing capacity (dry), N/mm Wet, N/mm	5.7 4.94	4 3
3	Impermeability	The lower surface shall not show any formation of drops of water except for traces of moisture	The lower surface shall not show any formation of drops of water except for traces of moisture
4	Water Absorption, (after 24 hrs)%	11.9 - 13.5	max: 15
5	Cyclic test	No delamination even after 3 cycles	No delamination
6	Resistance to falling weight Resistance to fire a) Flame penetration, minutes b) Rate of burning, minutes	Test piece does not break or show any crack or tear 18.4 40.3	Test piece shall not break or show any crack or tear Min: 10 Min: 20
c)	Surface spread of flame, mm^2	3168	Max: 4500

BMCS manufactured at the pilot plant facilities were tested in-house as well as and in an independent laboratory to confirm the load bearing capacity and bond integrity (Table 4 & 5). It can be seen from results that the values obtained in the independent laboratory agrees with the in-house testing indicating that the BMCS manufactured at pilot plant were excellent with respect to load bearing capacity & internal bond strength and hence can be used as a constructional material. The test results of the BMCS manufactured during trial production using multi daylight hydraulic hot press installed in one of the unit at Meghalaya are comparable with that of BMCS made in the pilot plant (Table 6). This indicates that the process parameters

followed for the manufacture of BMCS are technically feasible.

Table-4: Loading Bearing Capacity Average width 430 mm, Thickness of the sheet 3.5 mm Span 1000 mm

Sample No.	Load bearing Cap N/mm of width	
	Independent Lab.	In-House
A_1	5.2	4.04
B_1	5.31	4.22
C_1	5.26	4.06
D_1	5.43	4.55

Table-5: Internal Bond Strength
Thickness of the Sheet 3.5 mm

Sample No.	No. Internal Bond Strength N/mm^2	
	Independent lab.	In-House
A_1	2.35	1.86
B_1	1.88	1.63
C_1	2.12	1.78
D_1	1.92	1.70

Table-6: Test Results of BMCS made during Production Trials

Sl. No.	Load bearing cap. N/mm^2	Internal Bond Strength N/mm^2
1.	4.56	0.98
2.	5.07	1.07
3.	4.41	1.08
4.	4.75	0.90
5.	4.73	0.95
6.	4.66	1.02

Conclusion

Studies carried out under the project clearly indicate that bamboo mats can be efficiently and effectively used for the manufacture of BMCS and BMRC. The platen profile was decided keeping in view the pattern of existing corrugated roofing material and the characteristics of the bamboo mats. The physical & mechanical properties of BMCS made in the pilot plant as well during production trials were found to be excellent especially with regard to load bearing capacity, water permeability and internal bond strength. Properties of BMCS meets requirement as per IS 15476:2004 (Indian Standard Bamboo Mat Corrugated Sheets — Specification). Production of BMCS and BMRC is technically feasible but the economic feasibility depends on the availability of bamboo mats and its cost per unit area. In order to get very smooth surface finish of the product one should go for CNC profiled dies for BMCS and larger length of BMCS to avoid wastages due to overlapping when the span is very large. BMRC can accommodate wide range of roofing angles. BMCS and BMRC will be an ideal ecofriendly material for roofing.

Figure 3: Bamboo mat Corrugated Sheets (BMCS)

Figure 4: Bamboo Mat Ridge Cap (BMRC)

Figure 5: Indian Railways, Haridwar PP Shelters

Figure 6: Indian Railways, Rewari Heritage

Machinery cost:

Production of 252 BMCS & 84 BMRC in 8 hr shift (7 hr Working) =Rs 8-9 Crores.

References : contact author at udayn@icfre.org

Natural Wood Preservative Formulation from Coconut Shell Pyrolytic Oil

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Recently the Institute of Wood Science and Technology has been granted with a patent (Patent Number: 440779; Period of Grant: 20 years from the 13th day of February 2018). This brings to us a background of why this patent is important and how this can change the wood preservative industry. As we all know wood is one of the basic materials that have been naturally and abundantly available to mankind and in use since time immemorial for many purposes, primarily for fuel, shelter, fishing and agricultural tools, weapons, furniture, packaging, artworks, and paper. However, this natural material is prone to attack by various wood-degrading organisms such as bacteria, fungi and insects and thus needs to be protected by using various preservatives. The practice of wood treatment dates back to the use of wood itself. During the Industrial Revolution, wood preservation became an integral part of the wood processing industry. Treated wood was used primarily for industrial, agricultural, and utility applications and its use grew considerably thereafter. Over the last century, wood protection research has focused on chemicals with lower human toxicity and lower environmental impacts. Innovation in treated timber products continues to this day, with consumers becoming more interested in less toxic materials (Richardson, 1978; Eaton and Male, 1993; Barner and Murphy, 1995). As a result, new eco-friendly wood preservative products are venturing into the market.

Our newly patented wood preservative formulation based on coconut shell pyrolytic oil is one such product. Coconut shell pyrolytic oil is produced by the pyrolysis of coconut shell i.e., burning the coconut shells under no or limited supply of air. Any industry that can use and develop this technology into a product can buy the raw material, coconut shell oil from the charcoal industry, as it is a byproduct during the preparation of charcoal using coconut shells. The coconut shell liquid obtained will be dark in colour, which is a disadvantage in the preparation of wood preservatives. Not to worry institute has developed a technology to improve the nature and efficiency of coconut shell oil so that it can be used for any indoor applications.

For the final product, a development that was submitted for patent, crude coconut shell oil was subjected to different separation techniques under different temperature gradients and impregnated with different inorganic components to obtain a completely miscible, colourless wood preservative formulation that is patented and ready to be transferred to interested industries under technology transfer initiatives.

The prepared wood preservative formulation was tested against termites, decay fungi and woodborers as per set Bureau of Indian Standards, against termites (IS 4833), decay fungi (IS 4873 Part-I) and wood borers (IS 4873 Part-II) using brush coating, dipping and pressure impregnation treatment methods. To provide assured results throughout India, exterior field testing was conducted at different locations.

Sl No.	Name of the site	State	GPS location
1	Hyderabad	Telangana	17° 22' 31" N / 78° 28' 27" E
2	Jodhpur	Rajasthan	26° 18' N/ 73° 04' E
3	Nagercoil	Tamil Nadu	8° 17' 30" N / 77° 39' 62" E
4	Nallal	Karnataka	13° 4' 0" N / 77° 47' 53" E
5	Prayagraj	Uttar Pradesh	17' 30" N / 77° 39' 62" E
6	Visakhapatnam	Andhra Pradesh	17° 42' 0" N / 83° 18' 0" E

Results indicated that the prepared wood preservative solution was very effective against fungi, termite and woodborers against interior as well as exterior conditions. The data and results obtained were submitted to patent granting authority of India in the year 2018. After careful evaluation of the data the Patent Office, Government of India granted the patent to the institute on 27/07/2023. The above said patent is available for the technology transfer and interested parties can contact the Institute.

पेटेंट कार्यालय भारत सरकार
पेटेंट प्रमाण पत्र |
The Patent Office, Government Of India
Patent Certificate

पेटेंट सं. / Patent No. 440776

आवेदन सं. / Application No. 201941005329

फाइल करने की तारीख / Date of Filing 13/02/2019

पेटेंटी / Patentee INSTITUTE OF WOOD SCIENCE AND TECHNOLOGY

आवेदन किया गया है कि पेटेंटी ने, उपरोक्त आवेदन में अभ्यर्पणीय NATURAL WOOD PRESERVATIVE FORMULATION FROM COCONUT SHELL PYROCYTIC OIL नामक आविष्कार के लिए, पेटेंट अधिनियम, 1970 के उपबंधों के अनुसार दाता तारीख फरवरी 2018 से तेरह वर्ष की अवधि के लिए पेटेंट अनुदत्त किया गया है।

It is hereby certified that a patent has been granted to the patentee for an invention entitled NATURAL WOOD PRESERVATIVE FORMULATION FROM COCONUT SHELL PYROCYTIC OIL as disclosed in the above mentioned application for the term of 20 years from the 13th day of February 2018 in accordance with the provisions of the Patents Act,1970

दाता की तारीख
Date of Grant 27/02/2023

Controller of Patents

Honeycomb Panels Using Bamboo Slivers

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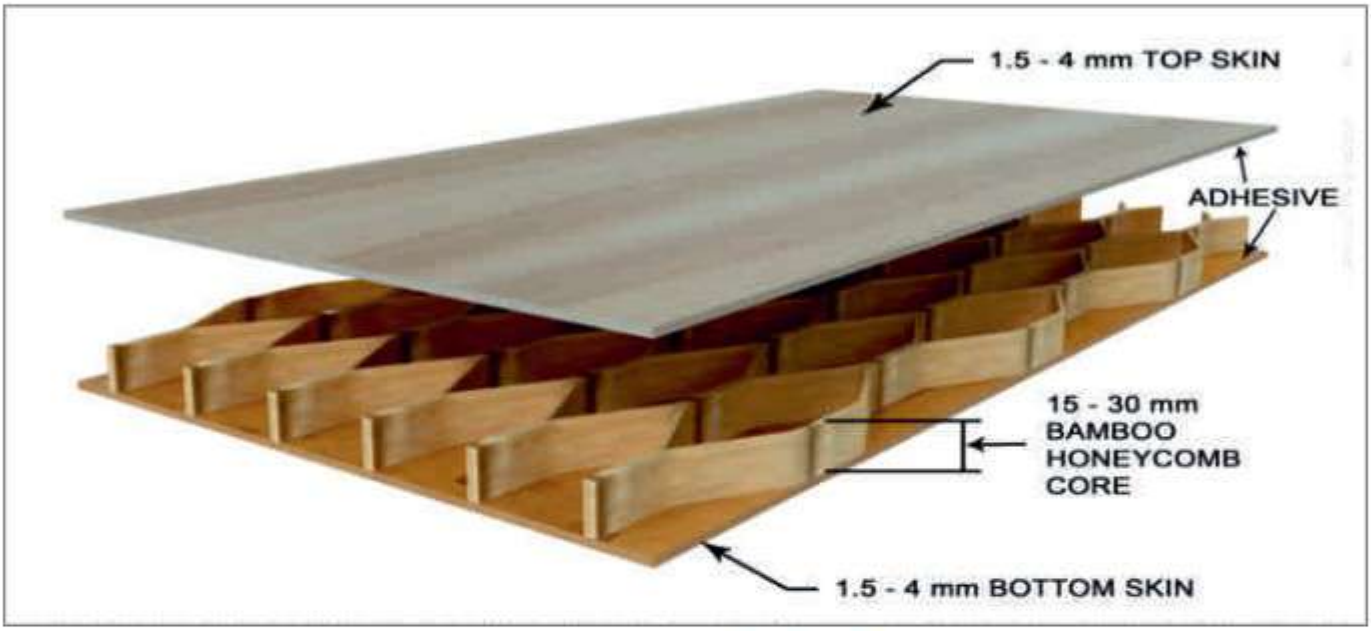
Lightweight honeycomb sandwich panel constitute a new raw material for furniture, joinery, panel and housing industry. The honeycomb offers high strength to weight ratio and are produced in thicker panels than the conventional wood based panels (plywood, particle board, medium density fibre board etc.). This exploratory study is carried out to develop cellular structure core using bamboo slivers of 1.5 and 3 mm thickness for making honeycomb panels. The honeycomb structure core was achieved by hot pressing the bamboo slivers in trafford profile dies. The bent slivers obtained after hot pressing were then joined side by side for forming a cellular/honeycomb structure. This cellular structure can be sandwiched between plywood or as core of flush doors with the help of resin, followed by pressing at room temperature. The performance of the honeycomb panel samples was studied by evaluating load bearing capacity, water resistance test, compressive strength and density of the samples. The performance of the door was evaluated by subjecting the door to tests prescribed in Specification for wooden flush door shutters (cellular and hollow core type) part 1- plywood face panels IS 2191 Part 1 (1983) as per specification of test method for door shutters given in IS 4020 (1998). The door achieved the desired performance requirement as per IS 2191 Part 1 (1983).



Introduction

Sandwich structures are composed of two thin but stiff material as skins bonded to a lightweight material as core. This presents a structure with properties for high bending stiffness with overall low density. Sandwich structures are usually used as an alternative material to achieve the same structural performance as conventional materials with less weight (Tan et al. 2011).

