IWST

ICFRE

wood *is* good

GROW MORE, USE MORE

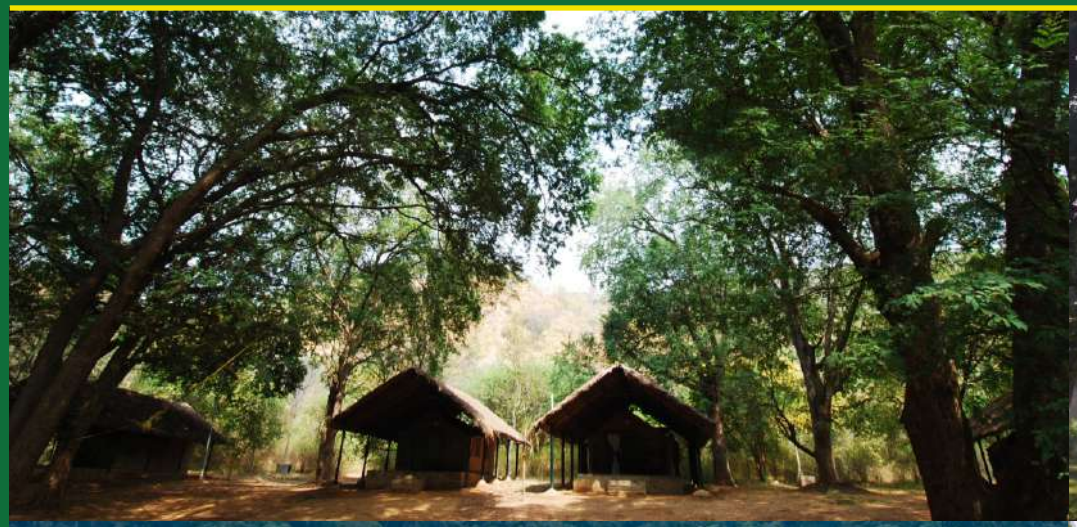
Vol 1 . Issue 1 . April -June 2020

INSTITUTE OF WOOD SCIENCE AND TECHNOLOGY, BENGALURU

Indian Council of Forestry Research and Education

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

EXPERIENCE NATURE IN KARNATAKA!




RESORTS: JLR Kings Santuary Nagarhole * Bandipur Safari Lodge • Bannerghatta Nature Camp • Bheemeshwari Nature & Adventure Camp • Bhimgad Adventure Camp • Blackbuck Resort • Devbagh Beach Resort • Dubare Elephant Camp • Galibore Nature Camp • Hampi Heritage & Wilderness Resort • K Gudi Wilderness Camp • Kabini River Lodge • Kali Adventure Camp • The Old Magazine House • OM Beach Resort • Phalguni River Lodge • River Tern Lodge • Sadashivagad Sea View Resort - Karwar • Sharavathi Adventure Camp

JUNGLE CAMPS: Anejhari Butterfly Camp • Bhagawathi Nature Camp • Sakrebyle Elephant Camp • Seethanadi Nature Camp • Belagavi Nature Camp

Jungle Lodges & Resorts Ltd., No. 49, West Wing, Ground Floor, Khanija Bhavan, Race Course Road, Bangalore - 560001 T: +91 80 40554055
www.junglelodges.com • www.jlrexplore.com

JUNGLE LODGES & RESORTS

wood *is* good

GROW MORE, USE MORE

Submissions for publication of articles & advertisements may be made to extension_iwst@icfre.org

A lifelong touch of endurance

With footprints in national as well as international shores, Greenply Industries Limited is one of the nation's leading interior infrastructure companies, with a wide range of products like plywood, blockboards, flush doors, decorative veneers and PVC products to match every aspiration. We also offer lifetime warranty on all our premium offerings.

We are an ever-growing family of industrious individuals and concern for environmental welfare lies at the heart of all our endeavours. Our journey has always been towards sustainability and good health. This is why we ensure the products we offer, conform to negligible formaldehyde emissions, offering safe and clean indoor air quality. We hope to add to our already diverse portfolio of E-0 grade products in the days to come. After all, everyone deserves a wholesome living space.

PLYWOOD | BLOCKBOARD | DOORS | VENEERS | PVC/WPC BOARDS & uPVC DOORS

Toll Free No.: 1800 103 4050

INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION

(An Autonomous Council of Ministry of Environment Forest and Climate Change, Government of India)

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 :
Assistant Director General, Media & Extension Division,
Indian Council of Forestry Research and Education,
Dehradun - 248 006
Phone:- +91-135-222 4814, +91-135- 2755221,

मंत्री
पर्यावरण, वन एवं जलवायु परिवर्तन,
सूचना एवं प्रसारण और
भारी उद्योग एवं लोक उद्यम
भारत सरकार

MINISTER
ENVIRONMENT, FOREST & CLIMATE CHANGE,
INFORMATION & BROADCASTING AND
HEAVY INDUSTRIES & PUBLIC ENTERPRISES
GOVERNMENT OF INDIA

सत्यमेव जयते

स्वच्छ भारत
एक कदम स्वच्छता की ओर

प्रकाश जावडेकर
Prakash Javadekar

FOREWORD

Wood, with its unparalleled versatility, is a fabulous gift of nature. Having a wide range of applications, it has played an important role in the progress of human civilization. In the current scenario of global climate change, unlike any other non-renewable material, wood can be sustainably produced, processed and converted into a range of products with minimum carbon footprints. Lower embodied energy, carbon locking, carbon sequestration, renewable and biodegradability are some of the characters that are of immense value in combating climate change. Enhancing use of wood has been advocated as one of the effective strategies in climate change mitigations.

Recognizing the importance of wood as a sustainable material, wood science research has gone transformational change globally from being focused on primary wood processing to the development of new biomaterials, advanced engineering composites, novel packaging, nanotechnology, innovation based manufacturing, bio-energy, lignocellulosic conversion to high value products and life-cycle analysis. The wood science research in the country also need to be aligned in-line with the developments in other parts of the world to equip the wood based industries and develop new products based on the requirements.

India, as part of its contribution to the global fight against climate change, has committed itself to creating an "additional carbon sink of 2.5 to 3 billion tonnes of carbon dioxide equivalent" by the year 2030. This should also provide an opportunity for the farmers to double their agricultural income by growing more trees along with traditional agriculture practices. The Government of India is working as per slogan 'Plant Tree, Grow Tree and Use Tree', to generate livelihood and economic activity in the sector while meeting the international commitment towards mitigating climate change.

पर्यावरण भवन, जोर बाग रोड़, नई दिल्ली-110 003 फोन : 011-24695136, 24695132, फैक्स : 011-24695329
Paryavaran Bhawan, Jor Bagh Road, New Delhi-110 003,Tel. : 011-24695136, 24695132, Fax : 011-24695329
ई-मेल/E-mail : minister-efcc@gov.in

Institute of Wood Science and Technology, Bengaluru (an institute under the Indian Council of Forestry Research and Education) has been continuously striving to study the adoption of emerging technologies and rational utilisation of wood and wood based materials. The institute is launching the all new quarterly publication **"Wood is Good: Grow More, Use More"** to curate, voice and share wood based technologies, success stories, industry perspective and emerging trends. One of the aims of this initiative is to create a wood science expert forum (a pool of human resource in wood science and technology) and to initiate an awareness campaign about adoption of emerging technologies and rational utilization of wood based materials. This will also provide a platform to researchers, industry professionals, consumers and other stakeholders to express their perspectives. Currently, this publication is quarterly but hope the institute will have it monthly very soon.

Date: 21.07.2020

(Prakash Javadekar)

CONTENT

01 About the Institute

Activities during April-June 2020 04

Popular articles

07 M.P. Singh
Reviving wood based industries

C.N. Pandey and Sumit Roy
Plywood and panel industry in India: Current scenario and key issues 15

19 Prakash V.
Importance of Indigenous tree species *Melia dubia*

Anuj Divanji
Use of modified wood in India 21

23 Prahallada K.N.
Relevance of skill based training in woodworking technology

Apoorva Lakshmi R.
Journey of wood in Indian architecture and construction: Past, Present and Future 27

33 M.P. Singh,
Shakti Singh Chauhan, Ritesh D. Ram
Wood based multi-story buildings

Jikesh Thakkar
Raw material options
A challenge to panel boards industry 41

43 S.K. Sharma
Simarouba glauca "Lakshmitaru":
A multipurpose tree

Aditya Kumar, Nitin Kulkarni
Status of popular-based agroforestry in North Bihar and challenges 47

53 H.D. Kulkarni
Agroforestry for wood based industry: A new proposal


VANA VIGNAN

About the **INSTITUTE**

The Government of Mysore had set up a Forest Research Laboratory (FRL) at Bangalore in 1938. In the initial years, work was carried out mainly on properties and uses of different timber species, essential oils, other non-wood forest products and protection of wood and trees from pests and diseases. In 1956, this laboratory was organised as a regional centre of Forest Research Institute and Colleges, Dehra Dun. In 1977, Sandal Research Centre was set up to undertake research on wide-ranging aspects of genetics, silviculture and management of sandal, a valuable tree well distributed all over Southern India. In 1977, the marine centres of Wood Preservation Branch, Forest Research Institutes & Colleges, Dehra Dun functioning at Vishakhapatnam, Madras, Goa and Kochi were transferred to Forest Research Laboratory, Bangalore.

In 1988, forestry research in India was reorganised with setting up of the Indian Council of Forestry Research and Education (ICFRE) and the Forest Research Laboratory was upgraded and named as Institute of Wood Science and Technology (IWST) merging Sandal Research Centre and Minor Forest Products Unit functioning in the same campus, with it. The Institute is mandated to conduct research on wood science and technology as a national objective and focuses its research problems to important forestry research needs at a regional level. Taking into consideration, the expertise available and contributions made by the Institute, the ICFRE has now recognised the Institute as Centres of Advanced Studies in the areas of (a) Improved utilisation of wood and (b) Research on sandal.

The Institute mainly aims to develop strategies for sustainable use and production of wood and wood products. In addition to this, the Institute has Advanced Woodworking Training Center (AWTC) in its premises. It was established as a joint venture between Institute of Wood Science & Technology (IWST), Italian Trade Commission (ICE) and Italian Woodworking Machines and Tools Manufacturers Association (ACIMALL). The training Centre is presently being run by IWST and is first of its kind in India, which aims to enhance the skill in the area of woodworking to attain global competitiveness by using state of the art machineries.

Vision of IWST

To be a global leader in Wood Science and Technology.

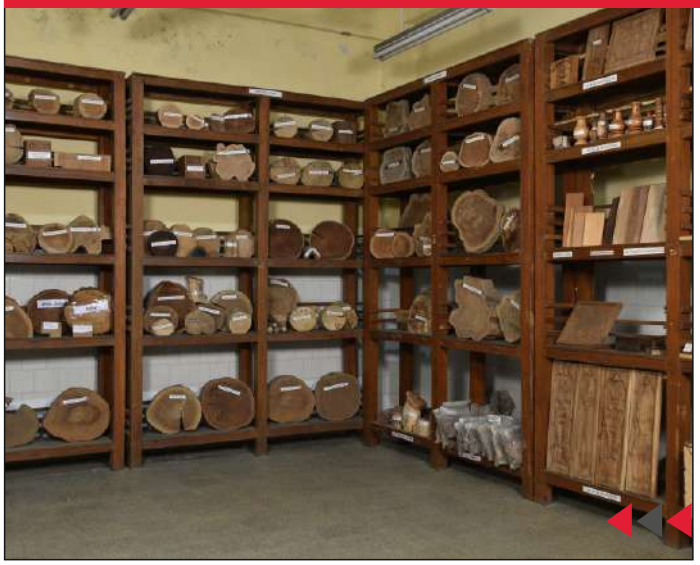
Mission of IWST

Advancing scientific knowledge and developing innovative technologies for promoting wood as a sustainable material contributing towards climate change mitigation and biodiversity conservation.

Research DIVISIONS

- Wood Properties and Uses Division
- Wood Processing Division
- Forest Protection Division
- Silviculture and Forest Management Division
- Extension Division
- Facilities and Services Division

Wood Properties & Uses Division



The division is working on creation of database on anatomical, physical and mechanical properties of plantation grown timbers including bamboo for their improved utilisation, value-addition and their recommendation for various end uses. The division is also working on wood modification (thermal and chemical), nano-wood composites, wood coatings, transparent wood, bamboo lumber and non-destructive testing.

Wood Processing Division

The division strives to increase service life of wood, wood based products and develop efficient wood processing technologies. The division looks into drying behaviour of plantation timbers, assessment of wood quality parameters, preservative treatment of wood and developing eco-friendly wood preservatives. The division has been engaged in research and development of wood polymer composites by blending lingo-cellulosic fibres and thermoplastics

Forest Protection Division

The division works with multifaceted specialization on Forest Entomology and Forest Pathology, responsible in covering all the aspects of insects and diseases, their integrated management (the prime intention to adopt IPM/IDM is to avoid economic loss for a sustainable production and prevention of adverse effects of chemicals to the environment) with ultimate goal of tree and timber protection thereby maintaining the health of trees and conservation of natural forest ecosystem.

Silviculture & Forest Management Division

The division has the goal of enhancing productivity by improving the quality of planting stock and conservation of germplasm of economically important species. The division has developed modern nursery practices and macro/micro-propagation protocols for the high value tree species and bamboo species. Molecular marker based species identity through barcoding and assessing fidelity of micro-propagated plants has been established. The division also works on capacity building in sandalwood cultivation, nursery techniques and bamboo propagation and management

Extension Division

The division liaison with stake holders such as state forest departments, corporations, wood and wood based industries, farmers and other end users for dissemination of research findings. The division is regularly organising trainings / seminars / workshops / stakeholder meetings for the benefit of end users. An Advanced Woodworking Training Centre provide trainings to enhance the skill in the area of woodworking to attain global competitiveness by using state of the art machineries

Facilities & Services Division

The division is responsible for infrastructure development and resource maintenance in the institute and provides general facilities like library, information technology support, etc. to the divisions.

Activities

during April-June, 2020

World Bio-diversity Day

Institute of Wood Science and Technology celebrated World Biodiversity Day on 22nd May 2020 to promote and raise global awareness on issues related to biodiversity. The theme for the current year was "Our Solutions are in Nature". The theme emphasises the importance of working together at all levels to build a future of life in harmony with nature. The officers and scientists of the institute participated through virtual meeting in which Director, IWST addressed the meeting and highlighted various issues related to biodiversity.