Honeycomb structures have the geometry of a Honeycomb to allow the minimization of the amount of material used to reach minimal weight. A honeycomb shaped structure provides a material with minimal density and relative high out-of-plane compression properties and shear properties. For engineering and housing applications honeycomb panels are being manufactured from plastics, papers and metals but not from lignocellulosic materials such as wood because of its limited flexibility and difficulty in processing for making honey comb panels. As bamboo slivers are comparatively flexible/ elastic as compared to other lignocellusic material such as timber, horizontally

woven. Honey comb panels are used for various applications such as Flooring, Roofing and Ceiling, Partitions and Wall cladding, Doors and windows, Furniture, cabins, Structures with backlit effects, Material handling pallets etc. and have potential application in prefab housing systems. Honeycomb section is much more efficient than standard sections and are having various advantages such as: Light weight, yet strong, High strength to weight ratio, etc. In addition to this bamboo slivers will have added advantage of being Green product, nature and eco friendly and better thermal and electric insulation.

Honeycomb structures are manufactured by using a variety of different materials, depending on the intended application and required characteristics. Honeycomb panels are being made of different materials such as paper, plastics, metals etc. This study was done for manufacturing honeycomb panels using bamboo. The selection of raw material for manufacturing honeycomb panels depends on end use application, ease of manufacturing and economy.

Bamboo slivers are used to make engineered panel materials such as BMB, BMVS, BMCS etc. However, no or very few instances are available where bamboo slivers are used vertically (along width). This study was carried out for exploring use of bamboo slivers of uniform width and thickness for development of honey comb structures and veneers as skins both joined together for making composite panels. Honeycomb section is much more efficient than standard sections and are having various advantages such as Light weight-yet strong, High strength to weight ratio, Acoustical and vibration dampening, Easy to fabricate and install. Whereas, honeycomb panels from bamboo slivers will have added advantage of being Green product, nature and eco friendly and better thermal and electric insulation.

Materials and Methods

Four sided planed bamboo slabs of Bambusa nutans and Dendrocalamus strictus species a of about 1 m length, 20 mm width and 5-6 mm thickness were procured. The slabs were converted to slivers of 1.5 mm and 3 mm uniform thicknesses.

The slivers were then pressed in sinusoidal/ trafford platen dies under temperature. The bamboo strips with sinusoidal shape were then joined side by side forming a cellular structure. This cellular structure was sandwiched between 4 mm thick BWP grade plywood by gluing followed by pressing at room temperature. In this study three grades of resins were used for joining slivers and boding with plywood skins. viz.

A. Polyvinyl acetate (PVA – Fevicol™),

B. Standard epoxy resin (resin and hardener - Araldite™) and

C. Epoxy resin (LY 566 with HY591 hardener)

Since there is no Indian standard available for evaluation of properties of honeycomb panels, Indian standards on bamboo mat corrugated sheet (IS:15476), block board (IS:1659) and, particle board (IS 2380) plywood (IS:1734) were referred and tests were identified for evaluating strength and performance of the honeycomb panels. Flush Door as specified in IS 2191 Part 1 (1983) of "8 DS 20" Designation of door with 700 mm width, 1905 mm length and 25 mm thickness was also manufactured. The properties of honeycomb panels and doors manufactured are as given below:

Table: Properties of Honeycomb panel

Sl No	Property/Test	Result	
		Sample 1	Sample 2
1.	Sliver thickness, mm	3	1.5
2.	Density, gm/cc	0.252	0.228
3	Compressive strength, Kg/m²	7.43	5.19
4	Load Bearing capacity per M meter span / meter width (under bending - 3 point load), N/m	2265.6	1511.4
5	Modulus of Rupture (considering solid section), Mpa	4.33	2.47
6	Modulus of Elasticity (considering solid section), Mpa	612.2	565.9

Table: Water resistance of Honeycomb panels produced with differentresin systems

Sl No	Property/Test	Result		
1	Resin	PVA - Fevicol™	standard epoxy resin - Araldite™	Epoxy (LY 566 with Hy591 hardener)
2	Water resistance test	N/A	Conforms to IS: 1659, MR Grade	Conforms to IS:1659, BWP Grade

S.No	TESTS	Minimum value for conformity as per IS 2191 (Part 1)	Results
1	Dimensions a) Length mm b) Width mm c) Thickness mm	 Length- ± 5mm Width - ± 5 mm Thickness- ± 1mm	 4 2.5 0.54
2	Squareness, mm Deviation per 500mm a length	Square ness - not more than 0.5 mm per 500 mm length	0.4
3	General flatness, mm a) Twisting b) Cupping c) Warping	Twist, Cupping & Warping not greater than 6 mm	0.72 0.75 0.6
4	Local Planeness, mm	Depth of deviation not greater than 0.5 mm	0.2
5	Flexure, mm 15 mts after loading 50 Kg 3mts after load removal	Deflection at maximum load not greater than 1/30 of length & 1/15 of width, whichever is less. Residual deflection not greater than 1/10 of max deflection	46 3.7
6	Impact indentation	No cracking, tearing or delamination. Depth of indentation not greater than 0.2mm	No crack or deformation Max. Indentation = 0.1mm
7	Edge Loading test (deflection in mm) Initial Reading After 15 minutes of 100kg loading 3 minutes after load removal	Deflection at max. Load not greater than 5mm. Residual deflection after removal of load not greater than 0.5mm Not more than 2mm during loading Not more than 2mm during loading No residual buckling after load removal	4.8 0.4 No residual buckling
8	Shock Resistance a) soft & light body impact b) soft & Heavy body impact	 No visible damage No visible damage	 No visible Damage or Delamination No visible Damage or Delamination
9	Buckling resistance test (deflection in mm) After 5 minutes of 40 kg loading 15 minutes after load removal	No deterioration Initial deflection not more than 50mm. Residual deformation after 15 min of load removal not greater than 5mm	No deterioration 35.2 2.8
10	Slamming Test	No visible damage after 50 drops.	No visible Damage
11	Misuse	No permanent deformation of the fixing or any other part of the doorstep in hindering it's normal working after the test.	No permanent deformation

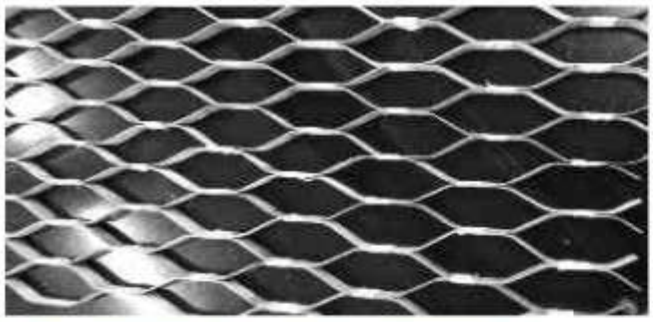


Fig. bamboo honeycomb panel

Fig. bamboo honeycomb structure placed in door framework.

Results

From the results it can be seen that low density of less than 250 - 270 gm/cc was achieved for the panels as compared to low density particle board (IS:3129 – 1985) which specifies maximum density of 400 gm/ cc. The load bearing capacity of the panel was found to be 1511 - 2265 N/m per meter width of the panel, which is theoretically comparable with load bearing capacity of 12 mm thick plywood. However, honeycomb panels thus developed is having 3 to 4 times more strength to weight ratio as compared to the plywood, which makes it suitable for use in roofing and other load bearing component of a structure.

The compressive strength of approx. 5 -7.5 Kg/cm^2 was achieved which shows sinusoidal pattern of slivers also provides additional resistance to lateral buckling under compression.

From the results of water resistance tests to study the bonding between sliver to slivers and sliver to skin, it is observed that the honeycomb panels made with PVA resin can be used in dry locations, honeycomb panels made with standard epoxy resin can be used in humid conditions. Whereas, the honeycomb panels made with epoxy resin can be used in exterior conditions similar to BWP grade block boards.

From the results it can be observed that, the door manufactured using honeycomb structure from bamboo slivers meet the requirements specified in the Indian standard IS 2191 Part 1 (1983). The result of water resistance, Glue adhesion, Varying humidity and End immersion test, shows that PVA resin of Marine grade used for bonding sliver to skin can be used for manufacturing BWP grade door shutter. The door also met the desired performance requirements such as Flexure, Edge loading, Shock resistance, Buckling, Slamming, Screw withdrawal.

Conclusion

The use of honeycomb cellular structure also helps to save about 45% consumption of wood in making flush doors and thereby saving the natural resources. Wood conservation is highly desirable in the present context of wood raw material shortage. In the study the preliminary processing of bamboo for making slivers and converting it to honeycomb structure was mostly done manually at lab scale, which appeared to be time consuming. However, with introduction to suitable mechanization and skill of the worker, the time duration for this can be considerably reduced. The honeycomb panels developed in the study are light weight and are having good strength to weight ratio. The suitable resin may be used depending on the end requirement ranging from PVA resin for use in dry location to Epoxy resin for use in exterior applications. It was found that the honeycomb panels developed has potential to be used in variety of applications such as partitions, furniture, prefabricated housing etc.

References :Contact author at nandanwaran@icfre.org

Ultrasonic Technique for Detection of Tree Trunk Hollowness

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1. Introduction:

Brief Description : Forest Research Institute, Dehradun has developed an ultrasonic technique to detect the location and magnitude of the deterioration (hollowness) inside the main tree trunks for different girths which helps either to take timely precautions for the safety of the valuable tree by giving suitable and effective treatment or to get good yield (timber) for utilization purposes. This technique is beneficial to the State Forest Departments and other agencies in managing urban forestry to take timely decision for removal of hazardous trees which are at prime locations for the safety of life. Diameter at breast height (DBH), the girth of tree trunk is measured using tape. Peripheral division of the girth is done into 6 or 8 segments for transducers. Trunks of girth less than or equal to 120 cm are divided into 6 segments and those of girth more than 120 cm are divided into 8 segments. At these segment points, bark is drilled up to wood in order to provide location for transducers. With the help of Vernier scale, liner distances between each pair of segment points and the time of travel within the wood medium is recorded from ultrasonic concrete tester and is fed into the software to see the presence of the hollowness.

2. The problem or situation being addressed by the innovation

Various non destructive testing techniques based on different concepts are known for use in the field conditions for deterioration detection mainly to identify hazardous trees, to prevent the spread of decay and to improve stand conditions. Among several non destructive test methods, vibration test technique (acoustic/ultrasonic) is one of them and employed to evaluate the elastic properties, presence of defects of wood and wood products as it has several advantages over traditional testing such as less time consuming, economical, reliable results and also easy to transport instruments at inspection site. Sounding a tree by striking it with a tool can detect advanced decay or hollows inside the trunk, but this method is not effective on large thick-barked trees. Therefore, acoustics and ultrasonic techniques which are non destructive testing techniques and have proven to be effective for detecting and estimating deterioration in tree stems and wood structural members. These techniques are simpler and economic than other techniques. Because the propagation of stress waves is basically a mechanical phenomenon, these waves are frequently used to detect internal defects in wood.

3. Description of the innovation and its salient features

Ultrasonic testing technique has been used for hollowness detection in tree trunk. Ultrasonic velocity in tree trunk is transmitted along multiple transverse directions of the tree trunk (Fig.1).Ultrasonic velocity is determined along multiple transverse directions of the tree trunk. In the presence of hollowness, ultrasonic velocity decreases. Magnitude and location of hollowness in tree trunk is estimated using EXCEL sheet or software.

3.1. Defect detection in timber by ultrasound

Direct ultrasonic wave transmission technique is used for defect measurement in tree. Ultrasonic waves transmitted through decayed wood moves slowly as compared to solid wood. Ultrasonic waves of lower frequency (25 KHz) along the multiple transverse direction of the tree trunk is transmitted and time taken to reach at receiving ends (Points) is recorded. Ultrasonic velocity is determined based on the formula (distance/time). Presence of defect in tree is estimated on the basis of drop in stress waves velocity compared to the reference velocity. For eight or six point testing of the trees, its whole girth is divided in to eight of six parts at equidistance and trees trunk is divided into segments (Fig.1). Bark from these eight or six points (test points) is removed and surface of each points is made smooth with the help of drill machine or using suitable nail in the marked point for placing ultrasonic transducers (transmitter and receiver) for testing. Distance between these points are recorded at the accuracy of 0.1 decimal. Testing of trees for defect detection (8 or 6 points) is carried out by placing transmitter (transducer of

frequency 25 KHz) at the point 1 and receiver of same frequency at point 2 using couplent with soft iron nail to make good contact among them or directly place the transducer at point where bark has been removed. Time (u sec.) taken by the ultrasonic waves to travel from point 1 to 2 of the trees is noted. After that position of transmitter remains same at position 1 of the tree and position of receiver varies from 2 to 3, 4, 5, 6, 7, 8 and for each position of receiver time is recorded. Thereafter, position of transmitter is kept at the point 2 of the tree and receiver is placed at the point 3, 4, 5, 6, 7, 8 and for each position of receiver, time is again recorded. The similar test procedure is followed for all point marked (1-8 &1-6 points) on the tree.