Inuagration of Growth Chamber in Tissue Culture Laboratory

Shri. Sanjai Mohan, Pricnipal Chief Conservator of Forests (PCCF) and Head of Forest Force, (HOFF), Karnataka Forest Department inaugrated the extended growth chamber under BTSG-ICFRE programme for strengthening the tissue culture laboratory of the institute on 6th June 2020. The PCCF also addressed the officers and Scientists of the institute and emphasised on the colloborative work between IWST and the forest department

World Environment Day

The institute joined celebration of World Environment Day on 5th June 2020 through video conferencing which was chaired by Sri. Prakash Javadekar, Hon'ble Minister of Environment, Forest and Climate Change. The honourable minister emphasized on urban forestry and asked all the citizens to not only plant tree but also to take care of it after planting. He said that our lifestyle is inextricably linked with nature, and trees and all species are a part of our life. We have forests in rural areas but not much in urban areas. Therefore, we have introduced the scheme of urban forests. In cities, there are gardens but not forests. We have to create forests so we decided to launch an urban forest programme in 200 corporation cities of India. We will fund it to some extent to compound it and to carry out minimum services there, Javadekar said at the virtual celebration of World Environment Day 2020. The Minister of State, Shri. Babul Supriyo also addressed the

participants in same meeting through video conferencing. He also said these trying times can be overcome if everyone understood their responsibility towards nature.

The institute also celebrated the Environment Day in its campus through virtual platform (WebEx) with theme "Biodiversity Conservation & Climate Change Mitigation ". A number of Talks were delivered on Wood is Good: Grow More, Use More. The prominent speakers were Dr. M.P. Singh, Director, IWST, Dr. N.C. Saha, Former Director, Indian Institute of Packaging, Mumbai, Dr. A.K. Handa, Principal Scientist, ICAR- CARI, Jhansi, Sri. Naval Kedia, Director, President, Federation of All India Timber Merchants Saw Millers & Allied Industries, Kolkata, Dr. Sanjeev Kumar Chauhan, Professor, PAU, Ludhiana , Dr. S.S. Chauhan, Scientist-G & Head, WP Division, IWST. Around 50 participants from various institutes/ industries/ organisations attended the webinar. Saplings of various species were planted in the campus and IWST Campus Forest Biodiversity Assessment was undertaken. As part of awareness a map of IWST Biodiversity was prepared and displayed. Further, tree species in the IWST campus were identified and named.

Annual General Meeting of ICFRE

The XXVI Annual General Meeting of ICFRE Society was held at MoEF&CC New Delhi through Video Conference on 27th April 2020. Dr. M. P. Singh, Director IWST participated in the meeting. The meeting was chaired by Shri. Prakash Javadekar, Minister of Environment, Forests and Climate Change. The hon'ble minister emphasized to bring more innovation and research from lab to land. He also stressed that forestry research should ensure improvement of quality of forest, benefit farmers and help promote and help promote agro forestry.

All India Coordinated Research Projects (AICRP) Review Meeting

The Director and Principal Investigators of various ongoing research projects participated in discussion with DDG (Research), ICFRE Dehra dun on progress of All India Coordinated Research Projects (AICRP) which are being implemented under CAMPA scheme

Meeting with Canadian Wood, India

A meeting between representatives of Canadian Wood, India and the Scientists of wood science group along with Director, IWST was held on 19th May 2020 to discuss the various issues related to construction of mass timber building (pre-phase) at IWST campus. Same day, the team also visited a few places in Bengaluru where timber buildings are already existing with the help of Canadian wood.

A Webinar on “Wood in Structural Use (II)-Building Techniques” was attended by the Director and Scientists working in wood science area on 25th June 2020. The main emphasis in the webinar was on the use of wood in building mass timber buildings in India. Director, IWST expressed his views on working together to build such structures as multi-storeyed building at IWST campus using mass timbers for demonstration purpose.

Reviving
wood based industries

M.P. Singh
Director- Institute of Wood Science and Technology & Indian Plywood Industries Research & Training Institute, Bengaluru
Email: dir_iwst@icfre.org

Wood is Good – A renewable natural resource and a most important commodity, has various uses in building (housing) construction, scaffolding, Railway sleepers, Railway coaches, Ship building, Truck body building, Bullock carts, Plywood and veneers, Fiberboards & Particleboard, MDF, Pulp, Paper and Paperboard, News print, Packing cases, Handicrafts, Bobbins-shutters and Textile, Matches and Splints, Sports goods, Furniture, Pit props for Mining, Electricity poles, Agricultural implements, Fuelwood, Energy production, Charcoal, Biochar, Wood chemicals, miscellaneous - Shoe lasts, Katha, Cooperage, Pencils, Cork, Agarbathi sticks, Chopsticks, Tooth peck, etc. wood based products. However, wood being in short supply, National Forest Policy, 1988 envisaged to relieve the existing pressure on forests for the demands of railway sleepers, construction industry (particularly in the public-sector), furniture and paneling, mine-pit props, paper and paper board etc. substitution of wood needs to be taken recourse to. These substitutions have come in the form of materials, which are non-renewable and having more carbon foot prints. The concept of climate change and life cycle assessments were not in vogue. With holistic understanding of the issue, Government of the day is advocating Plant more, Grow more and Use more.

The main considerations governing the establishment of forest-based industries and supply of raw material to them envisioned in the 1988 policy were as follows:

- As far as possible, a forest-based industry should raise the raw material needed for meeting its own requirements, preferably by establishment of a direct relationship between the factory and the individuals who can grow the raw material by supporting the individuals with inputs including credit, constant technical advice and finally harvesting and transport services.

- No forest-based enterprise, except that at the village or cottage level, should be permitted in the future unless it has been first cleared after a careful scrutiny with regard to assured availability of raw material. In any case, the fuel, fodder and timber requirements of the local population should not be sacrificed for this purpose.

- Forest-based industries must not only provide employment to local people on priority but also involve them fully in raising trees and raw-material.

- Natural forests serve as a gene pool resource and help to maintain ecological balance. Such forests will not, therefore, be made available to industries for undertaking plantation and for any other activities.

- Farmers, particularly small and marginal farmers, would be encouraged to grow, on marginal / degraded lands available with them, wood species required for industries. These may also be grown along with fuel and fodder species on community lands not required for pasture purposes, and by Forest department/corporations on degraded forests, not earmarked for natural regeneration.

- The practice of supply of forest produce to industry at concessional prices should cease. Industry should be encouraged to use alternative raw materials. Import of wood and wood products should be liberalised.

With above policy guidelines, Forest-based industries, have metamorphosed to become wood based industries in last three decades. Forests are no longer serving the industries or in other words, these industries have charted new path and managed to survive and grow on supply either from agroforestry or by the imports. The Institute of Wood Science and Technology and Indian Plywood Industries Research and Training Institute, Bengaluru organised Industries-Institute meets at Kolkata, Bangalore and Gandhidham to understand the industry perspective during December 2019-March 2020 prior to the outbreak of COVID-19.

Industries-Institute meet held at
Kolkata during
December 2019





Industries-Institute meet held at
Bengaluru during
January 2020


Industries-Institute meet held at Gandhidham during March 2020

These wood based industries also have greater role in Make in India and Aatmnirbhay Bharat. It has been reiterated by one and all that almost 25% dependence on import of wood products can be an opportunity for accelerated growth of this sector.

Outbreak of COVID-19 Pandemic is a challenging issue for the country to maintain a balance of prevention of the spread of virus and economic sustainability. During the lockdown period due to outbreak of the COVID pandemic, a WhatsApp group was created with these wood based industries as partners to further understand their point of view on different issues related to this sector, which are illuminated below:

Augmenting Raw Materials for the industries

The industry needs to be supported in a big way, not only by promoting agroforestry to ensure availability of their wood requirements on a sustainable basis, but also by relaxing/liberalizing the Licensing/Permits requirements for transportation and processing of agroforestry Timber:

The concept of Agmark may be extended on products made from wood from the agriculture lands in India and wood imported from other country under any certified regime. Accordingly, it is imperative to remove the licensing of wood based industries solely dependent on plantation wood like Eucalyptus / Poplar/ Silver Oak/ Rubber wood/ *Melia dubia* etc. and imported wood wherever in India. Most of such industries are in the nature of cottage and small industries. These convert the plantation wood to raw-materials for plywood industry.

The traditional mind-set that the licensing helps check the illegal wood flow from natural and reserved forests is totally irrelevant for wood supply from agroforestry. Removal of licensing will result in more and more veneer mills at the plantation centers and help improve the farmers income which is lost significantly in transport cost and limited demand results in low pricing for the wood given the fact that there is a big gap in demand and supply of wood and this imbalance is only increasing day by day.

E-marketing platform like **TimberCart** may be developed on all India basis to augment raw materials

for the industries. This will also facilitate timely auction of wood from Government Depots, there is deterioration of timber value due to delay in auctioning timber from government forests.

Doubling farmers income through supply of AgriWood produce from agroforestry

Declaring agroforestry produce as Agro-based produce which enjoy all the tax benefits that is derived by agricultural produces.

The concessional rate of Urea for the farmers may be extended to technical grade urea being used in plywood industries as small and medium industries to reduce input cost so as to pass on the maximum benefits to farmers and compliance of low/zero emission of formaldehyde for general health of consumers and compliance with international standards.

However, the concept of minimum and maximum pricing for AgriWood may be invoked to facilitate level playing field for the farmers. There has been artificial crashing of prices of poplars and casurina species in the past. Regulatory Authority or Empowered committee, like Agricultural Prices Commission, comprising of renowned experts from forestry, agriculture, rural economics, administrators, representatives of state governments, wood based industries and farmers may be set up to deal with the issues related to minimum and maximum price for farm grown wood and transparent timber trade.

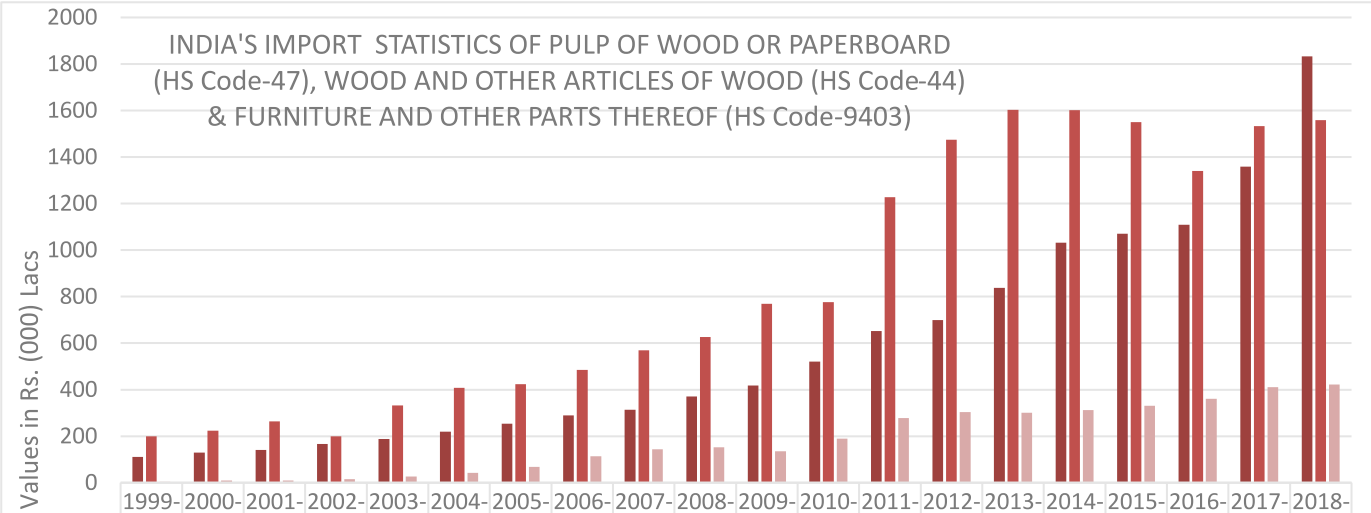
The current provisions related to import of wood and wood based products may be reviewed to discourage import of pulpwood and veneers of such species that can be easily substituted by farm grown, poplars, eucalyptus, casuarina, Melia spp; or other timber trees that our farmers normally grow. **Specified species of durable hardwoods and conifers, that our farmers do not grow, can be permitted to be imported till we find a sustainable way to meet up our demands domestically.**

Duty structure in the case of furniture and timber

On the issue of an apparent inverted duty structure existing in the case of furniture and its associated raw-material, timber, it is to be submitted that higher import duty for semi-finished or finished wood products will generate demand for locally made wood products. This will in-turn generate better market for wood from the farmers' agricultural lands thereby helping in Make-In-India programme and Doubling **Farmers income scheme of the Government.**

India is presently deficient in timber production and the timber demand is met by the import and trees grown outside forest areas mainly through agroforestry. The major species imported in the country are mainly pine and teak which are not grown in the agroforestry system and are not available from forests harvesting. The species grown in agroforestry systems are mainly used by plywood, particle board and fiber boards. In order to have the continuous supply of raw material, it is proposed that import of wood in the log form should be continued without any change in the present import duty.

Wood is also imported in the sawn form which is the first fundamental processing step. The saw milling industry in the country primarily depends on imported logs. It is necessary to increase the import duty for



	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
47	110.5	128.9	140.5	166.1	188.0	219.9	253.7	289.2	313.2	370.6	417.7	520.7	652.4	699.0	837.8	1,032	1,069	1,108	1,359	1,832
44	199.4	224.3	263.0	199.4	332.5	407.7	423.0	484.5	568.6	626.3	768.8	776.3	1,227	1,474	1,603	1,602	1,550	1,340	1,533	1,559
9403	4.34	9.14	9.98	15.94	26.65	41.69	67.49	113.9	144.0	152.2	135.8	190.0	278.4	303.9	301.3	312.6	331.3	360.7	410.4	422.5

Table 1. Proposed changes in the import duty

Sl. No.	HS Code	Description	Present Import Duty	Proposed Import Duty
1	4401 to 4404	Wood in log form, roughly squared, fuel-wood, wood charcoal	5%	No change
2	4406 to 4409	Sawn wood exceeding 6mm, sheets, strips, etc.	10%	15-20%
3	4410 to 4421	Particle boards, Oriented Strand Board, Waferboard, fiber board, plywood, laminated wood, packing cases, boxes, crates, cable drums, pallets, casks barrels, assembled flooring panels, joinery and carpentered wood products, table and kitchen wares and other articles of wood	10%	25-30%
4	9403	Furniture	25%	35-40%
5	4701 to 4706	Pulp	5%	15-20%
6	4804	Un-coated craft paper and paper board	10%	25-30%

sawn materials in order to support the local saw milling industry. Therefore, the import duties on sawn timber or lumber and veneers may be increased from present 10% to 15-20% covering HS Code 4406 to 4409.

Further, value addition of sawn logs and production of other finished products should be encouraged in the country as wood based MSME creating employment opportunities in the sector. Therefore, import of wood based processed products including panel products should be discouraged and consequently such products should attract high import duty. This will also avoid dumping of inferior quality wood products in the Indian market. Therefore, it is important to levy higher import duty to 25-30% on items listed 4410 to 4421 to make level playing field for our industrial wood products.

Furniture industry in India is a sunshine sector with huge opportunity for growth and the sector is expected to expand at a Compound Annual Growth Rate (CAGR) of 12.91% during the period of 2020-2024. Factors attributing to the growth of India's furniture market are growing middle-class population, rising disposable income and the increasing number of urban households. Further, impetus is given by growing tourism and hospitality industry in India. The small unorganized local players mostly dominated the furniture market in India. But from the last decade, the Indian furniture market is witnessing an increase in the contribution from organized players like Godrej Interio, Durian, Wipro, Evok, Nilkamal, Century Plyboards India, Urban Ladder and Pepperfry etc. Now the competition has intensified with entry of global players like H&M, Zara, IKEA, Decathlon, etc. There is also high spike in import of furniture where there is no value addition happening in India especially under Free Trade Agreement (FTA). Therefore, it is recommended that furniture (HS code 9403) should be kept under the negative list of Free Trade Agreement and an increase on duty should be done to 35-40%.

Presently, pulp of wood or of other fibrous cellulosic material; recovered (waste and scrap) paper or paperboard is also being encouraged by imposing Custom Duty of only 5% which is equivalent to that of wood logs. This is harming the interests of farmers who are ready to diversify their produce from the farms and raising pulpwood species. This duty should be raised, to provide market for wood produce from the agroforestry in the interest of farmers. agroforestry of eucalyptus, casuarina, bamboos and such species at short rotation suits the requirement of farmers in getting remuneration at smaller intervals. All bamboo forests have been rendered unproductive because of lack of demand. This will boost income of farmers even in rain fed areas. Like agarbatti bamboo sticks, augmentation of raw materials for pulp products from local farmers will not take much time. The value added pulp products like paper and paperboard; articles of paper pulp, of paper or of paperboard and printed books, newspapers, pictures and other products of the printing industry;

manuscripts, typescripts and plans need discouragement for import in order to sustain and promote the Indian industries. Therefore, the custom duty should be enhanced for these products substantially.

Considering all these factors, it is recommended to change the import duty as proposed in table 1 for different products taking into account the processing and value addition involved into different stages. Value addition and product developed has to be encouraged in the country to support the Indian industry which will contribute to the economy and can save substantial foreign exchange.

Issue of imported furniture involving use of harmful chemicals

Many volatile hazardous chemicals are being used in the treatment of wood and making of furniture. These hazardous chemicals pollute the Indoor Air Quality, which is a serious health concern as 90% of our daily time is spent indoors. A large number of studies have associated many of the respiratory, skin and sometimes chronic health problems to being exposed to indoor air toxicity from harmful substance emissions being released from most of our building materials & furniture used for modern interiors. So, it is necessary that we take utmost care in the purchase and utilisation of imported furniture products having harmful & toxic chemical substances.

Harmful volatile emissions of Formaldehyde from plywood & panel products, Vinyl Chloride from PVC products, Vinyl Acetates from PVA & EVA containing products, Epichlorohydrin from Epoxy containing products, Isocyanates from Polyurethane based products, and Styrene from Polystyrene containing products may be considered to be restricted subject to non-conformity of emission norms. Imported furniture products should conform to the Volatile Organic Compounds emission limits specified. The issue of imported furniture involving use of harmful chemical products may be considered for being suitably addressed through the adoption of following technical standards:

Imported furniture products have to carry disclosure certificates of the chemicals used during the manufacturing process and authorized certifications for the following emission parameters of Indoor Air Quality control:

1) Total Volatile Organic Compounds (TVOC) – 500 µg/m^3 [Defined as the total response of VOCs falling in the C6 – C16 range]
2) Formaldehyde Emission Limits – 0.1 mg/m^3 or 0.10ppm
3) Benzene – 1.7 µg/m^3
4) Carbon Monoxide – 7 mg/m^3
5) Naphthalene – 0.01 mg/m^3
6) Nitrogen dioxide – 200 µg/m^3
7) Trichloroethylene – 2.3 µg/m^3
8) Tetrachloroethylene – 0.25 mg/m^3
9) Poly Aromatic Hydrocarbons (PAHs) – 0.12 ng/m^3 [Benzo[a]Pyrene (B[a]P) considered as the single best indicator compound]
10) Vinyl Chloride – 1.0 µg/m^3
11) Isocyanates (All) – 0.07 mg/m^3 [Except Methyl Isocyanate – 0.02 mg/m^3]
12) Epichlorohydrin – 7.5 mg/m^3
13) Vinyl Acetate – 14 mg/m^3
14) Styrene – 70 µg/m^3

Alternatively import of panel products like plywood, particle board, medium density fibre board, etc. and furniture made out these products may comply with minimum E1 (European Norms) or equivalent CARB standards for formaldehyde emissions and total volatile organic compounds (TVOC) within the limit of 500 µg/m^3.

Rationalization of GST and IGST to promote furniture industry

On two counts namely domestic market demand generation and application gradual value-added principle on wood products, GST should be rationalized. These products are from HS code 4401 to 4404 should be with 0% GST without any exception just like agricultural produce. This will support farmers' cause in getting better price for wood from the agroforestry. Further items under HS code from 4406 to 4409 should be levied 5% GST as one step value addition as intermediary product at MSME such as saw mills etc. Items with HS codes from 4410 to 4421 should be levied 12% GST. This will facilitate further value addition as wooden furniture and modular furnishing, generating further employment under MSME sector and import of such furniture and lifestyle items will not be favorable. Thus, there is two pronged strategies, reducing GST on local manufactured furniture and increasing custom duty on imported furniture to augment wooden furniture and furnishing industry in India.

Seasoning and preservative treatment

Seasoning and preservative treatment of sawn timber, plywood and panel products including board, flooring and flush doors meant for use in buildings, residential houses and furniture making etc. should be made mandatory with due safeguards.

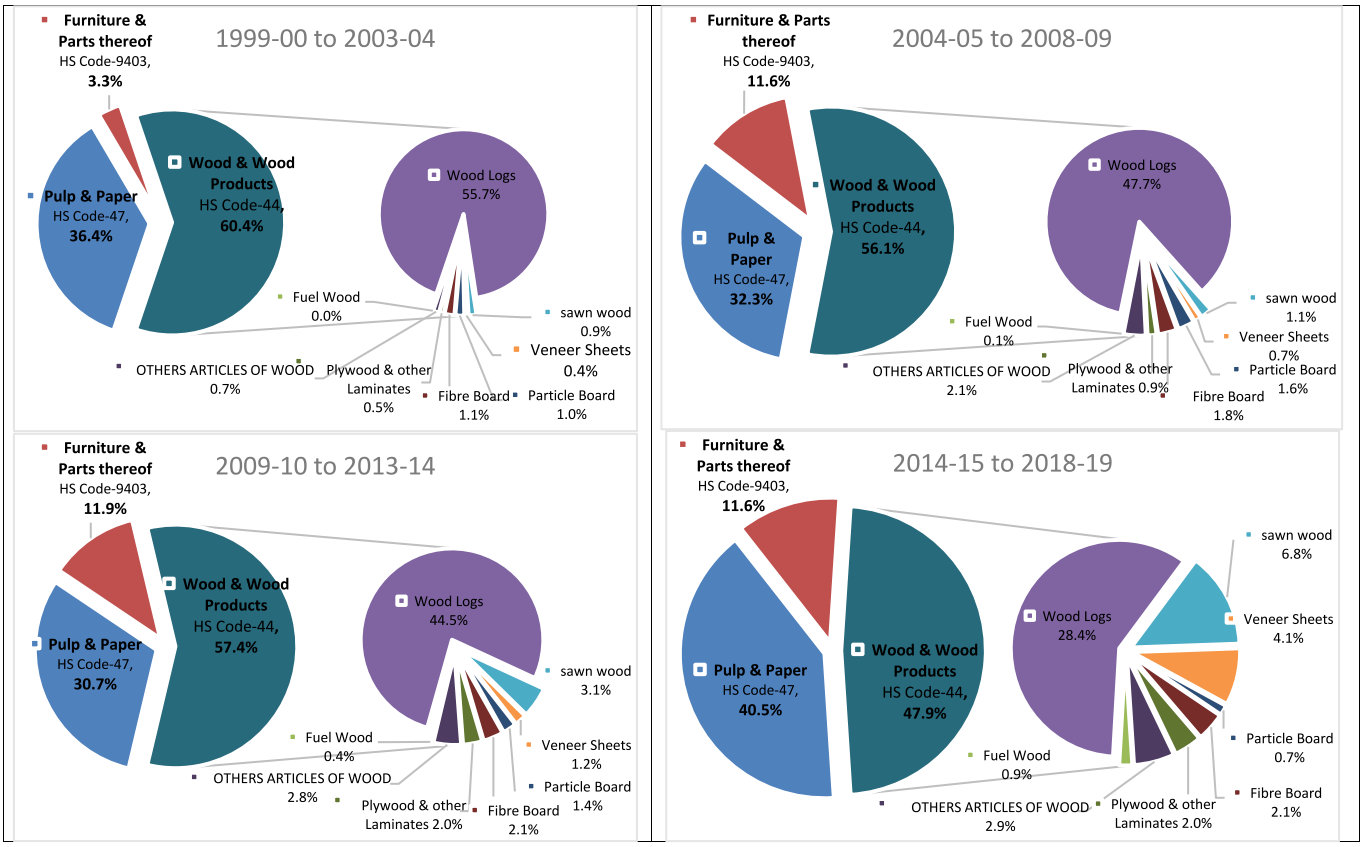


Fig: Percentage share Import of Pulp and Paper, Furniture & Parts thereof and Wood and Wood Products during five years' period.

- Modernization and expansion of capacity of existing factories and establishment of new wood based industries to manufacture high quality international standard products suitably treated to improve their longevity and durability exclusively from farm grown wood should be facilitated and incentivized.
- Suitable regulations and standards should be laid down and institutional framework for quality marking and certification of such products should be put in place. These measures will prevent extensive damage caused to such untreated products by termites, wood borers and fungal pathogens and improve longevity, durability of wood products and their utility as long term carbon sinks. This will also prevent colossal losses suffered every year by the consumers and the nation and save our natural and planted forests indirectly.

Export Promotion:

Give emphasize to promote export of panel products fulfilling the statutory obligation/formalities to be completed in a least possible time, promoting indigenous machinery and technologies and facilitating testing services to ensure to meet the product quality at international level. Strengthening R&D and testing infrastructure including scientific workforce to develop more products and processes using various indigenous ligno-cellulosic materials for self-reliance of the country, promote Make in India and Atma-Nirbhar Bharat Abhiyan (Self-reliant India Mission).

Utilization of agro/crop residues for value addition:

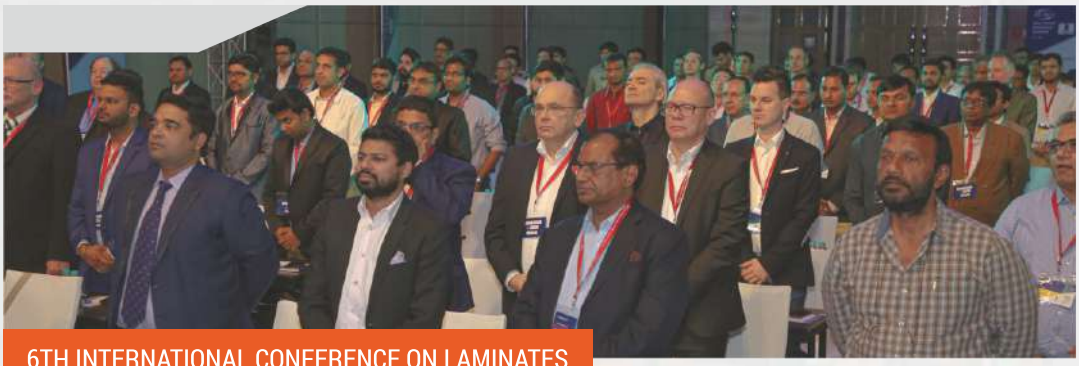
The use of other renewable resources such as agricultural residues (wheat straw, rice straw, etc.) in the production of composite panels (i.e. particleboards, fiberboards) and paper products has recently been considered attractive both from the economic and environmental point of view. The use of straw can by this way help to protect the virgin forests in regions where there is a shortage of wood. In addition, great quantities of straw residues are available today where the burning of straw has been prohibited, and no proper (efficient) uses for these wastes have been found up to day. Special promotion as 0% GST and free inputs and establishment cost subsidies etc. can be explored with a High-Powered Committee.

All this will support revival of this sector in future.

www.ilma.org.in

INDIAN LAMINATE MANUFACTURERS ASSOCIATION

ILMA



6TH INTERNATIONAL CONFERENCE ON LAMINATES

Strength of Unity

Indian Laminate Manufacturers Association (ILMA) is nonprofit making organization of manufacturers of Decorative and Compact laminates or high pressure laminates, Particle Boards, Plywood and Pre-lam (Short Cycle Laminates). It is the only registered association of the laminate industry at national level and we are proud to complete 20years since 1998. More than140 manufacturers of Laminates of India are the registered members of ILMA.

ILMA is a place where companies collaborate to get more opportunities to grow their business. ILMA is a symbol of Indian Laminate Manufacturer's unified commitment to provide seamless & world-class decorative surfaces. ILMA assembles its manufacturers on a unified platform & voices out its fair opinions. It unanimously provides a healthy competition, creating great opportunities by using different strategies and combining the views of the manufacturers.

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)

FOR REGISTRATION
Contact us on +91 9904125666/ +91-79-400 53443
Write to us at ilma@live.in
Join us on Facebook.com/ilma.org.in
Visit our Website www.ilma.org.in

REACH OUT TO US AT
INDIAN LAMINATE MANUFACTURERS ASSOCIATION
Regd. Office:
301, ILMA, Shubham Complex, Nr. Vastrapur Lake, Opp. Sanjeevani Hospital, Vastrapur, Ahmedabad, Gujarat, INDIA 380015.