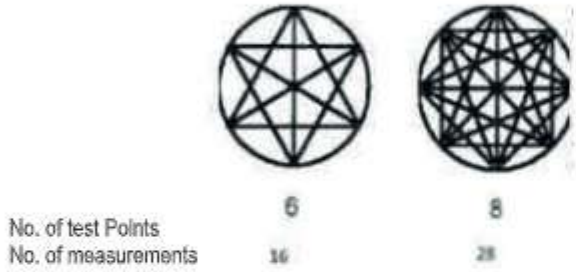

Fig. 1 : Multiple transverse directions of the tree trunk for transmitting ultrasonic velocity

Total twenty eight (8 points) or sixteen readings (6 points) are recorded. Ultrasonic velocity is determined for each position of transmitter and receiver (eqn. 1). Thereafter the value is computed in the software to find the hollowness presence (Fig. 2).

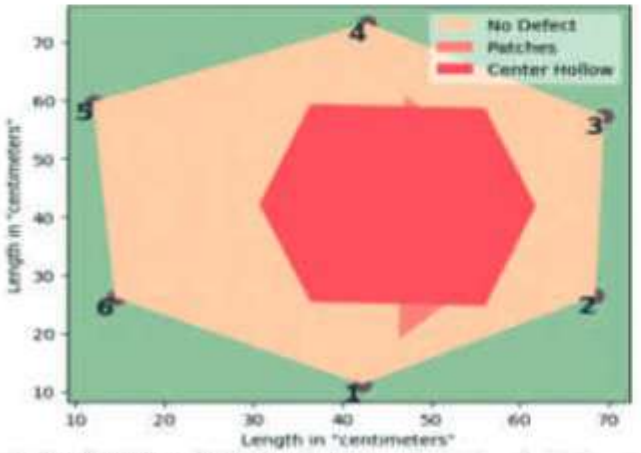

Fig.2 : Hollowness presence

Salient features

- Defects in standing or living trees can be detected easily.
- Defects can be detected within 15 to 20 minutes.
- Equipment are handy and very easily operated by any trained person

4. Required resources in terms of raw materials, equipments, machineries, etc.

Equipments:

(I) Commercially available an ultrasonic equipmentwith two probes for producing ultrasonic frequency up to 50 Hz.

(ii) A battery operated drilling machine for removing the bark form the tree so that ultrasonic probes can be placed properly

Manpower:

Two skilled people for recording reading of the equipment and one labor for cleaning and hole making and plugging of that hole in the tree using wax.

Materials:

Small stools (02) are required, one to keep the equipment and other one for person to sit and take the reading from the machine. Honey wax to plug the tree hole. A computer, and a software (available with the FRI, Dehradun) to process the data.

5. Specific problems/ obstacles likely to be faced by the user during use and their solutions

Sometime equipment won't give reading if the tree is branched inside. In that case reading is taken from little upper side of the tree Probes of the equipment should be placed properly to avoid the erratic reading. Drilling should be done up to the trunk to record the proper reading. Sufficient amount of silica gel should be applied to the probes and to the reading points to get the uniform wave diffusion.

6. Impact of the innovation

In the year 2019, Fani cyclone killed at least 89 people in eastern India and Bangladesh and caused damages estimated to be US$8.1 billion in both India and Bangladesh, mostly in Odisha. In India over one million trees that once stood tall and provided green cover to the Odisha capital were uprooted by the raging winds of Cyclone Fani and also it damaged the property. Developed technique is an effective diagnostic technology for decay detection in trees and timely prediction of their hollowness saving thereby people and their property loss. Use of this technique doesn't require high inputs in terms of cost, energy, or any other materials and can be adopted by the forest departments and City Municipal Corporations and others with minimum input cost.

7. Suitability and possibility for upscaling

Developed technique, being effective, non destructive and inexpensive, is highly suitable in

diagnosing hollowness in the trees grown in the forest, rural and urban are as there by enabling the state forest departments to take corrective measures for their protection. This technology can easily be up scaled.Ultrasonic defect detection process can be made more users friendly if it is digitized and made functional with mobile application.

8. Economic viability

Cyclonic tree falling have devastating effect in rural and urban areas, especially in coastal areas, every year. The developed technology enables to monitor the trees regularly and to detect their decay timely there by minimizing the cyclonic damage to the life and property. It is a simple technique which can be handled by a technician with one helper. Cost of the technology (buyer will be directly procured the Ultrasonic tester equipment from the open market) is about Rs. 6.00 lakhs (Rs. 4.00 lakhs for software, Rs. 1.00 lakhs for Institutional charge and Rs. 1.00 lakhs for training on software by FRI, Dehradun).

9. Significance for (and impact on) policy making

This ultrasonic hollowness detection technique has problem solving orientation and thus focuses on policy issues desired in urban forestry.

10. Possibility and scope of extension to the stakeholders (SFDs/ communities/ industries, etc.)

The officials of the forest departments and City Municipal Corporations can easily build their capacity to use this technology. Capacity building to artisans, youth and women with use of this technique would create employment opportunities for them.

11. Description of the institution responsible and its organisational aspects

Forest Products Division, Forest Research Institute, Dehradun is one of the constituent institutes of the Indian Council of Forestry Research & Education (ICFRE), Dehradun. ICFRE is an autonomous Council of Ministry of Environment, Forest & Climate Change, Govt. of India.

References: contact author at rezhumalai@icfre.org

Low Formaldehyde Emitting Particle Board by Nano-Particle reinforcement

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Introduction:

The wood panel industry depends on thermosetting resins, of which urea formaldehyde is one of the most significant. Particle board panels are created from wood particles and are a renewable bio resource. Particle board panels are commonly used in furniture and decoration, whereas plywood panels are mostly employed for structural purposes.

Nanoscience and nanotechnology also have numerous advantages for renewable biomaterials like wood and wood composites. Nanotechnology has been identified as an innovative upheaval by scientists from all over the world. It is required to be a critical driver of worldwide economic growth and development in this century because it is a multi-disciplinary field of research. Nanomaterials often have unique physical and physiochemical properties that set them apart from larger particles of the same substance. The use of nanotechnology in the development of different wood panels is of great importance to overcome the formaldehyde emission issue.

Formaldehyde emission is one of the major concerns in wood-based panel products as most the manufacturers use formaldehyde base resin systems. A great deal of attention is being paid by the researchers on this issue during the last decade. The major sources of formaldehyde emissions are mainly categorized from formaldehyde compound in wood material, residual free formaldehyde of the resin which is unreacted formaldehyde released by the structural degradation of the wood-based panel used. Among them, the unreacted free formaldehyde in the panel is the major concern as it is the main source of indoor air pollution and have serious health implications to users. Because of the health hazard associated with formaldehyde emission, many countries have established the formaldehyde emission requirements and testing methods.

The main goal of the modern adhesive industry is to compromise these needs and produce effective urea formaldehyde resin with very low, if no zero, formaldehyde emission. The use of nanotechnology has been advocated to have a great importance in overcoming the issue of formaldehyde emission from particle boards and plywood. There is only limited research on the formaldehyde emissions of particle board enhanced with nanomaterials under various settings. The aim of this paper was to create an environmentally friendly particle board with minimal formaldehyde emissions and to investigate the impact of nanoparticle loading on thermosetting resins.

The study was carried out with the objectives of optimizing the adhesive formulation with incorporation of nano particle for low formaldehyde emission in the manufacture of particle board and evaluation of physical, chemical and mechanical properties as per the relevant standard. In the research, Wollastonite was used as the nano-particle and added in different concentrations in the resin.

Materials:

Poplar particles and UF resin has been used for development of particle board. Wollastonite (Kemolite KFB-1010) was provided by M/s Wolkem India Limited, Rajasthan, India.

Preparation of Nanoparticle:

Commercially obtained wollastonite (KFB-1010) powder particles with average particle size of about 8 μm was used as starting materials. A high-energy planetary ball mill machine was used for ball milling (Retsch PM 100). Zirconium balls with a diameter of 10 mm were confined in a bowl as the milling container.

Fig. 1. Preparation of nano particles.

Hardened chromium steels were used to make both the ball and the bowl. The ball to powder weight ratio was preserved at 4:1 in all runs, and the bowl rotation speed was around 300 rpm. The speed has been selected as per instrument and materials. Milling was done in an open environment at ambient temperature (Fig.1).

Board formation:

A square wooden frame with dimensions equal to that of the aluminium caul plates. BOPP paper was placed over the aluminium caul plate, followed by the wooden frame. Glued particles are taken inside the frame and spread uniformly by hand. The lid is placed over the particles within the frame and pressed hard to compact the particles, as far as possible, Keeping the lid in place, the frame was removed slowly without affecting the mat. The lid is then removed. A BOPP paper was placed over the mat and finally covered with an aluminium caul plate. Aluminium rods of required thickness (thickness of the board to be made) were placed on two sided of the furnish formed mat. The assembly was ready for hot pressing. The pre-pressed mat assembly was then inserted into hot press, where the platens were kept at a temperature of 160 ± 5° C. Supporting rods to control the thickness to 12 mm were placed on either ends of the assembly. A pressure of 25 kg/cm^2 for compression cycle for 6 minutes both the resin system followed by curing cycle of 12 kg/cm^2 for about 6 minutes curing time was employed for 12 mm thick particle board. The pressure was initially increased to get a high surface density on the board. After the time was up, the pressure was reduced to zero for a few seconds to release the steam that had built up on the boards, and the final result was taken from the hot press. After being removed, the boards were piled on a level platform to achieve moisture equilibrium before being trimmed to size.

Result and Discussion:

Field Emission Scanning Electron Microscope (FESEM): FESEM was used to view the sample surface. The samples were gold-coated to ensure that the electron beam had sufficient conductivity. Figures 2 show typical FESEM pictures of milled powder. The average particle size of powder particles was around 8-micron wollastonite. The average particle size of nano particles was detected in the range of 25-100 nm in different magnifications when considering the morphologies of the powders milled. Size of particle in SEM micrographs were determined with the help of image analyser software, which were show in figure. The produced nanoparticles were uneven in shape and size, as evidenced by SEM micrographs. Nanoparticles in the sample had a semi-spherical shape.

Water absorption and Thickness in swelling:

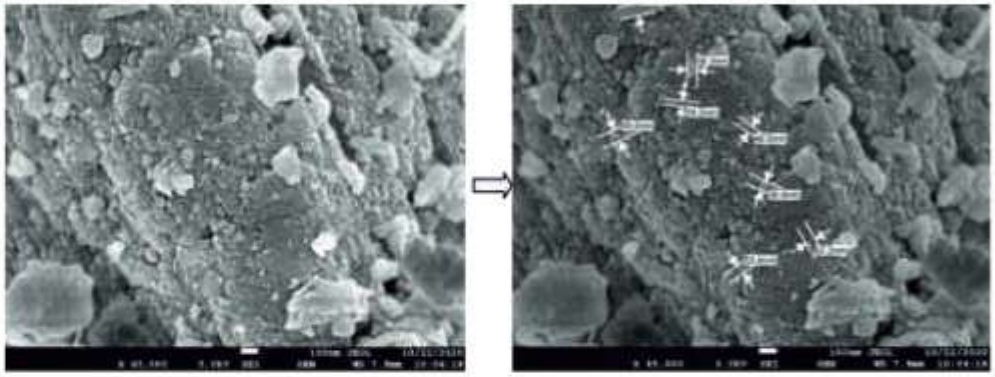

Fig. 2. FESEM micrographs of micro and nano wollastonite.

Although particle board panels are commonly utilised in interior applications, they must nonetheless resist water absorption. According to visual inspection, there was no visual difference between the control panels and the panels with nano particle content. When nanoparticles were up to 2 percent in the case of wollastonite, water absorption decreased significantly; however, when nanoparticle content was more than this, water absorption increased. The explanation for this can be traced back to the density of different treatments being equal. After 2 and 24 hours, water absorption in nano particle treated panels was lower than in control panels. Table 4 shows the thickness in swelling values for the nanoparticle panel and the control panel. The results show that the nano material loading amount, nano material type, and the combined effect of these factors considerably reduced the thickness swelling values of the composites after all water soaking periods.

Modulus of Rupture (MOR), Modulus of Elasticity (MOE) and Internal Bond (IB) strength properties:

Table 1 shows the results of research on the mechanical properties of board as a function of the amount of nano particle added to the urea formaldehyde resin. As shown in the results, adding a little amount of nanoscopic wollastonite, to the glue resin (in the range of 0.5-2 percent) generated a considerable increase in the board IB in comparison to the control board. When the amount of nano particle

was increased, the IB dropped to a level that was comparable to the control board. The increased wood adhesive contact and removal of gaps on the wood surface by nano particles can be linked to an increase in nano-reinforced boards bonding strength.

In addition, adding a small amount of nano to a glue resin improved the boards' bending strength MOR and MOE. Table 1 shows the modulus of rupture and modulus of elasticity of the nano reinforced and control boards. All of the nano composites had greater MOR values than the control panel. The reason for increasing mechanical properties due to increase in the crosslink density of urea formaldehyde resin. Further, the mechanical properties of particles boards depend on the bond between particles and adhesive and the quality of the particles. The bonding of particles- adhesive can be improved by increasing the contact surface area between the matrix and particles.

Formaldehyde Emission Content:

Nanomaterials have distinct properties, such as high chemical activity. Physical characteristics as well as a big specific surface area. These characteristics could be leveraged to improve the performance of thermosetting resins and composite materials, opening up new possibilities. Some nanoparticles, however, are prone to aggregation in liquid. Increased nano particle loading levels may have generated aggregation in the nano reinforced resins, lowering the formaldehyde emission value. The particle board panels were made using urea formaldehyde that had been changed with different nano particles at varying loading levels.

Table 1 showed the formaldehyde data for the nanomaterial reinforced particle board panels and the control panels. According to table, UF nanocomposites could effectively decrease the formaldehyde emission of the UF adhesive. After adding up to 2 % wollastonite to the adhesive formaldehyde emission reduced. However, increasing the level of nano particle loading resulted in more formaldehyde emission. The reason is as follows: firstly, nano particles could adsorb the formaldehyde; secondly cross-linking network of the UF nanocomposites could prevent the formaldehyde escaping from the polymer and thirdly, structural stability of the network became stronger and the polymer chain; could not easily be broken to emit formaldehyde. It could be noted that the formaldehyde emission was least when the wollastonite 2.0% were used. The reason for that particles were dispersed in the solution. When the content was high, it was more difficult for the particles to be dispersed in the solution. The active group of urea formaldehyde can react with group available in nano particle.

CONCLUSION:

Table 1: Physical, Mechanical and Formaldehyde Emission properties of Particle Board

S.N.	Properties	Prescribed value IS 3087-(2005) Grade-2	Control UF Resin	$WO_{0.5}$	$WO_{1.0}$	$WO_{1.5}$	$WO_{2.0}$
1.	Density, Kg/m^3	500-900	723	758.7	772.5	774	759.4
2.	Moisture content, %	5 – 15	9.7	5.94	5.89	5.79	5.86
3.	Water Absorption, % a) After 2 hours of soaking b) After 24 hours of soaking	 Max 40 Max 80	 32.7 61.8	 31.9 69.96	 30.76 65.4	 28.56 62.8	 26.43 54.7
4.	Swelling due to general absorption, % (After 2 hours soaking) a) Thickness b) Width c) Length	 Max 12 Max 12 Max 0.5	 6.2 0.29 0.29	 6.86 0.3 0.29	 0.29 0.29 0.28	 4.98 0.26 0.24	 4.86 0.24 0.22
5	Modulus of rupture, N/mm^2 a) Average b) Min. Individual	 Min. 11 Min 10	 24.5 21.6	 21.07 19.34	 24.79 23.85	 24.46 23.76	 28.75 28.38
6.	Modulus of elasticity, N/mm^2 a) Average b) Min. Individual	 Min. 2000 Min 1800	 3353 3078	 2246 2178	 2298 2193	 2465 2393	 2589 2496
7.	Tensile strength perpendicular to surface (IB strength), N/mm^2	Min 0.3	0.35	0.36	0.43	0.47	0.52
8.	Swelling In thickness due to Surface Absorption (after 2 hours soaking), %	Max 9	7.6	4.9	3.8	2.06	1.99
9.	Screw withdrawal strength, N a) Face b) Edge	 Min 1250 Min 700	 1680 876	 2100 915	 2245 1071	 2875 1471	 2950 1860
10.	Formaldehyde content	E1 class <= 8 mg/100gm oven dry sample	8.9	6.85	5.63	4.86	3.2

The use of nanoparticles for UF resin results in significant decrease of formaldehyde release from the produced particle boards. Nano wollastonite was used to reinforce particleboard composites at different loading levels i.e., 0.5-2.0 % in this study. The average particle size of nano particles was detected in the range of 25-100 nm by FESEM.

It was found that the fortification of UF resin with 2 % nano wollastonite can be considered as an optimum level. Results showed that optimum level have significantly lower water absorption, thickness swelling, low formaldehyde emission and higher mechanical strength. Poplar (Populus deltoids) species with a density of 750-800 kg/m^3 were used to make particle board. As for modulus of rupture and modulus of elasticity, the highest performance was obtained in the composites reinforced with 2 % nano wollastonite. From the studies, it was found that 2 % nano wollastonite reduces the formaldehyde content in the panel without affecting the strength properties.

References : Contact author at ryadav@icfre.org

A Technology for Wood Quality Improvement of Plantation Grown Timber

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The expanding consumer and commercial interests in wood products has resulted in an increase in wood demand. India is also becoming a furniture exporter of finished products from imported wood. It is also a fact that in handicrafts production traditional timbers including *Dalbergia sissoo, Mangifera indica and Acacia spp* have played substantial roles. However, too much exploitation of traditional timbers and lack of new plantations has resulted in excessive price rise for quality raw materials due to diminishing supply.

Rapid urbanization is expected to lead to a huge demand of wood and wood products, especially in the construction sector. Country's middle-class growth along with rising incomes seem to be changing the consumption patterns in favour of imported timbers for applications in building projects, particularly for finishing and furniture uses. Plywood, particle board, MDF, and paper and pulp industries in India, mainly thrive on agro-forestry plantations of poplar and eucalyptus. However, Solid wood furniture and handicrafts sector industry still dependents upon traditional timber species like shisham and teak, which have very long rotation ages.

The long-rotation tree crops are generally not grown under farm forestry and agro-forestry systems due to lack of adoption by the farmers, for accrual of benefits after considerable long duration. Wood based industries in India especially, handicrafts, plywood & panel industries, which are dependent on long-rotation tree crops, have been facing the shortage of supply of wood, thus relying more on wood imports of these species. Technological interventions in wood processing of short rotation plantation grown timbers for solid wood handicrafts production has important role to play in the present context. However, development of eco-friendly techniques for industrial processing is the need of the hour. With reference to recent studies, it can be said that plantation grown *Melia dubia* wood has almost all the desirable qualities to replace traditional timbers used in solid wood with some drawbacks. The lower wood density of the species (0.39 g/ cm^3) makes it a weak contender of the replacement of traditional timbers. An economical method of increasing its density may prove a game changer for the solid wood industry.

Thermo-hygro-mechanical (THM) modification of the wood is an emerging eco-friendly method which includes the combined use of temperature, moisture and mechanical action on the wood. Using THM technique, a process for quality improvisation of *M. dubia* is developed. The present invention relates to a package of processing methodologies to enhance the quality of plantation grown wood of *Melia dubia* in terms of improved color (from dull pale white to golden brown), improved texture (semi coarse to fine) and improvement in density (from 0.35 g/ cm^3 to 0.58 g/ cm^3). The modified wooden planks are found to be improved in spring-back (immersion in water at 40 °C for 1 week), change in sp. gr. (from 0.39 to 0.58), changes in hardness, change in appearance like colour, texture, grain etc. Moreover, if required, the density may further be increased.

Fig. 1: Raw and modified *M. dubia* wood

Domestically, the invention is substantially useful for wood-based industries in India. The application of *Melia dubia* wood after densification for furniture will open up a new range of raw material for industries at comparatively cheaper price. The developed technology is an eco-friendly method of wood modification. No chemical at any stage was used for the purpose. Hence, the environmentally friendly nature of

the wood is retained. A patent has also been filed for the technology.

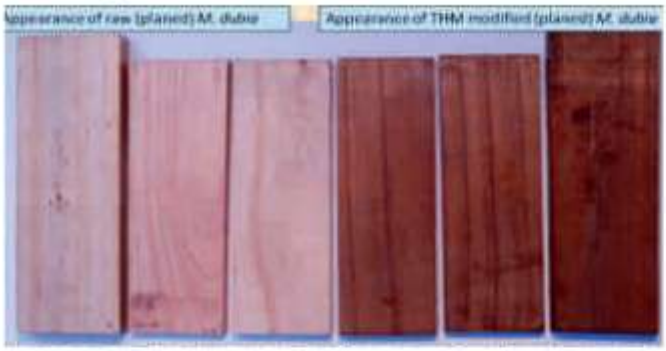

Fig.2: Raw and modified M. dubia wood

Modified wooden pieces were used to make boards as shown in fig. 3. It can be seen that the colour and texture of the planks can be controlled as per requirement.

Fig. 3: *Melia dubia* boards-raw wood (extreme left) and modified wood (right)

In the similar lines, another plantation grown timber Populus *deltoides* (poplar) was also attempted to be modified. However, the biggest problem with the poplar wood is that an excessive shrinkage (collapse) occurs on modification. This excessive shrinkage results in uneven surface (sinking and ridges) on the planks. To address the problem a polymer is integrated with the poplar wood, which has sorted out the problem of excessive shrinkage.

Fig. 4: Wooden boards from modified poplar wood

A package of processing steps is developed for poplar wood modification as shown in fig. 4.

Excellent improvement in hardness in modified poplar wood make it an alternative candidate for flooring timbers. The modification process enhances the decay and fungal resistance in modified wood. To test this hypothesis, mould resistance test was carried out in laboratory. The mould infection on treated samples indicates that at higher treatment temperatures, the occurrence of the mould infection is lower as compared with the lower temperature treatments. Chemical changes (holo-cellulose and lignin) were determined in the laboratory. Most affected chemical component was holo-cellulose which was found to be decreased in modified wood. Reduction of equilibrium moisture content (EMC) in modified timber indicates that shrinkage and swelling also gets reduced in modified wood.

An exploratory work was carried out on modification of veneers on similar lines as presented in fig. 5. The veneers have been modified using a two-step approach using a polymer with controlled pH, temperature and pressure.

Fig. 5 Modification of Veneers

As shown in above figure, middle layer of veneers are the natural ones. Upper and bottom layers are modified veneers using two different approaches. From above figure, it can be seen that color of the veneers has drastically changed. The darkness or lightness of the veneers can be adjusted as per the requirement. Moreover, the water repellence and hardness of veneers is also expected to enhance. Veneer modification is a proof of concept at this stage and needs further investigations as per the interest of the industry.

References: Contact author at kumarsro@icfre.org

Listening to the Sound of Wood - Application of Non-destructive Acoustic Technology in Testing of Wood

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1. Introduction:

Wood has been employed by humans for various purposes owing to its versatile properties. It serves as a raw material for the production of diverse finished goods, such as furniture, pulp, paper, wood-based panels, and construction materials. The properties of wood are determined by its chemical, anatomical, and cellular features. The characteristics of the final product are significantly influenced by various wood properties, particularly mechanical ones, thereby establishing the value of wood. Criteria like density, static and dynamic modulus of elasticity, and modulus of rupture are widely used to assess strength quality in construction applications (Lin et al., 2006). However, the conventional bending tests employed for evaluating mechanical properties of wood are characterized by high costs, time consumption, and a destructive nature.

Non-destructive testing (NDT) of wood is a crucial practice that combines science and craftsmanship to assess the structural integrity and quality of wooden materials without causing any damage. Historically, the need to evaluate wood has been driven by the importance of this versatile material in construction, furniture, and various applications. The earliest forms of wood testing date back to ancient civilizations, where craftsmen relied on visual inspections and tactile assessments. However, the advent of technology has ushered in a new era in wood testing, offering more sophisticated and non-invasive methods.

Non-destructive testing (NDT) assesses a material's mechanical and physical characteristics without altering their end-use capabilities (Pellerin and Ross, 2002; Liang and Feng, 2007). In the last few decades, NDT tools have been developed and employed by researchers and the forest products sector, for a variety of applications, ranging from the assessment of standing trees to the testing of wood based products, composite products, and logs (Lin et al., 2006). NDT are indispensable for the comprehension of internal structure and the health and properties of living trees, as well as felled logs without significantly compromising their viability for various end uses. Since a long time, acoustic tools have been applied as a robust instrument for measuring the quality of wood products. Planning, harvesting and efficient use of timber can be facilitated by the use of acoustic tools. These acoustic tools can also be used in early evaluation of trees for wood quality as part of breeding and genetic improvement research programme. Measurement of dynamic modulus of elasticity (DMoE) using vibration frequencies and propagation of ultrasonic and stress waves are gaining popularity (Chauhan and Sethy, 2016).

NDT plays a pivotal role in ensuring the safety and longevity of wooden structures. Its significance as a tool in future studies lies in its ability to provide detailed insights into the internal conditions of wood, aiding researchers and practitioners in making informed decisions about preservation, restoration, and the sustainable use of this natural resource. As we look toward the future, non-destructive testing emerges as an indispensable ally in the pursuit of a more resilient and environmentally conscious approach to working with wood. The article discusses The prospect of acoustic testing of wood in standing trees and felled logs.