Plywood and panel industry in India *Current scenario and key issues*

C.N. Pandey

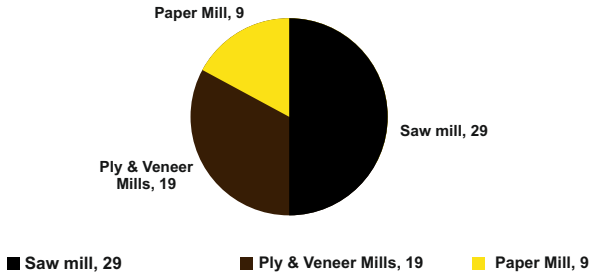
Principal Technical Advisor, FIPPI and Century Plyborads (I) Ltd., New Delhi
Email: cn.pandey@centuryply.com

Sumit Roy

In-charge, R&D and Deco-Veneer Lab, Century Plyboards (I) Ltd., Kolkata

With rapidly developing economy and Government's plan to establish smart cities, besides constructing 50 million houses for poor people in coming five years, production and consumption of plywood is also increasing rapidly. Although in last decade, production and consumption of other alternative/ substitute panel products like Medium Density Fibre Boards (MDF) and Particle Boards (PB), has been growing rapidly, plywood has retained its dominance and constitutes almost 80 to 85% of share in all panel products. These panel products are for mass consumption, used extensively in housing and furniture manufacturing, mostly catering to the lower and middle income segment of the society. Wood panel industry can play a major role in building affordable houses and therefore it is all the more necessary that the cost of production remains low and wherever possible, brought down, to make the products more affordable for common man. Plywood and other panel products manufacturers, mainly use plantation/agroforestry wood, such as Poplar and Eucalyptus in Northern India and Rubber wood and Silver oak in Southern India. These units provide direct employment to more than 1 million people and almost equal number of people are employed indirectly, mainly in rural India.

Saw Mills	**29 million cum**
Ply and Veneer Mills	**19 million cum**
Paper Mill	**9 million cum**
Total	**57 million cum**



Agroforestry and farm forestry have taken deep roots in the country. These Trees outside Forests (ToF) are contributing to the increase in country's tree cover and are enhancing ecosystem services, besides meeting bulk of the country's demand for wood. Most importantly, agroforestry is providing a steady and climate resilient income to the farmers. Thus promoting use of wood obtained from sustainably managed agro-forests and trees would play a significant role in mitigating climate change and ensuring sustainable living. It is worth pointing out here that, realizing the importance of agro-forestry, many states like Punjab, Haryana, Karnataka, Tamil Nadu, Andhra Pradesh, Gujarat, Uttar Pradesh and others States have already initiated massive plantation program.

Production and consumption pattern of industrial wood

The Forest Survey of India (FSI), had in 2017, estimated annual production of timber from agroforestry (trees outside forests) at 74.5 million cum. Besides this, the annual availability of timber from Government forests was estimated at 2.4 to 3 million cum, and another 6 million cum timber was estimated as being imported annually. Thus from the total availability of timber of about 83.5 million cum, only 3 million cum - less than 4% is out of the Government forests. Agroforestry constitutes major source (nearly 90%) of timber required for industrial purposes – Saw Mills, Ply & Veneer Mills and Paper Mills. While timber availability from agroforestry is estimated at 74.5 million cum, as per Indian Council of Forestry Research and Education (ICFRE-2012 report,) the requirement of timber for all industrial purposes has been estimated at only 57 million cum, the break-up of which is as under:

In view of the above facts and figures, it is quite evident that timber produced from agroforestry itself is more than estimated requirement for industrial

purposes. Therefore, the need of the hour is to set up more and more such agroforestry based industries. Product wise distribution of industrial wood consumption is given below.

Plywood and panel industry

Indian Plywood and Panel Industry, as on date, consists of around 3,300 units (small, medium and large units), supporting directly around 1 million livelihoods. Out of these 3,300 units, nearly 3,200 units are in the un-organized sector. Plywood is the most significant product in terms of the overall demand for wood panels and the market size for Indian plywood industry is approx. INR 25,000 crore. In the last five years, the segment witnessed a CAGR of 6-7%. The Indian plywood industry is highly fragmented with ~80% of the market share controlled by the unorganised sector, while the residual 20% is with the organised segment. Moreover, among the few organised players; Century Plyboards India Ltd. and Greenply Industries Ltd. are the two pan India companies which dominate the organised market with a share of nearly 52% (26% each).

Plywood and panel production for last 3 years

Product	Quantity (Million cum)		
	2017	2018	2019
Plywood	8.93	9.50	10
Particle Board, OSB & similar boards	1.07	1.14	1.2
Fibre Board-HDF/MDF	0.89	0.95	1.0

MDF Industry

Presently, industry's installed capacity is estimated at 1.4 million cum while another 0.25 million cum is imported annually. Currently country's production is 1.15 million cum which is 80% of total installed capacity. Indian MDF industry has a market size of nearly 1,600 crores. In the past five years, the industry grew at a CAGR of 20%. Century and Greenply dominate the local MDF plywood market with a share of 26% and 23% of the current MDF capacity. Presently, roughly 30% of the MDF is imported but it is expected that the share of imports will decline to 15% by FY20 as Indian companies ramp up the MDF capacity.

Particle board

There are about 30 particle board units in the country. Except few most of them are in un-organised sector. Plantation timber lops and tops, wood wastes and

Sl. No.	Description	Year	Import (Crores)	Export (Crores)	Import - Export gap (Crores)
1	Plywood, veneered panels and similar laminated wood	2016 -2017	516.09	184.71	331.4
		2017 -2018	718.08	213.02	505.1
		2018 -2019	825.25	226.04	599.2
2	Particle board and similar board of wood & other lignocellulosic materials; agglomerated with resin or other organic binding substitutes	2016 -2017	222.50	23.64	198.9
		2017 -2018	208.15	28.75	179.4
		2018 -2019	280.19	46.82	233.4
3	Fibre board of wood or other lignocellulosic materials w/n bonded with resin/other organic substitutes	2016 -2017	561.02	100.78	460.2
		2017 -2018	778.53	117.80	660.7
		2018 -2019	793.15	157.64	635.5
4	Other furniture and parts thereof	2016 -2017	3,607.91	3,865.18	257.3
		2017 -2018	4,104.04	4,424.05	320.0
		2018 -2019	4,225.03	5,647.03	1422.0
5	Wood sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end jointed	2016 -2017	1,805.55	119.42	1686.1
		2017 -2018	2,615.18	50.42	2564.8
		2018 -2019	3,092.05	33.47	3058.6
6	Wood in the rough, whether or not stripped of bark or sapwood, or roughly squared	2016 -2017	7,801.00	300.59	7500.4
		2017 -2018	8,314.77	275.05	8039.7
		2018 -2019	7,631.48	630.14	7001.3
Grand total (1+2+3+4+5+6)		**2016-2019**	**48099.9**	**16444.6**	**31655.4**

Source : DGCIS - Kolkata

agro residue are the basic raw material used by the sector. Very few industry manufacture the products as per BIS quality norms. These industry produce nearly 1 million cubic meter boards in different thicknesses. To meet the gap between demand and supply we import nearly 0.160 million cubic meter particle board.

It can be seen that the share of imports in total turnover is still quite high, more so in PB and MDF. This is because imported panel products are available at a cheaper rate than locally manufactured PB and MDF. With increasing thrust on agro-forestry, wood availability for manufacturing these products will increase and more units for manufacturing panel products can easily come up in the country.

If encouraged properly, the demand and production of panel products will increase at a much faster pace, which in turn will increase the demand for agro-forestry wood. The entire chain – farmers involved in agroforestry, workers employed in mfg. units, common man – who is the main consumer – housing and furniture products, and the governments who can earn higher revenues on increased production, save foreign exchange due to reduction in imports, earn foreign exchange due to increase in exports. Everyone single person/entity in the chain gets benefits. However, all this can be achieved only and only if the cost of these panel products to the end consumer, is somehow reduced, without affecting any stake holder in the chain. All this will be possible by bringing direct and indirect taxes to zero and declaring agro-forestry produce as Agro-based produce which enjoy all the tax benefits that is derived by agricultural produces.

Key issues

The industry needs to be supported in a big way, not only by promoting agroforestry to ensure availability of their wood requirements on a sustainable basis, but also by relaxing/liberalizing the licensing/permits requirements for transportation and processing of agro-forestry timber. It is therefore suggested that Government should address the following key policy issue for the further development and future growth of this sector.

- Remove the licensing of wood based industries solely dependent on plantation wood like Eucalyptus/Poplar/Silver oak/Rubber wood/*Melia dubia* etc. and imported wood wherever in India. Most of such industries are in the nature of cottage and small industries. These convert the plantation wood to raw-materials for plywood industry. The traditional mind-set that the licensing helps check the illegal wood flow from natural and reserved forests is totally absurd and illogical. Plantation wood is less than half the price of any natural forest structural wood and totally non-competitive in the changed scenario of wood based industry. Removal of licensing will result in more and more veneer mills at the plantation centers and help improve the farmers income which is lost significantly in transport cost and limited demand results in low pricing for the wood given the fact that there is a big gap in demand and supply of wood and this imbalance is only increasing day by day.

- Arbitrary phytosanitary requirement on timber import should be rationalised. Several representations are pending without any outcome. There is a Schedule-III in P&Q Order 2003 which deals with prohibited timber. There are two schedules VI and VII permitting import under specified conditions. The sacrosanct condition is Methyl Bromide fumigation (MB) before export. Most countries have banned it. There is a 5 times penalty on those who import timber with other fumigants approved in the country of export besides re-fumigation in India. Request is to allow any and all wood which is not on Schedule III by condition of MB fumigation in India without any penalty. Much good and competitive wood cannot be imported because of harsh conditions in P&Q Order 2003.

- Setting aside part of the forest area for commercial high jurisdiction forestry besides giving tax incentives for capital investment in farm forestry.

- Bringing direct and indirect taxes to zero. Declaring agro-forestry produce as Agro-based produce which enjoy all the tax benefits that is derived by agricultural produces.

- Nationalisation of felling and transit permit regime.

Federation of All India Timber Merchants, Saw Millers & Allied Industries

Head Office: Federation of Karnataka Timber Merchants & Saw Millees, White Pearl, Flat 201, Bangalore 560026.

e-mail: contact@timberfederation.in

Website: www.timberfederation.in

Sri Naval Kedia, President
e-mail: naval@costaawoods.com
Mob: 9830200497

Sri D Ramakrishna, Hon. Secretary
e-mail: dwararamakrishna@gmail.com
Mob: 9440176081

Zonal Offices:

East: "Diamond Prestige", Room No. 409, 41A,
AJC Bose Road, Kolkata - 700017 (WB).
033 - 22640073 / 74

West: "Timber Bhawan", Room No. 409, Plot No. 47,
Sector 8, Gandhidham, Kutch - 370201 (Gujarat).
02836 230676

North: C/O Mahalaxmi Lumbers Pvt. Ltd, 1/57A,
WHS Timber Market, Kirti Nagar, New Delhi-110015.
011 - 41009111

South: Timber Yard, Aryapuram, Rajahmundry - 533101
Andhra Pradesh.
0883 - 2464949

Central: C/O United Timbers, New Timber Market, Fafadih,
Raipur - 492009.
8770862991

Importance of

Indigenous tree

species Melia dubia

Prakash V.

Indian Plywood Industries Research & Training Institute, Post Bag No. 2273, Tumkur Road, P.O. Yeshwanthpur, Bengaluru - 560 022
Email: prakashv@ipirti.gov.in

Availability of raw materials and suitability of available raw material to produce a particular product is the key to successfully establish and run any wood based industry. Process parameters needs to be worked out for individual tree species to optimally produce any particular product from them before considering it as raw material for wood based industries. Most of the wood industries depends on the local timbers for their raw material as the demand can be met by taking up plantations through agroforestry and farmforestry in collaboration with local farmers through buy back scheme/agreements etc. Every timber species may not be suitable for producing panel products from them, a detailed study needs to be undertaken before concluding on the suitability of any particular species for producing a specific product from them. *Melia dubia* an indigenous tree species grown in southern India is one such species which is proving to be a promising raw material source for plywood industry. It is known for its fast growing characteristic and its geometry is an added advantage for veneer based industries such as Plywood and Laminated Veneer Lumber etc. It is also suitable for producing face quality veneers which are mainly produced by Gurjun in the current scenario. It involves low cost for setting up and maintaining a plantation of this species and a variety of intercrop can be grown for first two years which supports the farmer's income. As this species is drawing the attention of farmers, few private nursery growers are misleading the farmers by misguiding them with a numerous incorrect information like this particular species can be harvested at the age of 4 to 5 years and the density of plantations can be as high as 1000 trees per acre etc. Survey has shown that a *Melia dubia* plantation with spacing 20 X 20 feet is ideal when the timber is targeted for harvesting at a shorter rotation period aimed at veneering. High density plantations may take a relatively longer time to attain good girth to consider it to be suitable extensively for veneering but in case the spacing during plantation is 5X5 feet, every second row may be harvested after 4 years and every third row may be harvested after 7 years and the first and the fourth row which is now having 20X20 feet spacing can be harvested after 10 or 12 years, this tree can also be used for producing face veneers. It is the need of the hour to reach farmers through industry interactive meet / information leaflets / pamphlets etc. else farmers may lose interest in indigenous tree species like *Melia dubia* which is a setback to wood based panel industry.

***Melia dubia* plantation with ideal spacing**

***Melia dubia* plantation with high density**

Suitability of *Melia dubia* for wood based panel products

Veneer Peeling from Melia dubia log

Indian Plywood Industries Research and Training Institute (IPIRTI) has optimized the process parameters for producing a wide range of panel products from *Melia dubia*.

Particle Board

Particleboards from lops and tops of *Melia dubia* conforms to IS: 3087, the Indian standard for particleboards.

Laminated Veneer Lumber (LVL) from *Melia dubia* conforms to IS: 14616, the Indian standard for LVL.

Laminated Veneer Lumber

Since this timber is anti-termite by nature, preservative treatment of veneers prior to the manufacture of LVL is not necessary which is an added advantage.

Flush Door and Block Boards

Flush Door and Block Boards – Sawn pieces of *Melia dubia* can be converted in to battens which can be used as core for flush door and block boards.

Medium density fiberboards (MDF) – *Melia dubia* is also suitable for producing MDF which conforms to IS – 12406, the Indian standard for MDF.

M D F

With such a variety of panel products that can be developed from *Melia dubia*, this species can be regarded as the best alternative plantation timber which could help in discouraging timber import and mitigate the scenario of timber shortage for wood based panel industries.