2. Acoustic measurement

Acoustic testing of wood, a subset of non-destructive testing (NDT), employs the principles of sound wave propagation to assess the structural characteristics and internal conditions of wooden materials. This method leverages the fact that sound waves travel differently through materials with varying densities and elastic properties. By analysing the transmission and reflection of acoustic waves, researchers and wood professionals can gather valuable information about the quality, integrity, and potential defects within wooden structures. Common acoustic testing techniques include stress wave timing, where the speed of sound waves is measured to estimate wood stiffness, and resonance frequency analysis, which evaluates the vibrational response of wood to determine its

mechanical properties. These methods find application in diverse areas, such as the assessment of timber in construction, the detection of internal decay in standing trees, and the evaluation of wooden artefacts in cultural heritage preservation. Acoustic testing provides a non-invasive means of obtaining critical data, enabling precise and comprehensive analyses that contribute to the sustainable utilization and preservation of wood resources.

2.1. Acoustic measurement in standing trees:

Acoustic studies on standing trees represent a cutting-edge approach in the field of arboriculture and forestry, utilizing advanced technologies to gain insights into the internal health and structural integrity of trees. Employing acoustic sensors and analysis techniques, researchers can tap into the subtle acoustic emissions produced by trees in response to various stresses or defects, providing a non-invasive and real-time method for assessing their physiological condition. For instance, the identification of cavities or internal decay within a tree can be achieved by analysing changes in acoustic wave propagation patterns. Additionally, monitoring the acoustic emissions during wind-induced flexure aids in evaluating a tree's mechanical stability. The application of acoustic studies extends beyond individual tree health, contributing to broader forest management practices by offering early detection of pest infestations, disease outbreaks, or environmental stressors. This scientific endeavour not only enhances our understanding of tree biomechanics and physiology but also provides valuable tools for sustainable forestry and ecosystem conservation.

The time-of-flight (TOF) technique emerges as a minimally invasive and expeditious approach for assessing the modulus of elasticity (MOE) in standing trees. To derive the acoustic velocity through the TOF method, a pair of probes (one acting as a transmitter and the other as a receiver) are introduced into the sapwood of the tree. Acoustic energy is initiated by tapping the transmitter probe with a hammer, facilitating the transmission of signals. The time taken for these signals to travel between the two sensors is measured, enabling the calculation of the acoustic velocity (figure 1.).

The acoustic velocity is subsequently, calculated using Equation (1): $V = \frac{S}{\Delta T}$

Where, V is acoustic velocity (m/s), S is distance between the two probes (sensors) (m), and ΔT is time-of-flight (s).

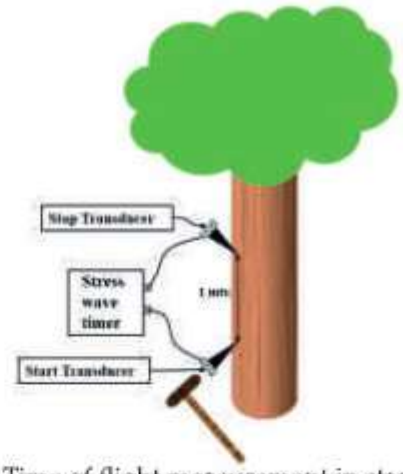

Figure 1. Time of flight measurement in standing trees

To conduct acoustic measurements in a natural setting, it is customary to insert probes into the tree trunk, typically on a consistent face, and penetrate them through the bark into the sapwood. The alignment of the probes is parallel to the axial plane. The lower probe is situated within the range of 40-60 centimeters above the ground. From a pragmatic perspective, the distance between the probes is commonly maintained at 1.22 meters. Consideration is given to the comfort of the individual conducting the measurements when determining the height at which the probes are placed (Wang, 2013).

Dynamic MOE is calculated from the acoustic velocity using Equation (2) (Schimleck et al., 2019):

$$MOE_{dyn} = \rho V^2 \qquad (2)$$

Where, MOE_{dyn} is dynamic MOE, ρ is the density and V is the acoustic velocity.

A number of tools such as FAKOPP TreeSonic™ model, Microsecond Timer, Pundit 250 Array etc. are being used nowadays for measurement of acoustic velocity.

2.2. Acoustic measurement in logs/lumber:

The application of acoustic studies on felled logs represents a pioneering approach in the field of wood science and forestry, aiming to discern vital information about the internal conditions and quality of timber without the need for invasive techniques. Acoustic methods capitalize on the propagation of stress waves through wood, offering a non-destructive means of assessing various attributes, including stiffness, and the presence of internal defects. This approach is particularly valuable in the forestry industry, where the accurate evaluation of felled logs is essential for optimizing timber utilization, ensuring structural

integrity, and minimizing waste. For instance, stress wave timing analysis enables the determination of wood stiffness, aiding in the classification of logs based on their mechanical properties. Additionally, resonance frequency analysis can identify defects such as decay or internal cracks, allowing for strategic log sorting and processing. The integration of acoustic studies in the assessment of felled logs not only enhances the efficiency of wood processing but also contributes to sustainable forestry practices by facilitating informed decision-making regarding the utilization of this renewable resource.

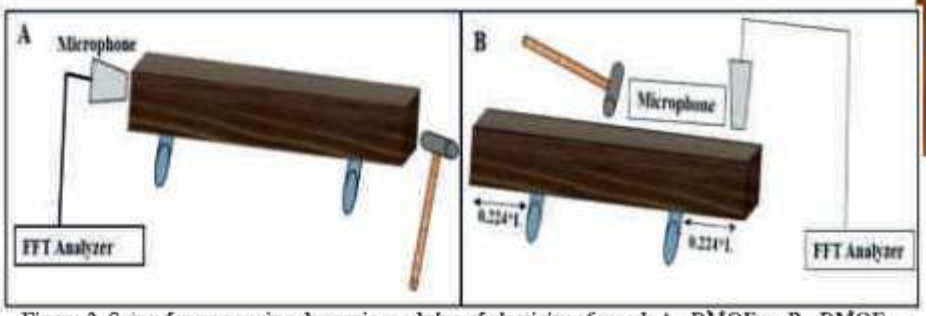

Figure 2. Setup for measuring dynamic modulus of elasticity of wood: A - $DMOE_{long}$, B - $DMOE_{flex}$

2.2.1. Resonance methods:

The resonance method, designed for measuring acoustic velocities in logs and lumber, involves transverse or longitudinal vibrations to assess stiffness. While also applicable for measuring Dynamic Modulus of Elasticity (DMOE), it is limited to test samples with two cut ends, making it unsuitable for estimating DMOE in standing trees. In contrast to the Time of Flight (TOF) method, which evaluates a small portion of material in standing trees, the resonance method provides an average quality measurement for the entire log, from bottom to top. Tools like WoodSpec and Hitman are employed in resonance-based acoustic measurements of wood.

In the longitudinal vibration method, wood samples are supported under a free-free condition using bubble wrap. Longitudinal vibrations are induced by gently striking one end of the wood sample with a spherical or ball-headed hammer, and the resulting time domain vibrations are captured by a microphone placed at the other end (Figure 2A). Spectrum analyzer software is utilized to convert received signals into frequency domain spectra using the Fast Fourier Transformation (FFT) algorithm, and the fundamental frequency of longitudinal vibrations is recorded. Acoustic velocity and dynamic modulus of elasticity in the longitudinal direction are then calculated using equations 3 and 4, as presented by Chauhan and Sethy. (2016.)

$$V = 2fl \qquad (3)$$

$$DMOE_{long} = \rho V^2 \qquad (4)$$

Where, f is fundamental frequency of longitudinal vibration (Hz), l is specimen length (mm), V is acoustic velocity, ρ is wood density and $DMOE_{long}$ is dynamic longitudinal modulus of elasticity.

2.2.2. Flexural resonance method:

In flexural resonance method, the sample is placed over rubber supports. The sample is supported in such a manner that the distance between each end of sample and nearest support was 0.224 times of the sample length (figure 2B). Gentle tapping is done at a point in mid-length of the sample in the tangential plane to induce flexural vibrations. The resonance frequency is determined using spectrum analyser software and frequency of the fundamental mode of flexural vibration is recorded. Dynamic flexural modulus of elasticity is calculated using the equation 3 (Chauhan and Sethy, 2016).

$$DMOE_{flex} = 0.946\rho f^2 l^4 / h^2 \qquad (5)$$

where, ρ is wood density, f is frequency of flexural vibration (Hz), l is length of sample (mm), h is thickness of sample (mm) and $DMOE_{flex}$ is dynamic flexural modulus of elasticity.

2.2.3. Ultrasound method:

In this method, transmission time of ultrasonic waves along the longitudinal direction of the wood samples was measured using an ultrasonic tester with transducers of different frequencies (figure 3).

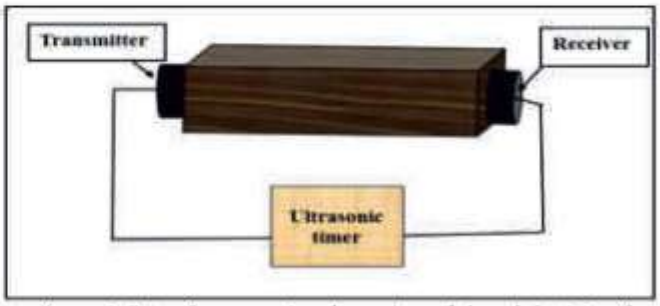

Figure 3. Setup for measuring dynamic modulus of elasticity of wood using ultrasonic technique

Two transducers were gently coupled with the wood samples using couplant. The start transducer generates an ultrasonic impulse, which travels through wood and received by receiver transducer at the other end. The transit time is measured in microseconds. The ultrasonic pulse velocity (V) and dynamic modulus of elasticity ($DMOE_{us}$) of wood is calculated using equations 6 and 7

(Chauhan and Sethy, 2016) respectively, which are as follows:

$$V = L/T \quad (6)$$

$$DMOE_{ac} = \rho V^2 \quad (7)$$

Where, L is the length of sample (m), T is transit time (sec.), V is ultrasonic pulse velocity (V) and ρ is density of specimens.

Acoustic testing of both standing trees and felled logs offers a multitude of advantages, contributing to the efficiency and sustainability of wood utilization practices.

3. Advantages of Acoustic Testing:

3.1. Standing Trees:

- **Early Detection of Internal Defects:** Acoustic studies enable the early identification of internal decay, cracks, or other defects within standing trees, allowing for timely intervention and targeted tree removal.
- **Assessment of Mechanical Properties:** By analyzing stress wave velocities, standing trees' mechanical properties, such as stiffness, can be estimated, providing insights into wood quality for potential end-use applications.
- **Non-Invasive Monitoring:** Acoustic testing is non-destructive, allowing for repeated assessments over time without causing harm to the trees. This facilitates long-term monitoring of wood quality and health.
- **Selection in tree-improvement programmes:** Acoustic testing allows opportunities in selecting clones/families/individual trees in tree breeding/ improvement programmes for superior quality timber. The technique can also be applied at an early stage (seedling stage).

3.2. Advantages of Acoustic Testing for Felled Logs:

- **Optimized Log Utilization:** Acoustic studies on felled logs assist in sorting and grading logs based on their mechanical properties, ensuring that each log is allocated to its most suitable end-use, thereby optimizing wood utilization.
- **Identification of Internal Defects:** Acoustic methods can detect internal defects in felled logs, such as decay or cracks, guiding decisions on log processing and minimizing the production of low-quality wood products.
- **Enhanced Efficiency in Processing:** By providing real-time information about the quality and characteristics of felled logs, acoustic testing streamlines wood processing operations, leading to increased efficiency and reduced waste.

4. Challenges and future scope:

The application of acoustic testing in forestry and wood science presents both challenges and promising avenues for future exploration. One notable challenge lies in the limited research on tropical hardwoods, which comprise a significant portion of commercial wood in regions like India. Understanding the acoustic properties of these woods is crucial for accurate assessments, as existing studies primarily focus on temperate species. Additionally, the precision of acoustic testing methods is a critical concern, as current technology tends to overestimate the stiffness property of wood. This discrepancy highlights the need for refining and calibrating testing procedures to ensure reliable and representative results. Another challenge arises from the insertion of probes into trees, penetrating up to the sapwood portion. This localized measurement may not accurately reflect the overall properties of the entire tree. Addressing this issue requires innovative approaches to account for the variability in wood properties within different sections of a tree. Furthermore, the calibration of acoustic testing tools remains a complex task, as variations in wood species, moisture content, and environmental conditions necessitate precise adjustments for accurate property assessments. The future scope of acoustic testing in forestry and wood science involves overcoming these challenges through dedicated research on tropical hardwoods, refinement of testing methodologies, and advancements in calibration techniques to enhance the reliability and applicability of acoustic assessments in diverse wood species and environmental contexts.