Use of

Modified wood *in India*

Anuj Divanji

Ritikaa Enterprises Pvt. Ltd., 4th Floor, Homeo House, 15th Road, Khar West, Mumbai-400 052
Email: anuj.divanji@ritikaawood.com

In today's scenario, energy efficiency, functional performance and sustainability are the top three considerations for choosing high performance windows/doors apart from basic needs of longevity, reliability and quality. When we talk about high performance windows and doors we mainly focus on energy efficiency, performance, sustainability and enhancing the health and well-being of the occupants.

Back to the future with wood

From an era of industrialization where the use of steel was prominent, to the rise of aluminium over wood and the shift back again to wood; the industry has undergone a gamut of changes. It has been accompanied by the advancements in technology of

windows and doors with modern contemporary times to outstanding designs. Overall, wood has remained to be very popular material, in the 1950 and 1960s. Wood was closely followed by aluminium but lost touch as we demanded a lifestyle change that required performance and functionality. But in today's age and time, with climate controlled homes, urban lifestyles that demand a practical and an aesthetic appeal that led to introducing wood back to the 21st century - but not as we know it... 'Modified Timber', in which a cutting edge technology, enabled it resist rot, retain strength and improve performance helped it stay strong for decades. It is incredible how this well 'acetylated wood' scores completely, to commonly use building materials. This high technology enabled wood has already being applied in commercial, residential projects and other high-end properties.

Why is modified wood necessary in India?

Unmodified wood contains 'free hydroxyl groups' that absorb and release water as weather conditions change. This makes standard wood susceptible to expansion and contraction, particularly when used outdoors for applications such as cladding, window and door frames. The expansion and contraction of wood often leads to splitting and rotting, impacting on the service life of wood. Moreover, wood from well managed sources is a natural, renewable solution for global environmental problems such as climate change, ecosystem destruction and landscape deterioration caused by increasing consumption. Besides forming a natural ecological habitat, forests act as an important carbon sink by filtering CO_2 out of the air and absorbing this in the biomass of the tree and the soil. These act as additional carbon stores while providing the forest the opportunity to regenerate and produce new biomass (acting as new carbon sink).

RitikaaWood timber is modified to its core and acetylation improves the wood's durability, stability and coatings service life. It is therefore ideal for exterior applications such as windows, doors, decking

and even structural projects especially when specialists are looking for an environmentally-friendly alternative to scarce hardwoods. The product is 100% biodegradable and fully recyclable, meeting an increasingly important sustainability agenda for many.

Modified Wood – Acetylation and how does It work?

Acetylation of wood has been studied by scientists around the world since 1920s for more than 90 years. The process alters the cell structure of wood, improving its technical properties and making it much stronger and more durable. Acetylation is an "environmentally friendly" wood modification technique which results in one of the most durable, low maintenance and eco-friendly timber products available, that can withstand the extreme weather.

This method of improving wood has been available to deliver such superior performance that it has been used as the "gold standard" against which the other timber treatments are measured due to its superior and long lasting performance.

The Process

The acetylation process changes the balance of naturally occurring chemicals in wood and abundance of chemical groups in the wood called as free hydroxyls that absorb and release water which make the wood shrink or swell. Acetylation transforms the free hydroxyls into larger stable acetyls which reduces the ability of the wood's cell walls to absorb water. As a result, water is largely precluded from the cell wall which makes the wood durable, weather resistant and stable with many other benefits.

The improved modified properties result from the fact that RitikaaWood timber holds negligible or no moisture. The acetylation process thereby significantly improves the durability, enhances dimensional stability making it a Class 1 Durable, 100% non-toxic timber that doesn't shrink or swell thereby making it more cost effective than other hardwoods and softwoods in the long term.

RitikaaWood has pioneered the 'acetylated timber technology' in India, with industry leading 50 year warranty offered on its timber with exceptional performance by giving peace of mind to homeowners and designers and delivering outstanding performance.

The Spirit of Sustainability

Manufacturing processes associated with wood products require less fossil fuels and are responsible for far less green-house emissions than the manufacture of materials such as plastics, metals and cement. Moreover, non-renewable sources of energy such as plastic and steel come with carbon intensive footprints. RitikaaWood timber on the other hand is sourced from legally, scientifically managed sustainable plantations that are FSC certified. It also provides compiling environmental advantages apart from the performance benefits. The wood is classified as Class I durability in comparison to the other wood species like Teak, Ipe.

RitikaaWood has therefore chosen to partner with Accsys Technologies – suppliers of sustainably sourced modified timber specially treated to warranty a life of 50 years even when used outdoors! Thus, we are helping conserve earth's timber resources whilst maintaining a low carbon footprint. Our products are engineered to last a lifetime in Indian outdoor conditions. With a product warranty of 5 years and a timber warranty of 50 years, a RitikaaWood product need to be bought only once in a lifetime. Such a long life equals lower use of natural resources such as raw materials and energy for processing and transportation.

While design and architecture will keep evolving over time; we believe sustainable designs is the need of the hour more than ever, with designers and architects revisiting traditional materials like wood by stepping back into time with a climate responsive architecture.

Relevance of skill based training in

Woodworking technology

Prahallada K.N.

Biesse Manufacturing Company Pvt. Ltd., No. 469, Jakkasandra Village, Sondekoppa Road, Nelamangala-562 123, Bengaluru Rural District, Karnataka
Email: prahallada.kn@biesse.com

Manufacturing and production have long been the major driving forces for shaping economic growth, development and prosperity of countries worldwide. These activities provide the crux for innovation, competitiveness, productivity, economic spend and mainly skill development. Nations with sound manufacturing base have recorded sustained economic growth and some have evolved as global powers. Invariably this has also led to infrastructure development and thus helped the economies in additional job creation alleviating poverty. Burgeoning economies also support vast services sector complementing the overall growth.

The three agents of change

Educational Institutes have long been the mainstay for imparting education and instilling values in the future generation. Though some Institutes are fast in adapting to the changes, most have to do the catch up act with the tremendous technological progress to strike a fine balance for providing quality education, cutting edge research and potential talent development.

Institutes must shun away complacency and be abreast with the current technological trends in industry and market place to offer courses on par with career aspirations of the students and demanding talent requirements of industries.

Industries are finding it difficult to deploy the new hires directly on the job as they lack the skills for the roles hired right from the word go. In fact, industries are burdened with in-house training programs to train the new hires. Industries must shirk away from complaining of not getting the resources with right skill sets. They can play a positive role working with Institutes to develop and jointly offer skill based training programs. In this regard, some industries have shown significant interest in resources development programs under the ambit of corporate social responsibility.

Government policy making bodies must be more competent with right and timely policy development and implementation. They need to create conducive environment for industries and institutes to work in tandem and facilitate the same through the large network of institutes, bodies and corporations across India. Government of India initiative of Indian Institute of Skills (IISs) for focused education and skill based training is a clear indication of emphasis towards development of highly competent manpower for employability in various industry and high technology sectors. Initiatives like make-in-India and policies like curbing non-essential imports in furniture will give a boost in arm to the fledgling industries and job market.

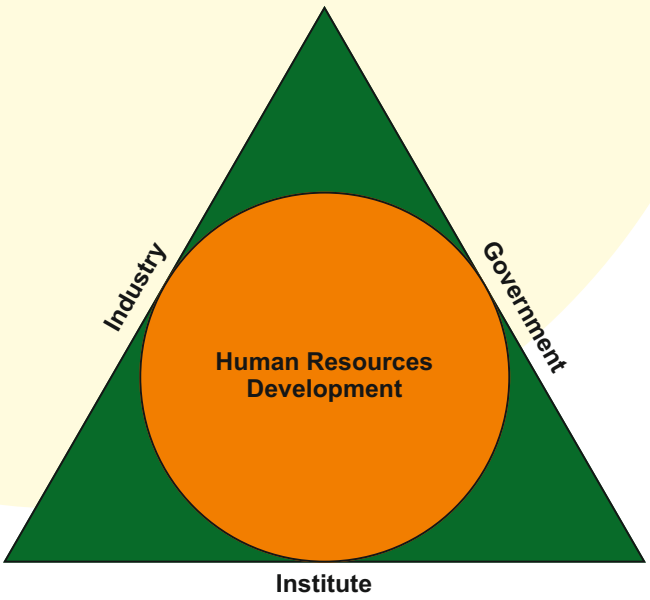
Nodal agencies like National Skill Development Corporation have paved the way with proactive measures along with industry for rationalization of skill development schemes and skills innovation initiative. Policies must seek balance in various industrial sectors in terms of employability and competitive wages mainly in manufacturing industries that can offer large scale employment.

Framework:

In the triad of development, Institutes can be the base to connect Government agencies that form the policy framework with public or private Industries for the technological knowhow and support. The collaborative space thus created can result in developing the human resources with the right combination of education and relevant skill sets to be gainfully employed. The rich harvest of demographic dividend can thus be realized in the large interest of overall development of India. Established institutes with infrastructure can partner with industries for facilities development, design, offer joint training programs and certifications thus spawning Centres of Excellence. This association has proven to be good

model for trained resources development in established and large scale employment sectors like automotive, aerospace, construction, metal manufacturing industries etc. In woodworking sector, this association is yet to take off in a big way though there are few of these in a large country like India.

As woodworking and allied industries embrace the latest technologies, there is a pent up demand for well trained professionals in operations be it in products or services. Operational roles are becoming multi-



dimensional with demand for resources with the right mix of technical and soft skills. Stake-holders viz.: Institutes, Government and Industry have a role in realizing objective of well-trained resources. Training needs are dynamic in nature and keep on evolving with the technology trends. Leveraging on the strength of woodworking institutes in terms of infrastructure and research capabilities, industries can partner in facilities development by equipping and offering expert training by establishing centre of excellence

Training courses too have a shelf life and can stay relevant if they are concurrent. Revisiting the courses being offered and revamping the course structure will become the new norm. This reinforces the collaborative effort from Institutes and Industries under the aegis of favourable policy and business environment from the Government. The onus will be on training the trainer programs in association with industry to stay relevant with the advances in technology. Focussed and relevant training programs which are in-line with industry requirements will gain momentum in the coming years. Trained resources with gainful employment or better capable of generating employment opportunities, will be the need of the hour for overall economic development. It is projected that 11 million human resources will be required in furniture and furnishing sector by 2022 in India. Wooden home furniture being the largest segment, it is a bright prospect on the horizon for industry oriented training programs in woodworking.

Quoting from Late Prof. Clayton Christensen, three classes of factors affect what an organization can or cannot do: its resources, its processes and its values. Resources in form of well-trained people will be the corner stone for 'can do' to happen again and again.

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**
Indian :		
Corporate	N. A.	Rs. 100,000
Institutional	Rs. 2,000	N.A.
Individual	Rs. 500	Rs. 5,000
Foreign :		
Corporate	N. A.	US $ 2,500
Institutional	US $ 50	N.A.
Individual	US $ 20	US $ 200

(To be Photocopied for Use)

INDIAN PLYWOOD INDUSTRIES RESEARCH & TRAINING INSTITUTE (IPIRTI)

(Autonomous Body of Ministry of Environment, Forest and Climate Change, Govt. of India)

Headquarteres in Bangalore with two centres in Kolkata and Mohali. IPIRTI is dedicated to Research & Development, Training, Testing and Extension activities in the field of composites based on wood, bamboo, agrowastes and other renewable natural fibres.

- Established in the year 1962 at Bangalore as a Society
- Accredited to NABL as per ISO/IEC 17025
- Recognized by Bureau of Indian standards (BIS) & associated with evolution of relevant Indian Standards
- Independent apex third party testing laboratory
- Winner of International awards for environmental best practices
- Centre for Bamboo Development (CBD) especially dedicated towards research and training activities related with bamboo

RESEARCH & DEVELOPMENT

- Excellent R & D infrastructure with pilot plant facilities and laboratories
- Research Projects sponsored by national and international bodies viz. FAO, UNDP, IDRC, INBAR, TRADA, AHEC, MoEF&CC, DC(H), BMTPC, NMBA, State Forest Departments, Coir Board, etc.

TRAINING & EDUCATION

- One year PG Diploma course on Wood and Panel Products Technology
- Nodal centre of FRI Deamed University for Ph.D
- Short Term training Courses on Panel Products and Bamboo Composites

CONSULTANCY

- Setting up of panel industries & testing laboratories
- Bamboo based housing systems
- Technology transfer of eco-friendly products
- Panel Industry related problems

TESTING

- NABL accredited mechanical and chemical laboratories
- Plywood, Block Board, Flush door, Panel door, Particle Board, MDF and composites from wood, bamboo and other renewable natural fibres
- Modern testing facility for fire resistance doors
- Synthetic resin adhesives used in panels
- Raw material analysis of chemicals used in resins
- Identification/classification of timbers/binders used in panels
- Retention of preservative chemicals in treated wood/plywood
- Fungal/borer/termite resistance of wood/wood-based products
- Specialized testing such as thermal conductivity, acoustic properties, weathering studies, emission of formaldehyde in panels etc.

For Further Details Contact :

DIRECTOR, IPIRTI, P. B. No. 2273, Tumkur Road, Yeshwanthpur, Bangalore - 560 022,
Ph: Director: +91-080-28394341, Gen: +91-080-28394231-32-33, Fax: +91-080-28396361,
e-mail: director@ipirti.gov.in, contactus@ipirti.gov.in, web : ipirti.gov.in, bamboocomposites.com
Kolkata : 2/2, Biren Roy Road., Sarsuna, Pincode: 700 061, Ph: 033-24983120
Mohali : Plot No. B-65, Phase 7, Indl. Area, Pincode: 160 055, Ph: 0172-5095875

Journey of wood

in Indian architecture and construction: Past, Present and Future

Apoorva Lakshmi R.

B. Arch., MA Psychology, PG Dip Urban Planning & Development, Architect
Anantha Consultants, Bengaluru
Email: ananthaconsultants@gmail.com

Wood as a material has been inherent part of human existence since times immemorial, especially in India. Starting from wood to light fire, to build houses and cities, to build ships & carts and later to Art and Architecture, wood has seen varied applications in Ancient India where it was used sustainably and thus was available for many generations. However, in the current day, we associate wood with furniture as the rest of the applications have found alternative materials to work with.

This drastic change in materiality was brought about by the onset of industrial era and globalization. However, it also seems to stem from lack of available resources to cater to the demands of growing population of the country. It is a well-known fact that the major forest cover of India was depleted during the colonial era as all forests were severely exploited. It is thus that the independent India began its journey with shortage of timber and other forest based resources. This gave rise to using substitutes for wood, most of which are energy intensive and environmentally harmful materials.