5. Conclusions:

In nutshell, acoustic testing in forestry and wood science presents a non-destructive and valuable approach for assessing wood properties. The method proves advantageous in early defect detection, evaluating mechanical properties, and optimizing wood utilization in both standing trees and felled logs. Challenges include limited research on tropical hardwoods, potential overestimation of stiffness, and the precision of testing procedures, particularly the insertion of probes into trees. Addressing these challenges is crucial for the future application of acoustic testing, involving refinement of methodologies, advancements in calibration, and dedicated research on tropical hardwoods to enhance reliability and applicability in diverse climate and different wood species.

6. References:

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DATA POINT:
Import Statistics- Particle Board (PB)(HSCode-4410) and Medium Density Fibre Board (MDF) (HSCode-4411) in India

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Over the last fifteen years, India has imported approximately 3,65,746 Lakh worth of PB and 7,78,638 Lakh worth of MDF. Major suppliers for India claim that only two countries, Thailand (39%) & Malaysia (34%) and contributed 73% of the total PB and 65% of MDF mostly coming from Malaysia (20%), Thailand (18%), Vietnam (14%), China (13%).

The wood and wood products are most important in forestry sector and it impacts economic growth and trade of the Country. In India wood and wood products demand is increasing continuously. The plywood alternatives such as Particle board and MDF have gained greater interest as substitute material to wood and plywood products. The need for ready-made furniture made of engineered panels like MDF and particle board is rising quickly along with the rate of urbanization. This offers a chance to produce such high-value composite material by using poles/small diameter logs, branches, and woody residues generated by wood-based industries. Medium density Fibre board (MDF) and Particle board are the third generation of engineered wood and is tipped to substitute plywood in number of applications particularly furnitures and interior applications. Globally, market of MDF and particle board is increasing at a rapid rate of 12-16% per annum. The market share of particle board was estimated to be about 6% and MDF was about 4% in the ₹ 25000 crore panel board markets in India which is dominated by plywood (Pandey, 2017).

India has imported 17,38,749 tons of particle board valued at ₹ 65,746 Lakh and 27,39,194 tons of MDF valued at ₹ 7,78,638 Lakh over a 15-year period (2008–09 to 2022–23). An average of 115916 tons of particle board valued at 24,383.04 lakh and 1,82,613 tons of MDF valued at 51,909 lakh are imported annually from various nations (Table 1). Fig. 1 shows the import trend for particle board and MDF during the recent 15 years.

Country-wise Import of Particle board and MDF in India:

Over a 15-year period (2008–09 to 2022–23), the combined percentage share of the top 10 countries in total imports of particle board was 95%, followed by 90% in total imports of MDF. Thailand ranked first among the top 10 countries that supply particle board to India, accounting for 39% of the total. Malaysia came in second at 34%, followed by Bhutan at 6%, Germany at 5%, China at 3%, Italy, Korea, and Bangladesh at 2%, Romania at 1%, and Spain at 1%. In terms of total MDF imports during this time period, the top 10 supplier countries were, in order, Malaysia (20%), Thailand (18%), Vietnam (14%), China (13%), Indonesia & Sri Lanka (7%), New Zealand (4%), Germany (3%) and Belgium & Turkey (2%) (Fig.2). The specifics of the annual trend and variation in Particle board and MDF between the top 10 countries are shown in Table 2(a&b) and Table 3(a&b).

Table 1: Import of Particle board (PB) and Medium density fibre board (MDF) (HSCode-4411) in India

Year	Particle Board (HSCode-4410)		Medium density fibre board (HSCode-4411)	
	Value (₹ Lakh)	Quantity ('000'KG)	Value (₹ Lakh)	Quantity ('000'KG)
2008-2009	17,830.61	88,437.38	22,008.75	98638.11
2009-2010	18,462.09	1,04,050.06	22,514.14	114365.40
2010-2011	27,546.63	136347.61	36,585.54	173717.43
2011-2012	39,234.24	166737.9	41,287.44	178461.02
2012-2013	31,627.29	116645.43	54,087.51	194413.97
2013-2014	24,430.06	111649.87	54,636.57	186404.72
2014-2015	19,205.16	83219.18	52,053.11	164330.13
2015-2016	23,627.40	113451.1	59,394.26	191954.09
2016-2017	22,249.91	123508.19	56,101.79	206427.06
2017-2018	20,814.75	111804.81	77,853.06	301040.61
2018-2019	28,018.54	160522.01	79,314.76	281119.73
2019-2020	30,824.40	185696.28	68,514.51	246454.78
2020-2021	19,591.90	102834.21	38,712.43	116879.33
2021-2022	18,463.47	59635.02	43,217.72	97566.99
2022-2023	23,819.23	74,210.68	72,357.10	187420.71
2008-09 to 2022-23.	**65,745.68**	**17,38,749.73**	**7,78,638.69**	**27,39,194.08**
Average	**24383.04**	**115916.65**	**51909.25**	**182612.94**
C.V.	**24.96%**	**30.06%**	**34.76%**	**33.48%**

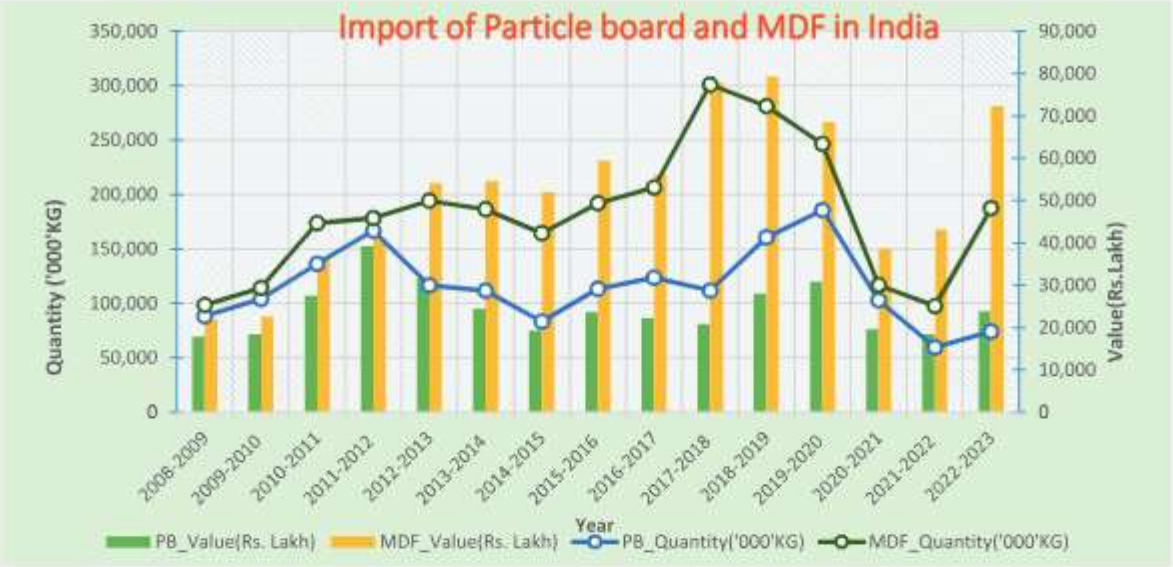


Fig1. Particle board and MDF import trends in India from 2008–09 to 2022–23.

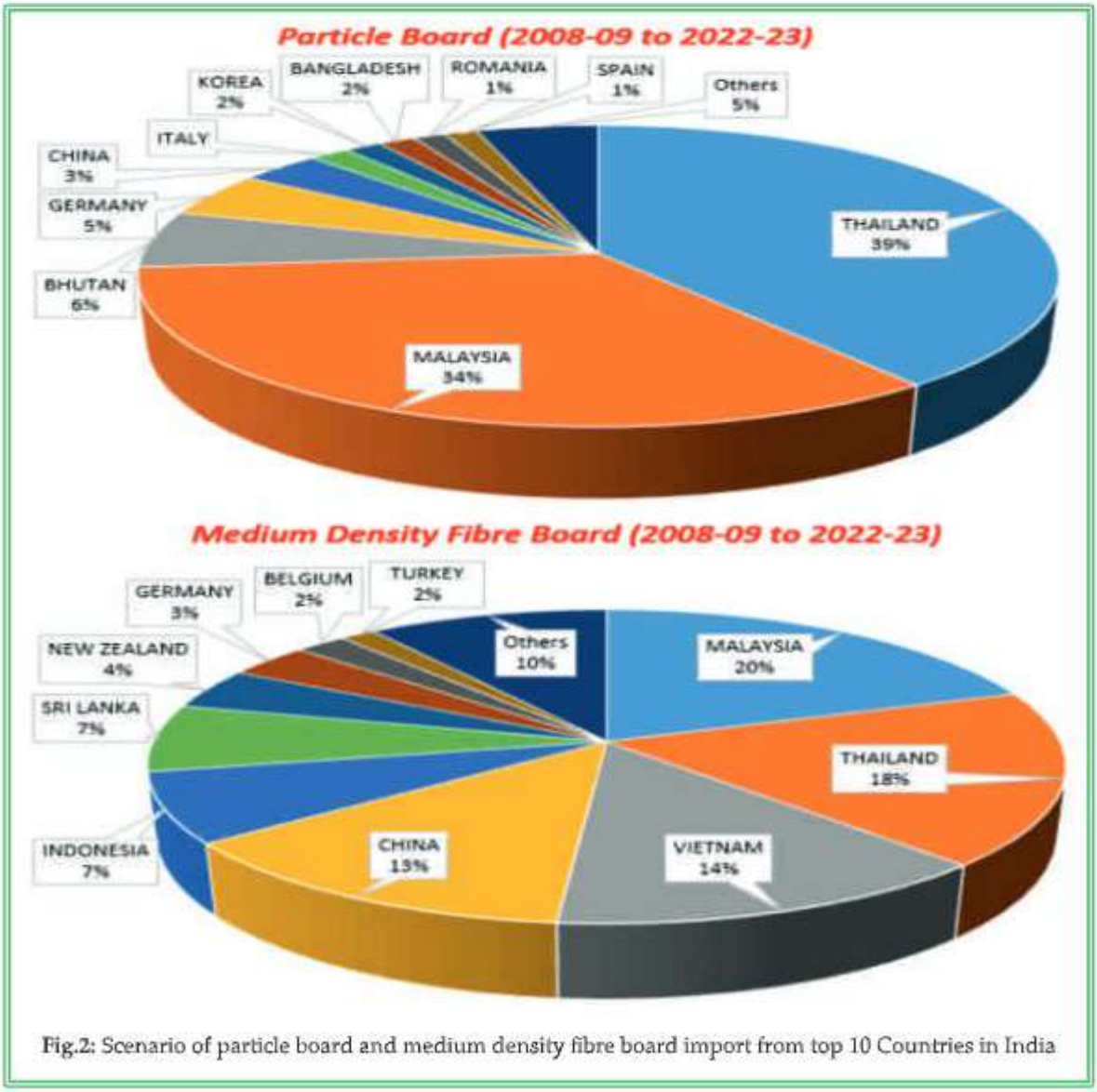


Fig.2: Scenario of particle board and medium density fibre board import from top 10 Countries in India

Table 2 (a): Particle board (HS Code-4410) import from top 10 Countries in India during the year 2008 09 to 2022 23

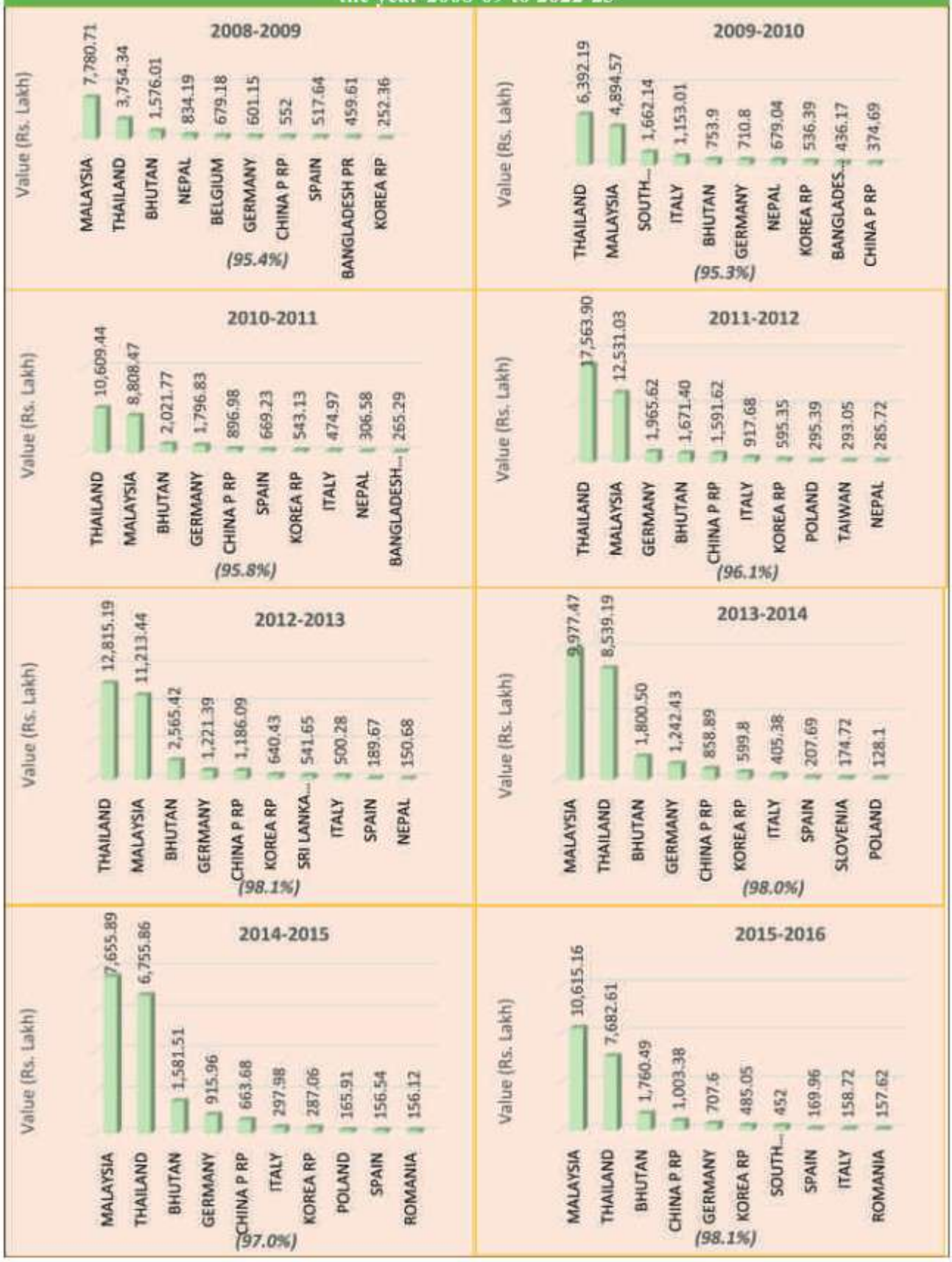
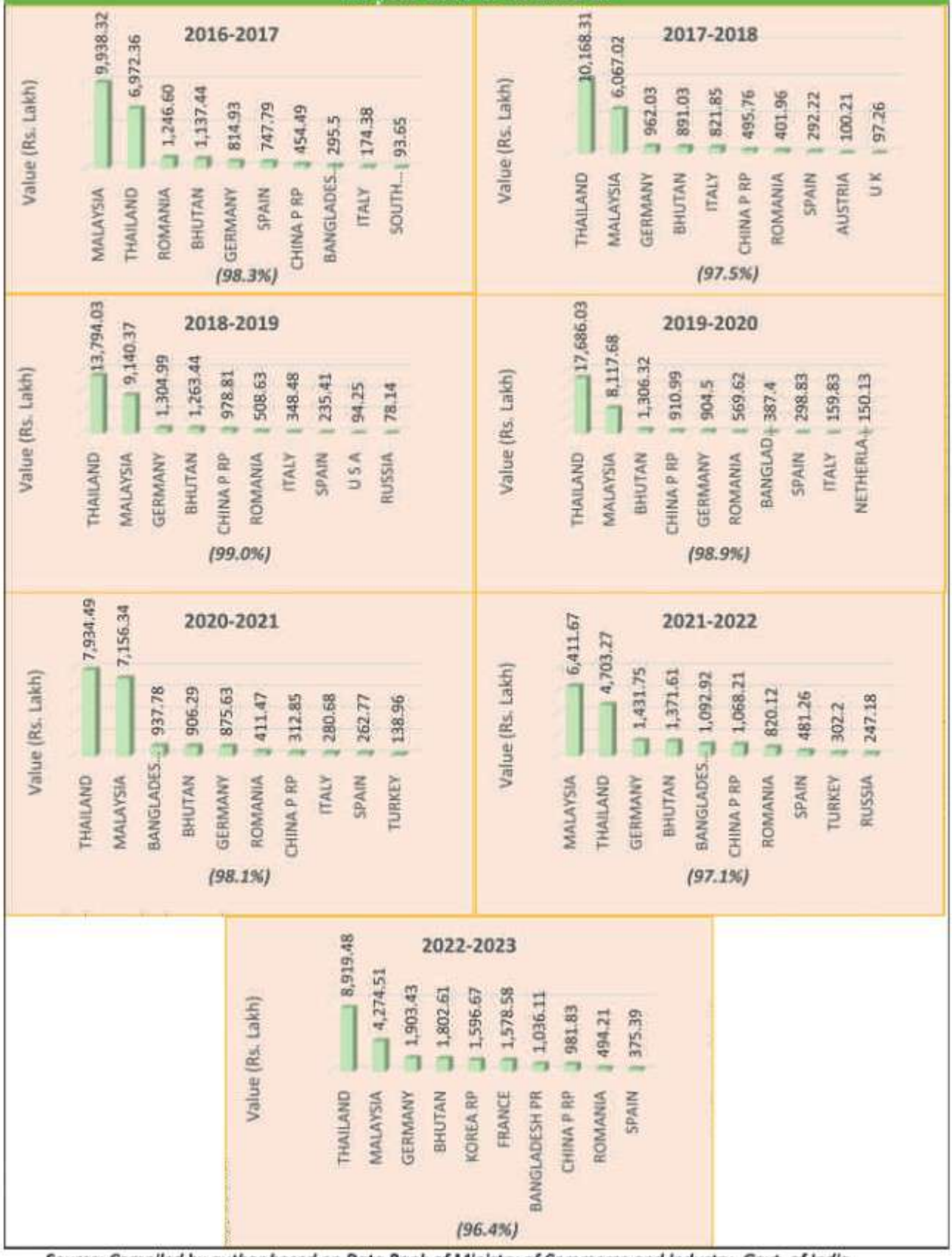


Table 2 (b): Particle board (HS Code-4410) import from top 10 Countries in India during the year 2008 09 to 2022 23



Source: Compiled by author based on Data Bank of Ministry of Commerce and Industry, Govt. of India

Table 3 (a): Medium density fibre board (HS Code-4411) import from top 10 Countries in India during the year 2008 09 to 2022 23

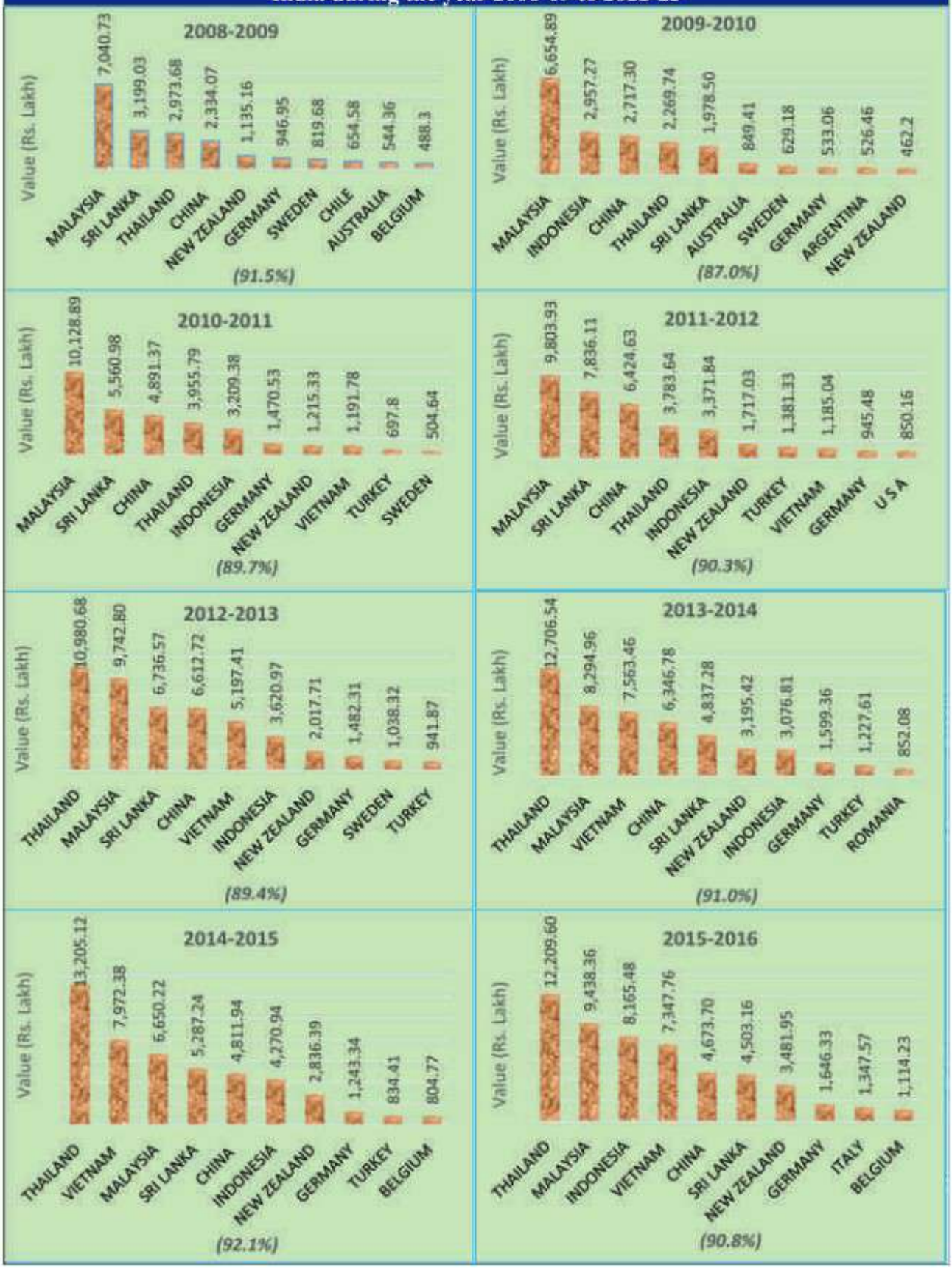
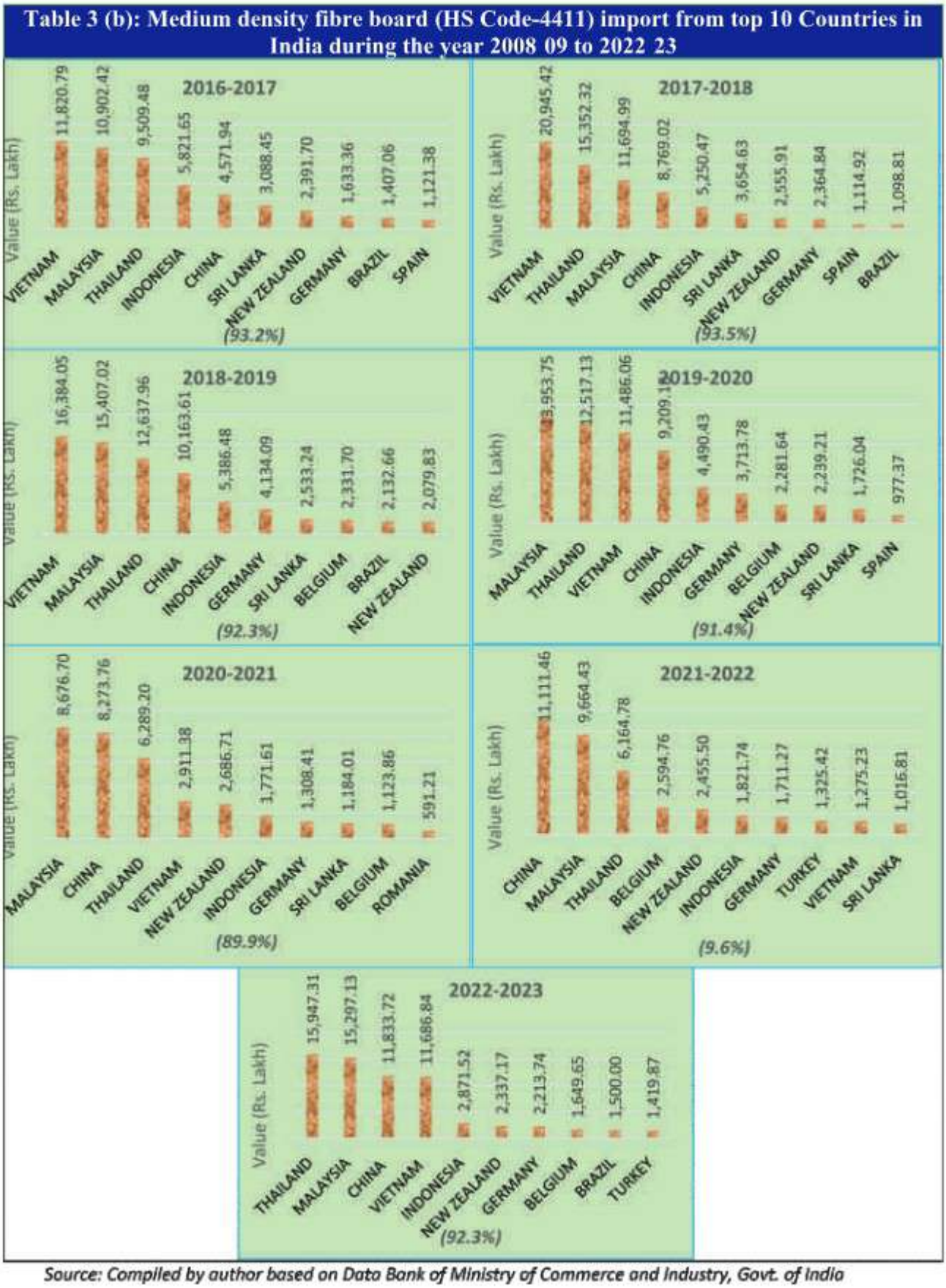