PAST: Wood in traditional Indian architecture and construction

The diversity of Indian culture and climate has resulted in varied indigenous construction styles & techniques with wood across India that are now being lost. As the wood availability started reducing and laws were placed against tree-cutting, it became less popular material, almost extinct now. However, there exist numerous examples across India which depict the importance that wood had in the indigenous construction practices. One of the first recorded cities, the mighty Pataliputra was built in wood and was surrounded by timber palisades for protection. The many forts of the country boast of large wooden doors which required elephants and complex contraptions to break into.

In the south of India, the states of Kerala and Tamil Nadu are famous for Palaces and temples built completely with wood, of which Padmanabhapuram palace is the largest wooden palace of Asia. The Chettinad house with elaborate timber pillars serve as the backdrop for many a folklore or movies. The Master Carpenter Perumtachan, who is almost a legend now was known to make miraculously complex wooden structures only to pass on this technical knowledge to the next carpenter worthy of the title Perumtachan. The tribes of Nilgiri hills are known for their wooden toda huts.

Toda hut in Nilgiri Hills

Source : www.reddit.com/r/bizarrebuildings

As we go to the west of India, we see centuries old wooden ship building yards such as Mandvi in Gujarat, one of the few of its kind active till date. Whether in the Pols of Ahmedabad. Bohrwadas of Sidhpur or Wadas of Pune, we can see Chowks and Mohallas with houses built out of Timber frames adorned with beautiful jharokas, pillars, doors and windows all in wood, sometimes ornamented with delicate carvings.

Wooden ship building yard in Mandvi

Further north, the cold mountains of Himachal and Ladakhi region with their deodar forests (tree of God) display a unique earthquake resistant construction practice called the 'Kath-kuni' form of architecture which uses wood and stone in making buildings. The intricately carved timber temples of Kulu valley and Mandi along with the Kashmiri walnut wood carving of handicrafts and doors is now a dying art.

Wood in Ahmedabad pol house

Bohra House of Sidhpur

A house built in Kathkuni style

Kathkuni Technique

Towards the northeast of India, one can see extensive usage of timber mixed with bamboo in the construction techniques of the tribal people still in use today. The wonderful Trukpa woodwork of Arunachal Pradesh, Morungs of each tribe and wooden foundations of the timber houses in hills of northeast states boasts their mastery over timber. The multistory havelis of central India mainly use timber structural framework with wooden trusses, mostly in teak and can be seen in vernacular architecture of the region in places such as Gondia. Wooden wattle and daube wall construction along with usage of bamboo was common among the tribes of central India such as the Baiga. One can see innumerous applications, usages and techniques of woodwork as one explores further into Art, Sculpture and carpentry of India, where wood has been the most widely used material, rivaling only Stone. Sadly, in the wake of urbanization this rich tapestry of wood application across India now lies homogenized as concrete jungles of cities and towns. The variety of traditional practices of art, architecture and sculpture being replaced by almost identical concrete buildings and more recently, glass boxes that lack any character and belie the rich knowledge our country possesses in field of art and architecture. The diverse techniques of wood selection, seasoning, joinery, carving and other techniques we possessed now lie lost to the world and the knowledge that is commonly available now is based solely on western scientific worldview.

PRESENT : Substitutes for wood in architecture and construction

1. Structure : Concrete, Steel and aluminum alloys are a major replacement for wood in modern era. The shift from Load bearing construction to framed structure construction has made RCC a default construction material for any building across any climate. The wooden pillars and beams are replaced with steel/aluminum alloys or RCC and have developed their own aesthetics into modern language of architecture.

2. Façade : The influence of Western movements of architecture such as Brutalism, Minimalism and other –isms still rule the Architect's design processes today. More importantly the international style (of using structural glazing on all facades) is rampant. Thus, instead of well detailed carved wooden walls or brick walls, jaalis and jharokas, that respond to the climate, we now see plain walls of concrete or concrete blocks or the vast stretches of glass walls that turn our buildings into huge energy guzzlers.

3. Faux wood & truth of materials: No matter how popular concrete is, it is clear that people prefer the touch and feel of wood as we have an innate biophilic nature that makes us want to be surrounded with natural materials such as wooden finishes. Sadly, due to the lopsided economy and market of wood in India, we see faux wood gaining a lot of momentum. There are numerous laminates and panels and boards available in such exact imitation of wood finishes that it is almost impossible to detect the truth of the material only by visual cues. These wood finish panels and laminates are economical and hence are extremely popular in the market currently to be used for external facades, interior walls, flooring, gates, false ceilings and so on.

4. Roofing : Traditionally, it was common to use wooden trusses for sloped roofs as well as wooden planks as a base over structural frame to install any other exterior roofing material. In the modern era however, these are replaced with flat RCC slabs irrespective of the necessity of sloped roofs. Where sloped roofs are still in use, they were until recently made with Asbestos or Galvanized Iron (GI sheets) and other metal sheets supported over steel structure. More recently we see even these materials replaced with Galvalume and polycarbonate.

5. Fenestration : This application of wood to makes doors and windows still seems to be popular but slightly more expensive than alternatives due to lack of availability of wood. It is a matter of quality and wealth to be able to still use teak wood doors and windows in a home. Even if all other doors find a replacement, a Hindu house will still have an intricately carved teak wood door for the Puja Room. The other doors and windows tend be made from UPVC in case of residential buildings and aluminum in case of commercial and large scale buildings and iron fabricated for industrial usage. The industry of UPVC and aluminum joinery has become an efficient mass manufacturer making it easy to install windows and doors which only increases their popularity.

FUTURE : Revival of wood application in architecture and construction

All the above mentioned materials that have replaced wood in architecture and construction are highly energy intensive and have huge greenhouse gas emissions through the life cycle of the material. The life cycle costs as well as mitigating costs of unsustainable materials currently used in the construction industry are very high. As the demand for construction is ever increasing due to growing population as well as urbanization, the carbon footprint and GHG emissions are also constantly on the rise. Carbon emissions of construction industry in India accounts to 30% of total CO_2 emission stemming from national economic activities. This depicts the negative impact we have on the environment which leads to climate change. There is dire need to move towards using materials with low carbon footprint for our requirements. The search for alternative construction materials is the talk of all sustainability forums across the globe. Wood is a material that is solution to many of these problems as it is sustainable, helps in carbon sequestration & reduced emissions by acting as a carbon store, has high strength to weight ratio, enables Rapid construction and creates productive occupant environments as a biophilic material.

Rethink construction with wood substitutes: Types of modern wood construction methods

Wood in architecture & construction can be broadly categorized as Lumber Construction, Mass Timber Construction and Other Engineered Wood Products. The following table shows how these wood substitutes can replace elements of construction in comparison to past present.

a) Lumber construction: This is where lumber or sawn timber or logs are used both for structural and non-structural purposes but is limited only to low rise to mid-rise constructions The various construction types using lumber are as follows:

i) Post and beam construction: Sometimes also known as Timber Skelet construction, this method uses sawn timber elements to take load in form of pillars and beams so as to allow for freer configuration of walls and facades. The walls and facades in this method can be executed in T&G (tongue & groove) method which can allow for ease of assembly and disassembly or wall sheathing or be made of glass facades/structural glazing.

Element	Past	Present	Future: Wood is Good, Use more Grow more
		Wood replaced by	Wood substitutes: Mass Timber & Lumber
Columns	Wood logs	RCC or Steel	CLT, GLT, LVL, PSL, Post & Beam method
Beams, Trusses	Sawn wood	RCC or Steel	GLT, LVL, LSL, PSL, Post & Beam method
Walls, Facades	Wood Panels	Brick, Glass, CC blocks, Composite panels	CLT, NLT, OSB, HDF, T&G method in lumber, Light frame method, PSL (interiors)
Floors & Roof	Wood Panels	RCC, Metal sheets	CLT, NLT, DLT, TCC, MPP
Fenestration	Wood Panels	UPVC, Aluminium, Glass	Lumber (with Glass)

ii) Timber frame structure/wood frame structure also known as light frame construction or stud-wall method is where the lightweight frames of wood with cross pieces or studs are sandwiched between gypsum or plasterboard panels or any other variety of panels) with insulation in the frame to compose wall elements in combination with structural frame made in wooden joists. Walls can be either load bearing or stiffening as per design.

iii)Wood over podium method: This is a composite technique where steel or concrete podium or platform is constructed until ground or first floor and upper floors are made in wood frame construction. The podium acts as a fire separator, Insect or pesticide controller as well as load bearing structure.

b) Mass timber construction: Also known as Solid Timber Construction (STC) or massive timber construction, this method uses large section sizes by joining of solid wood together and processed to achieve larger sizes, spans and structural capacities. As mass timber has higher dimensional stability than traditional timber frame systems, it has applications in high rise construction. It uses highly accurate offsite prefabricated machined sections/ components of high quality engineered wood products ready to be installed on-site in dry construction process. The engineered wood panels are generally fixed together with glue/adhesives and with variety of steel connectors. The exposed surfaces of the structure itself acts as a finish thus reducing costs of finishing the interiors but offering extremely aesthetic surfaces. This is the most promising Wood Technology that has potential for Indian market as Mass Timber structural timber elements can replace traditional RCC construction and can highly increase the efficiency, reduce construction times and be even be used for high rise applications. Following are the engineered products which are used in mass timber construction.

i) CLT or X-lam: Cross Laminated Timber is where timber boards are crisscrossed in layers perpendicular to each other and pressure-glued to bind them into a product as strong as steel. CLT finds application as load transferring member such as floors, roof slabs, walls, shear walls & diaphragms, cores as well as shafts.

ii) GLT: Glue Laminated Timber is where wooden boards glued together statistically average knots and natural defects of wood and create high load bearing capabilities. GLT finds application in form of beams, columns, trusses, roof purlins, cantilevers, cross bracings and arches of a structure as it can be cambered, curved and tapered as required offering flexibility of spans and shapes.

iii) NLT: Nail Laminated Timber uses traditional construction method of fastening individual dimensional lumber, stacked on edge, into a single structural element using nails to offer durability & strength. It finds application as floors and walls.

iv) DLT: Dowel Laminated Timber is all wood composition as the softwood lumber panels are stacked and friction-fit together using hardwood wood dowels without any adhesives or nails. DLT is best suited for horizontal spans such as flooring or roofing applications due to its one-dimensionality.

c) Other engineered wood products & wood composites:

Advancement in technology has led to creation of innovative engineered wood products which have easier application in architecture and construction compared to hardwood/solid wood or sawn timber/lumber.

i) Structural composite lumber LVL: Laminated Veneer Lumber is simply put, glued plywood veneers stacked in parallel, essentially a thicker, single-direction plywood. It is made up of dried softwood veneers, bonded together with adhesives so that the grain of all veneers is parallel to the long direction. Similar to glulam applications, LVL, due to its very high strength-to-weight ratio, can be used for columns, beams, truss chords, I Joist flanges, lintels

ii) Structural composite lumber PSL or Parallam: Parallel Strand Lumber is manufactured using flaked wood by clipping veneers into long strands laid in parallel to longitudinal axis of the member and bonded together with an adhesive to form the finished structural section. PSL is commonly used for long-span beams, heavily loaded columns, and beam

and header applications where high bending strength is needed. It is used as beams and columns in post-and-beam construction, and for beams, headers and lintels in light framing. PSL is also suited to interior applications as it is visually attractive.

iii) Structural Composite Lumber LSL: Laminated Strand Lumber is created by aligning thin chips or strands of wood and then gluing them under pressure. The wood grain of the flaked wood strands is oriented parallel to the length of the member. The semi random strand or fiber orientation is what provides it In-plane stability. LSL is used to create large structural components out of single piece, minimizing connections thus finding applications in long span beams. Plywood sheathing can be used to create in-plane stiffness to cater to lateral loads.

iv) TCC: Timber Concrete Composite, also known as hybrid mass timber panel, consists of a concrete layer poured either on-site or precast over a mass timber panel. The compression strength of concrete with tension strength of wood creates high flexural stability that achieves high span to depth ratios. Concrete is fixed to the timber panel in various ways such as glued in perforated steel plates or angles screws. The concrete can also be used to run MEP utilities. This method finds greater application in high rise structures and caters to wind & seismic loads

Laminated Strand Lumber, Laminated Veneered Lumber, Timber Concrete Composite
(via Structuremag)

v) OSB: Oriented Strand Board is a cheaper alternative to plywood. It is created from strands and fibers by compressing layers of wood strands (flakes) in specific orientation with hot wax and adhesive in a way to achieve dimensional stability. This offers resistance to delamination and warping and hence

these large boards can be used for wall sheathing or building envelope in dry service conditions.

vi) Structural Composite Lumber MPP: Mass plywood Panels is a veneered based engineered wood product that is an alternative to CLT. Engineered pre-made veneers or lamellae are overlapped in alternating long and cross-grain veneer layup, glued and pressed together. These can be used to create large format wood platforms, beams and columns.

Parallam

OSB board

vii) HDF: High Density Fiber Board is an engineered wood product similar to OSB. It is made by densely packing wood pulp together and glued with an adhesive. HDF can be made very flexible and hence find applications in curved walls.

The framing methods used in mass timber construction can be varied such as 'Post & Beam', 'Two-way panel deck', 'Hybrid light frame & mass timber' and 'Honeycomb' styles. Generally, it is either using CLT, GLT & other products as structural load bearing walls/panels for low rise constructions or with Hybrid construction preferred for high rise structures where RCC vertical cores and shear walls are surrounded with mass timber elements. Mass Timber thus offers possibility of beamless floors with solid panels bearing directly on columns.

Many other composite materials and technologies are being explored every day such as FFTT (strong column-weak beam method) in high rise structures, glass wood composite for windows and facades in place of double Glazed units or DGUs or Laminate cassette floor components. Thus, Mass Timber has a plethora of material options available to integrate into

construction sector as per requirements and becomes a very efficient and sustainable wood substitute to other energy intensive materials currently in use.

Creating Mass Timber industry of India in future is one approach of bringing wood application into commercial light and making it mainstream material. To this end, suitable forests need to be created from present day to develop sufficient wood resource to cater to prospective mass Timber Construction. This technology can help execute buildings in modern architectural styles with multistory systems and large spans/loads with more efficient usage of wood. Therefore, developing Mass timber industry in India by setting up the necessary resource supply, supply chain, demand, infrastructure, processing and distribution can be the direction to work towards.

THE WAY FORWARD: Make wood a sustainable alternative in India

Usage of timber as an alternative sustainable resource is a prospect that needs to be explored in India leading to the question of sustainable resource availability of timber within the country. We cannot use the existing forests of our country to obtain timber as they are of high conservation and biodiversity value. Therefore, it is important to resolve the issue of lack of forests ready to produce timber as product.