Table 3 (b): Medium density fibre board (HS Code-4411) import from top 10 Countries in India during the year 2008 09 to 2022 23



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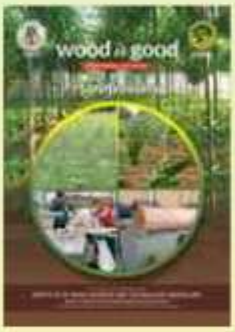

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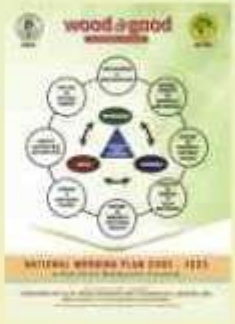

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TRAINING CALENDAR
(2023- 2024)

Sl No.	Name of Course	Course Director Particulars	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024
1	Sandalwood: Farming and Management of its Health	Dr. R. Sundararaj FP Division Ph: 080-22190154	10-14											
2	Saw Doctoring	Mr. V. Prakash: PPPT Division Ph: 080-30534009			05 07									
3	Micropropagation of Bamboo	Ms. Tresa Hamalton SFM Division Ph: 080-22190137			19-23									
4	Analysis of Raw Materials for Resin Manufacture	Dr. Mamatha B. S. PPPT Division Ph: 080-30534039				03-05								
5	Testing of Plywood and Block Board as per IS:303, IS:710, IS:1328, IS:4990 & IS:1659	Mr. Anand Nandanwar PPPT Division Ph: 080-30534016				10-14								
6	Bamboo Processing and Bamboo Composites	Dr. Vipin Kumar Chawla WPP Division Ph 080-22190193					07-11							
7	Bamboo Based Housing System	Mr. V.R. Ramkumar PPPT Division Ph: 080-30534007					07-11							
8	Testing Of Door Shutters As Per IS: 2202, IS:1003 & IS: 4020	Mr. Anand Nandanwar PPPT Division Ph: 080-30534016					21-23							
9	Bamboo: Propagation and Management	Dr. T. N. Manohara SFM Division Ph: 080-22190156					21-25							
10	Sandalwood Farming and Management of its health	Dr. Narasimha Murthy FP Division Ph: 080-30534210						11-15						
11	Plywood Manufacturing- II (Adhesives for Plywood and Plywood Manufacturing- Resin Preparation, Gluing, Hot Pressing)	Ms. Sujatha. D PPPT Division Ph: 080-30534005						11-15						
12	Epoxy Resin Table Top Manufacturing	Mr. V.R. Ramkumar PPPT Division Ph: 080-30534007						13-15						

Sl No.	Name of Course	Course Director Particulars	Apr 2023	May 2023	Jun 2023	Jul 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024
13	Resin Manufacturing	Ms. Sujatha. D PPPT Division Ph: 080-30534005							04-06					
14	Testing of Plywood and Block Board as Per IS:303, IS:710, IS:1328, IS:4990 & IS:1659	Mr. Kiran M. C. PPPT Division Ph: 080-30534012							09-13					
15	Plant Molecular Biology Techniques	Ms. Tresa Hamalton SFM Division Ph: 080-22190137								06-10				
17	Wood Seasoning and Preservation	Mr. Ritesh D. Ram Ms. C. N. Vani WP Division Ph: 080-22190175 080-22190174								20-24				
16	Testing of Door Shutters as Per IS: 2202, IS:1003, IS: 4020	Mr. Kiran M. C. PPPT Division Ph: 080-30534012									06-08			
18	Veneering	Mr. Uday D. Nagammanavar PPPT Division Ph 080-30534011									11-13			
19	Wood Identification	Dr. Anil Kumar Sethy Ms. S. Shashikala WPP Division Ph: 080-22190172, 080 22190215										08-12		
20	Seed handling, Nursery and Plantation Technology	Dr. N. Ravi SFM Division Ph: 080 22190155											05-09	
21	Wood Polymer composites	Dr. S. S. Chauhan WPP Division Ph: 080-22190145											14-16	

FEDERATION OF INDIAN PLYWOOD & PANEL INDUSTRY (FIPPI)

REGISTERED UNDER THE SOCIETIES REGISTRATION ACT XXI OF 1860, REGN. NO. S/2985/1968-69 DT. 4.1.1969

Part of FIPPI Achievements

With great efforts of Federation of Indian Plywood & Panel Industry (FIPPI), an Apex representative body of Plywood / Panel / Other Allied products including Furniture and Wood / Bamboo Working Machinery Manufacturers in India alongwith close cooperation with various Ministries and Premier Institutes through Agro and Farm Forestry and other Captive Plantation programme, the dying woodbased industry is again reviving in the country to produce various standard products like Veneer, Plywood, Panelboard, Particleboard, MDF, Laminates etc. which are internationally accepted. Further with great pursuance of the President and Senior Executive members of FIPPI we are highlighting and representing the crucial issues confronting the Plywood & Panel Industry. FIPPI also publishes quarterly Journal Indian Wood & Allied Products highlighting the development taking place in India and abroad, market profile, world timber market report, statistics, international exhibition and conferences, articles, write-ups etc.

FIPPI is cordially inviting all plywood / panel / bamboo / Laminates and other allied products manufacturers to become active member for the strengthening the platform of FIPPI and working for the development of the industry which is Internationally recognized by ITTO, FAO, European Union, IWPA, BIS, MoEFCC, Ministry of Commerce & Industry, BIS, FICCI, CII and other renowned Organizations.

FEDERATION OF INDIAN PLYWOOD & PANEL INDUSTRY (FIPPI)

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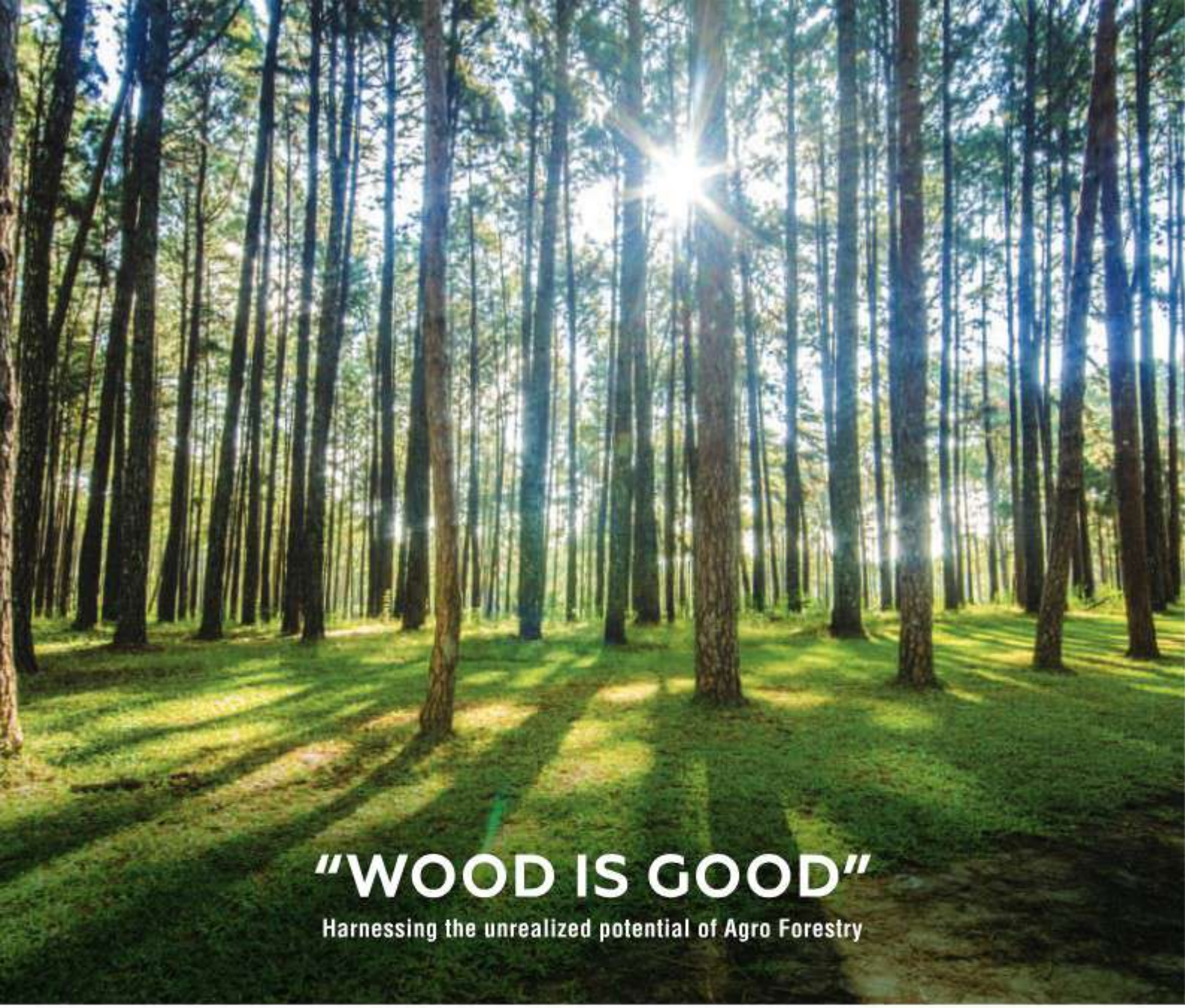

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AIPM
ASSOCIATION OF INDIAN PANEL BOARD MANUFACTURERS

THE INDIAN ACADEMY OF WOOD SCIENCE

Working Office: Institute of Wood Science & Technology Campus,
P.O. Malleswaram, Bengaluru-560 003 (India)
E-Mail: iaws.india@yahoo.com Website: http://www.iaws.org.in

The Indian Academy of Wood Science was founded in 1968 to advance the knowledge of wood science & technology and covers in its activities all the aspects related to wood, cellulose and their products such as logging, saw milling, wood working, plywood, fibre boards, particle boards, improved and composite woods, cellulose and cellulose based sciences and industries and allied fields. The Academy runs a Journal called "Journal of the Indian Academy of Wood Science". In addition to this, it also organises seminars and workshops. During some annual meetings, lectures from eminent scientists are also arranged. The Academy has joined hands with Springer, an internationally reputed publishing house, for bringing out the journal fully online for wider international readership. Authors may submit the manuscript of their research papers online following the Springer publication link http://www.editorialmanager.com/jiaw

APPLICATION FOR MEMBERSHIP

To,

The General Secretary
Indian Academy of Wood Science
Institute of Wood Science & Technology Campus
P.O. Malleswaram, Bangalore-560 003 (India)

Sir,

I wish to become a member of the Indian Academy of Wood Science and give below the necessary particulars for enrolling as "Corporate Member/Institutional Member/Individual Member" (as the case may be). Necessary remittance of Rs.* ..... is made by a Demand Draft/Cash, which may please be acknowledged. I agree to abide by the constitution of the academy and agree to the code of ethics contained therein.

Place: ..... (Signature of the Applicant)

Date: .....

1. Name of applicant in full (in block capitals)	
2. (a) Date of Birth, (b) Age (in case of individuals only)	
3. Academic and professional qualifications (in case of individuals only)	
4. Present employment/how engaged and brief history of previous career in case of individuals (separate sheet may be attached, if necessary)	
5. Brief description of general activities in case of Corporate, Institutional Members	
6. Address to which communications should be sent including phone, fax & e-mail	

* *Demand Draft should be drawn in favour of 'Indian Academy of Wood Science' and payable at Bangalore.*

Membership Type	Annual Fee	Life Time Fee
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Institutional	Rs. 2,000	N.A.
Individual	Rs. 500	Rs. 5,000
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Institutional	US $ 50	N.A.
Individual	US $ 20	US $ 200

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