Creation of forests for sustainable sourcing of timber

As expressed by the IPCC (2007), "In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fiber, or energy from the forest, will generate the largest sustained mitigation benefit".

One of the ways to do this is to develop new forests in available lands and implementing sustainable forest management methods and creating suitable forestry practices to take care of them. Following western or colonial practice of commercial forestry fails to consider the life of forest when it talks about timber. The colonial rulers and the western world saw forests, trees and wood as only a resource for man but not as an ecosystem which functions like a conscious entity. Thus there is a need now to develop forests in our country that respond to local climate, soils and ecology as well as to human requirements. The indigenous knowledge about the forests will be a great resource in this regard. Involving community as a stakeholder of the forest giving them a sense of ownership will help protect a young forest until the trees mature or until stable ecological cycle is established.

As this is a time consuming process, we may simultaneously begin the revival and conservation of indigenous forestry practices as well as knowledge systems regarding wood working. This will keep the community engaged with the development of the forests as stakeholders as well as bring the existing horde of knowledge and traditional construction practices into larger domain to be put to use. We must also create the required infrastructure such as Wood processing units, mass timber manufacturing industry as well as bring in mass timber technologies and facilities to India. Thus, when the trees are ready for felling, the resource of the forest will be used responsibly such that the resource generation is set into a pace with the supply chain balancing the demand. Sustainable wood construction can thus replace RCC and other energy intensive construction practices of India.

Wood based

Multi-story buildings

M.P. Singh, Shakti Singh Chauhan and Ritesh D. Ram

Institute of Wood Science and Technology, P.O. Malleswaram, Bengaluru-560 003
Email: ritesh@icfre.org

Wood is one of the oldest building materials known to mankind. However, the dwindling supply of naturally grown large girth durable timbers from forests and availability of various alternate construction materials has led to reduced usage of wood construction sector. In last three decades, wood has been systematically replaced by steel, aluminum, plastic etc. in various components of building construction. Of late, with the growing environmental concerns on using energy intensive materials and climate change threats, the construction sector is looking for environmental friendly materials and wood is the preferred choice. It is estimated that building construction contributes to about 40% of the total CO_2 emission worldwide. Wood is considered to be one of the most environmental friendly materials sequestering carbon during its production and locking it for a long duration when used for products with long life. For structural applications wood is converted into timber by sawing it into thick slabs and planks. Timber is also less carbon intensive to manufacture, transport and erect than steel and concrete structures. Therefore, increasing the use of timber in our buildings is expected to reduce the carbon impact of construction. There is an increasing trend in using more wood in building construction and the concept of completely wooden buildings has been put in practice. The limited supply of wood from forests has mandated to grow wood outside forest areas and large scale plantations of fast grown species have been raised to meet the demand for wood and paper based industries. All over the world, plantation forests have become the major supplier of wood. However, the properties of fast grown timbers are no match to the slow-grown and long rotation timber and therefore the use of such timbers for structural and semi-structural applications have received a set-back. However, with advancements in science and engineering, wood material from short rotation and fast grown plantation species can be converted to new class of engineering materials suitable for structural applications which has transformed the wood usage in building construction. Timber based construction are now characterized by a multilayered combination of different engineered wood which work together as a system to provide optimum stability, thermal, acoustic and moisture insulation and fire safety.

Engineered Wood

Extensive research and documented experience have led to several strategies which enable the utilization of fast growing and low quality wood for high end products including structural elements. The technologies for manufacturing plywood, particle wood, fiber boards, etc. have already gained commercial success in semi-structural and non-load bearing applications like furniture, kitchen cabinets, partitioning, etc. Over a period of time, a number of engineered wood products like Laminated Veneer Lumber (LVL), Glue-Laminated Timber (Glulam), Cross-Laminated Timber (CLT) have been developed for increasing use of wood in building sector where structural requirements are essential. These engineered products offer enhanced dimensional stability, strength and design versatility for project detailing. These engineered wood composites have provided the opportunity to utilize even small girth logs from short rotation timbers in terms of high value structural materials and development of these engineered composites have made it feasible to construct tall buildings using completely wooden elements.

In recent past, bamboo has also been tipped to be an alternate material suitable for converting into composites having properties required for structural applications. A brief description of engineered composites having structural suitability for timber building construction is as follows:

Cross Laminated Timber (CLT)

CLT is a multi-layer engineered panel wood product, manufactured from at least three layers of boards by gluing their surfaces together with an adhesive under pressure. The grain direction of consecutive layers is orientated orthogonally similar to plywood. This

specific orientation renders the board excellent strength, rigidity and stability. The degree of anisotropy in properties and the influence of natural variations are reduced insignificantly in CLT as compared to solid timber. CLT provides opportunity to utilize low grade kiln dried lumber to produce stronger structural material. CLT is always composed of an uneven number of layers (in general three, five, seven or even more) like plywood and it can be made in large dimensions. Product dimensions allow its application as large-sized wall and floor elements as well as for other large sized load-bearing structural components.

Production of CLT comprises kiln drying to desired moisture content, grading of kiln dried samples based on stiffness/strength, finger jointing of board segments to endless lamellas, adhesive bonding of lamellas to single-layer panels (optional), assembling and adhesive bonding of lamellas or single-layer panels to CLT. In order to get long boards, individual boards are finger jointed using a structural adhesive. In general cold setting adhesives like Melamine-Urea-Formaldehyde and Polyurethane (PUR) based adhesives are used for such panels. Between the two, PUR is the preferred adhesive. In addition, there are other variants of CLT like nail laminated panels where panels are joined using nails, dowel joined panels which reduces adhesive consumption. At present, CLTs are produced mostly from softwoods such as Norway spruce, White fir, Scots pine and to some extent from European larch, Douglas fir and Swiss stone pine. CLT can be produced in thicknesses from 50 mm up to 500 mm and these panels can be used as load-bearing plates and shear walls, in contrast to other wood-based engineered composite panel products. As a building system, CLT allows long spans without intermediate supports. CLT also has advantages regarding its fire performance because of the predictable burning properties of large-section wood structural elements. Unlike a wood frame system, CLT constructions create limited concealed spaces, which also reduce fire spread.

Cross Laminated Timber

Glue Laminated Lumber (Glulam)

Glue-laminated timber or glulam are also multi-layer composite wherein the grain directions of all layers are aligned parallel to each other unlike CLT. For manufacturing of glulam, individual board is selected and positioned according to defects and grain structure to maximize structural integrity. Glulam are characterized with high strength and stiffness along the length. Therefore, these panels are used for load bearing components of structure like beams and columns. The manufacturing process of glulam is very similar to CLT but they are manufactured in thick rectangular cross section and can be produced in curved shape also for arches. These products provide the strength and versatility of large wooden structure without relying on the old growth, solid-sawn timbers.

Glue laminated Timber suitable for load bearing components mainly columns and beams for the timber building

Bamboo Lumber

Bamboo plays a pre-dominant socio-economic role in our country but it has come in focus very recently although it has many economic valuable qualities. People used this resource in every step of their life that ranges from agricultural tools to food and shelter to lively hood. Bamboos are remarkably fast growing plants that thrive in a range of different climates. Solutions in this natural product come in different styles complimenting interior design choices from traditional to contemporary for totally unique look Products made from bamboos have provided a revolution in the world of interior design bringing a tropical atmosphere to any room.

The newly processed bamboo boards have the competence to match any other commercial grade ply and particle boards and several products like bamboo mat-boards, bamboo ply, bamboo strand lumber etc. have gained commercial interests. The properties of the bamboo boards can be used to the fullest for structural purposes by creating bamboo lumber and bamboo strand lumber. There are several species of bamboos which possess very high modulus of elasticity and strength (even better than wood) and therefore can potentially be transformed into structural components. Bamboo lumber is made by

converting bamboo into strips and then joining the strips with the help of a suitable species under pressure. Whereas, crushed bamboo umber or bamboo strand lumber use crushed bamboo and converting them into boards using adhesives. The suitability of these products for structural purpose depends on the properties of the bamboo used and the type of adhesives. Several components like wall panelling, door/window frames, stair case railings, etc. can be made using these products.

Bamboo lumber (potentially for columns, framing and trusses)

Current Trends

Development of these engineered wood products has allowed the construction of completely wooden building structures which are energy efficient, lower carbon emission and based on renewable resources. Timber buildings are thought to have the potential, architecturally, to create a more pleasing, relaxed, sociable and creative living experience. In the Western World, several tall wooden structures have come-up in last decades and the interest is continuously growing for such building through-out the world. In 2019, the tallest timber-frame structure in the world "The Mjøstårnet building" was constructed in Norway. The building is 85.4 m tall with 18 storey having a hotel, restaurants, offices, and apartments making it third tallest building the country. This building was constructed using locally available renewable resources and has used mostly CLT and glulam as the structural components. Prior to that, number of tall wooden towers have been constructed demonstrating the advantages in terms of speed of construction, carbon footprints, energy efficiencies, etc. and currently number of towers are under construction in many countries mostly in Europe, North America and Canada.

"Treet" in Norway is another 52.8 m tall residential building with 14 storey constructed using engineered timber in 2015. The building was constructed using 550 cum glulam and 385 cum CLT. Carbon12 is the tallest timber based 8-storey building in Portland, Oregon state of the USA. T3 Minneapolis Office Building completed in 2016 is the seven storey commercial building completed in about 10 months and consumed about 3600 cum of wood in form of 180000 sq ft of engineered wood panels. Vancouver's 18-storey Brock-Commons tower, built with a wood-concrete hybrid structure that includes prefabricated glulam columns and CLT floor slabs, is a testimony to the enormous possibilities of wood in multi-storey construction. Once the world's tallest timber building, it was built cheaper, faster and with less environmental impact than a comparable steel and concrete structure would have been – offsetting an estimated 2,432 metric tonnes of carbon. HoHo Vienna is another 84 m high, 24 story wooden skyscraper under construction in Austria. There are some 21 timber buildings over 50 meters (164 feet) tall which are near completion in Europe.

source -CLT hand book

Timber buildings using CLT & glulams

Grow More Wood- Use More Wood

Major reasons for shift towards tall timber building in Europe and North America is growing awareness for environmental impacts of conventional building materials like concrete and steel, availability and renewability of wood material, environmental benefits of wood in terms of climate change mitigation. In addition, waste generated during the manufacturing of timber and wood-based products is very little as almost all residues are used, either as a raw material or an energy source making it more economical sense in using more wood. Therefore several building construction companies in these regions started looking forward to use more and more timber in the building elements in terms of large-scale structural wood systems, including heavy timbers, engineered framing systems, and other modern wood products.

The timber structures are more energy efficient also due to exceptionally good thermal insulation properties of wood. The thermal conductivity of structural softwood (1.0) is much less than that of concrete (6.0), glass (7.0), steel (310.0), and aluminum (approx. 1,500). Therefore thicker wood panels

insulate even more effectively. Better thermal efficiency of wood means walls made out of CLT and other panel products can be slimmer, releasing up to 10% more space than other building methods. According to the Canadian Wood Council, maintaining indoor temperatures in a finished structure made with CLT requires about one-third of the heating or cooling energy required for a steel or concrete structure. Wood is also resistant to heat, frost, corrosion and pollution and the only factor that needs to be controlled is moisture. Easy processing, low energy requirements in its manipulation, amenable for industrialization with technological interventions have made it a preferred material for buildings. Additionally, production of wood is the most ecologically beneficial processes relentlessly soaking up CO_2 from the atmosphere, converting it into wood and releasing oxygen. It is estimated that 0.9 tonne of CO_2 is trapped in every tonne of wood. The increased use of short -rotation and fast grown timbers for high value products will ultimately encourage tree growers and farmers to plant more trees and produce more wood. The overall process of growing more trees and in-turn using more wood can turn out to be win-win situation on both environmental and economic front.

The Idea

In India, the concept of tall timber building is still in the conceptual stage. In this direction, it is envisaged to construct a multi-storey building with maximum usage of wood at the IWST Bangalore premises. This project proposes construction of one of the tallest mass timber hybrid structures project of its kind in the country standing at 10 to 14 storeys. It is proposed that the showcase building will comprise of two stage auditorium, museum, exhibition, classrooms, conference rooms and office space. Institute's building will reflect the Ministry of Environment, Forests and climate change's commitment to sustainability and the vision of managing climate change. Timber buildings are known to be energy efficient, have low embodied energy, utilize renewable resources, have lower carbon footprint and provide opportunity to utilize fast grown plantation timbers. Timber, by its very nature, during its production (growing trees for wood) removes CO2 from the atmosphere via photosynthesis and depending on the end-of-life disposal scenario, most of this captured carbon can be locked for a long duration or result in net-zero carbon emissions if burned for biomass energy (assuming a fossil fuel offset). Most of the work related to such building materials in the developed nations is confined to using low density coniferous species like pine, fir, etc. The technology of developing such mass-construction timber from fast grown hardwood timber species is still evolving. The utilization of hardwoods is expected to provide opportunity of obtaining higher bending stiffness and shear resistance in CLT panels without increasing thickness or possibly, reducing thickness. This project also aims to develop standard protocols for making CLTs and Glulam using agro-forestry species like Melia dubia, Rubber wood, Poplar, Eucalyptus, Silver oak etc. This will provide an opportunity to open up new avenues of utilizing these resources for high value products and helping growers to get more value of their material.

Challenges

There is a push to use more and more timber in building construction as the material is positively associated with well-being, aesthetic and eco-friendliness, which are important factors in the choice of a certain building construction mode. However these attributes are not sufficient on their own to trigger the choice of timber as a preferred construction material. In the Indian context, sustainability of the building material particularly production of wood to produce mass timber and availability of the facilities to produce the mass timber elements with desired properties are major concerns of material supply.

Economic V/s Environmental Cost:

The cost of the construction is a major factor in timber buildings. Concrete is shown to have an advantage over timber in terms of direct cost of the material, however the speed of construction which has been a favourable factor in timber building may help in offset the cost of construction. The long term environmental benefits of timber building can outweigh the material cost. The economics of such material also depend on the demand and supply balance. At present there are hardly any industrial scale production units manufacturing mass timber elements in the country and for any such building the material has to be imported keeping the material cost at the higher end. Additionally, even at global level, there are very few large scale manufacturing units of mass timber material making it a bit costly affair. However with the scaled up production across the globe, the production cost is set to come down considerably depending on the availability of locally available resources. Thus there is a need to create entrepreneurship in the manufacturing line within country so that cost factor can be optimized with the locally available resources particularly utilizing agroforestry material. Though, there are some key

questions about the life cycle of mass timber as enough data is not available to on the long term performance of such buildings and CO2 emission in manufacturing of mass timber material, the existing information on environmental benefits of wood use in terms of carbon locking and reduced CO2 emission may be taken as the base line.

Research and Development:

One of the major challenges would be to develop capabilities for producing mass timber construction material like CLT and glulam using the locally available resources which are grown sustainably. At present, preparation of such material is in the research stages. Unlike most conventional structural materials, timber is highly anisotropic and fast grown plantation timbers are known to show more anisotropicity due to faster growth. While timber's specific strength and stiffness in the along the grain direction are excellent, its properties perpendicular-to-grain are an order of magnitude less. This means that while large timber elements may carry high axial loads, the structural systems in which these elements are arranged must be thoughtfully characterized, designed and detailed in order to transfer loads for stability and structural integrity of the building. The large variability in properties within and between species is also a limiting factor for utilizing fast grown species for structural elements and structural designs and specifications needs to accommodate these complexities. The preparation of engineered martial like CLT and glulam can tackle the issue of anisotropy and homogenization of the properties can be achieved. The homogenization is essential when the variability in raw material is large. The Institute of Wood Science has already initiated research programme on development of CLT and bamboo lumber using different timber and bamboo species. In CLT, the suitability of rubber wood, Melia dubia, Eucalyptus, Silver oak etc. is being evaluated. The preliminary investigations revealed that CLT made from rubber wood and melia are better that pinewood base panels which is very encouraging. Protocols for preparing Laminated Bamboo Lumber and Crushed Bamboo Lumber using Dendrocalamus brandisii, Bambusa vulgaris, B. bambos and Guadua angustifolia have been developed. These bamboo based composites have potential to be used as an alternate to solid wood in structural and semi-structural applications.

Fire Safety:

The fire hazard is a major concern in tall timber buildings during construction and after occupation. This needs to be addressed for the duration of the construction phase. Proper guidelines are required relating to fire safety of timber building and during construction also as large amount of wood is stored for installation and is likely to be exposed to fire conditions which is a less of an issue in steel and concrete buildings. In absence of a proper fire protection, timber structure can form part of the fuel load in a fully developed fire. It should be noted here that CLT itself can be a good fire barrier as the thick section of wood in CLT provide fire resistance through 'charring'. The charring of the face layer of CLT act as an insulating layer preventing an excessive rise in temperature within the un-burnt core of the panel which keeps providing the strength to the structure unlike steel. However, extensive research needs to be carried out to work on fire resistance of timber buildings and fire testing capabilities needs to be developed for ensuring the performance of such materials.

Building Design Codes:

A key challenge of the Tall Timber structures is the development of design codes specific to the material used for construction. Simply copying the familiar forms of codes used for conventional construction in steel and concrete may not be applicable to such buildings due to inherent differences in the material properties. Unlike steel or concrete, it is often the strength or stiffness of connections or joints govern the behaviour of timber structures. For a tall building, the effect of even very small movements in connections at the lower levels can lead to lateral displacements at the top of the building several times larger than those predicted by a simple elastic deflection prediction. Therefore the design of connections of various structural elements and their performance analysis is very critical in construction of such buildings. Also, different installation skills for timber structural components are required than typical general contractors possess. Lack of familiarities about the design requirements for timber structure among the local designers, architect, engineers and permitting authority could be a major bottleneck in the construction of such structure in India. Detailed information on design related issues like seismic and wind resistance, fire safety, durability, dimensional stability, acoustics, connector systems and assemblies need to be readily available prior to building. In country like India, resistance against termites is very critical.

Capacity Building:

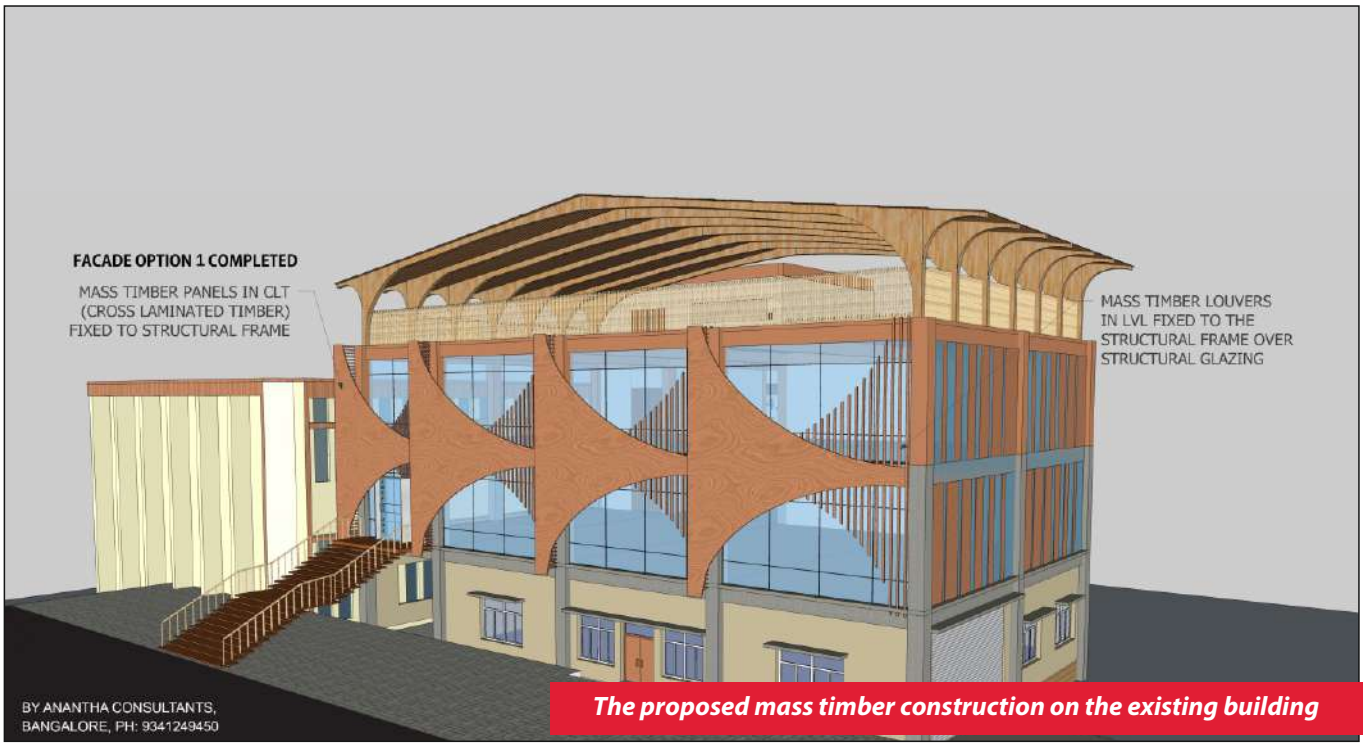
Manufacturing of mass timber material in large quantities with consistent and uniform properties is a key in timber building. For these technically skilled human resources with computer aided design skills, CNC fabrication machinery skills, digital integration from screen to job-site large capacity for timber seasoning and preservation and sustainable supply of raw material are essentially required. Promotion of timber buildings will necessitate development of such capacities for long-term sustenance. The capacity building in terms of technology and manpower will encourage entrepreneurs to take an initiative in manufacturing of mass construction timber materials. The Institute runs a programme on advanced wood working with exposure to CNC machines for processing of wood. This need to be further expanded in terms of processing such mass timber materials.

The Proposal

This project envisages overcoming these challenges through continuous research and development, and building a multi-storey timber tower building in the IWST campus for demonstration and promotion of wood for building construction. Considering the environmental benefits of using wood as a material, the project aligns with the objectives of Ministry of Environment, Forest & Climate Change, Government of India towards the mitigation of climate change. Promotion of mass timber material will lead to the development of local skills and industrial set-ups for manufacturing of such materials and pre-fabrication units for building which is in-line with "Make-in-India" mission of the Government. Further, development of such construction material from locally available resource will create a high-end market for agro-forestry species. This will help farmers in providing an alternate market channel for their products and enhancing their income. The research and development in this field is very much needed to develop the indigenous capabilities in this area of development. The project will be carried out in two phases. The first phase will focus on strengthening of research and development on material development, assessment of properties, creation of suitability indices, assessment of durability and weathering aspects and standardization of manufacturing protocols. The second phase will mainly involve full scale construction of the building, its evaluation in terms of its performance. Construction of such building will ultimately help in designing the standards and building codes for timber towers in the country.

As a pre-project exercise, IWST, Bengaluru is proposing to construct a three storey hybrid structure with maximum utilization of wood in terms of commercially available CLTs, LVLs and Glulams over an existing building. The proposed design of pre-project timber building is shown below. The pre-project phase will showcase the advantages of using wood in terms of ease in building construction, aesthetic appeal and environmental benefits.

The proposed construction will have RCC columns, beams and roofing for the first two floors. The wall components (outside and inside) will be CLTs. The



The proposed mass timber construction on the existing building

third floor will be having CLT walls and a roofing elements using corrugated bamboo-mat board. During this phase of the project, the Institute is proposing to engage with Canadian Wood Council and University of British Columbia, Vancouver. The University has already gained the expertise in constructing mass timber buildings. This pre-project phase will be a learning phase allowing us to understand the necessary requirements for the proposed Timber Tower, identify other partners, resource requirements and technical requirements. Based on the pre-phase experience, a detailed project report is to be prepared for construction of the timber tower with the help of the identified partners. The project is proposed to be carried out in two phases with set objectives and deliverables.

The objectives of this project will be achieved in two phases. The first phase will include developing mass-construction timber material from locally available plantation resources, evaluation of its suitability for timber tower, assessment of their design values and suitability for structural applications, assessment of fire resistance, capacity building for testing and designing wooden buildings (developing international partnerships and exchange visits), designing of 10 storey wooden building at IWST campus using mass-construction material. The second phase will include construction of multi-storey timber building, evaluation of the performance of the building and finally development of standards and building codes for timber towers.

The construction of IWST TIMBER TOWER will demonstrate that mass timber hybrid structural system is sustainable, economically viable, repeatable and adaptable to other building types and uses for urban development. For the developing and execution of the project, IWST looks forward for partnerships with experts and industries.

"Brock Commons Building", University of British Columbia, Vancouver, Canada

Courtesy : Dr Jimmy Thomas, Cardian Wood

MDF: THE NEW-AGE PLY

Association of India Panel Board Manufacturers (AIPM), is a non-profit organisation consisting of members who are manufacturers of MDF, HDF, Particle boards with and without pre-lamination, Laminated Flooring etc. with different grades and international-national norms like E0, E1, E2 and other standards. All members are encouraging agroforestry farmers as key raw material.

The Association members are continuously researching & adapting new techniques towards product advancement. Currently AIPM is working on modifying BIS standards to maximise usage of MDF boards with the help of IPIRTI.

AIPM is catering to the increasing urbanisation, demand for ready-made furniture, produced with engineered panels like MDF, which is growing rapidly and gradually replacing plywood.

Today's discerning consumer with a busy lifestyle, is looking for interior products which save time, are convenient to use, and are cost-effective, while being stylish. They want functional homes and furniture.

AIPM has been enlightening the trade about the usage of MDF ever since it forayed into the MDF production.

AIPM plans to organize the Carpenter meets frequently across the country to educate carpenters on the benefits of MDF and the tools required to work with it & enhance their skills and improve their livelihood opportunities by bringing professionalism in the field.

COST-EFFECTIVE | DESIGNER | SUSTAINABLE | DURABLE & ENVIRONMENT FRIENDLY | MOULDED INTO SHAPES

Address: 2nd floor, Rushil House, Near Neelkanth Green Bunglow,
Off. Sindhu Bhavan Road, Shilaj, Ahmedabad - 380058, Gujarat, INDIA.

Tele. No.: +91-79-61400400 | FAX No.: +91-79-61400401

E-mail: jt@aipm.in | Website: www.aipm.in

AIPM

ASSOCIATION OF INDIAN PANEL BOARD MANUFACTURERS

Raw material options

A challenge to panel boards industry

Jikesh Thakkar

Executive Director, Association of Indian Panel Board Manufacturers and Indian Laminate Manufacturer's Association

Off lately, India has been witnessing significant growth in real estate and infrastructure. Government policies facilitating ease of doing business and foreign investments for townships and residential development projects prophet increase in demand for furniture and panel boards. This brings us to address the question of availability of raw materials for panel industry that includes Particle Board, Medium Density Fiber Board (MDF) and other panel boards.

Agroforestry grown wood (Eucalyptus spp., Poplar Spp., *Melia dubia*, Silver Oak) and agricultural residues (wheat straw, rice straw, cotton stalk, bagasse etc.) form major raw material for the panel boards industry. Agricultural waste can specially help provide opportunities to rural communities to generate livelihood. This also has an added bonus of reduction in emission levels of CO_2 generated otherwise due to burning of agro-wastes The major constraints in use of agro-waste as raw material is that is requires large space of storage and are prone to quick moisture loss. Collection of agro-wastes from farmers and transportation to the manufacturing unit and the cost attached to it are also a challenging task to the industry. Agro-wastes have potential to be used in production of panel boards given an executable working-system is developed and technical know –how is provided by institutes involved in Research & Development. Sensitization of rural and agricultural communities to venture out with panel board industry can be jointly worked out with District Rural Development Agency, Joint Forest Management committees, Self-Help groups and Village Institutions along with the aid of several initiatives launched by the government.

Unlike other panel boards exporting countries, in India, price of the agroforestry grown wood keep up with the price of the agricultural crops. This scenario divulges from the fact that in India, raw material for panel industry is grown on agricultural land and this land has a competitive use. With support of MSP from government on various agro-crops, panel industries have tough time matching up to the cost of raw material so that farmers continue to grow agro-wood and ensure steady availability of raw material. Panel industry also competes for raw material with Paper industry that has been rapidly expanding and increasing their scale of production. Approval for panel industries does not commensurate with the demand and supply of the raw materials.

National Forest Policy, 1988, states that industries are to arrange their own raw material. This take of the government has left the industry players with no other options than to turn to farmers for raw materials directly. In 1970s, India was net exporter of wood and wood based products. Now it has emerged as one of the world's leading importer of wood. The change of scenario has been the result of series of government policies and regulation on harvesting and transit regime. As per National Working Plan Code 2014, about 10 % of the forest land has to be devoted to production forestry. About 33 % of the land under forest department is degraded. If agro-wood plantations are allowed on this land, it could aid to improved availability of raw material, let alone the scale of carbon sequestrations and revenue generation to the rural population. This would help lessen off the burden of cost of raw material from the industry players. The panel board industry falls under the purview of MoEF&CC, however, the several matters of interest of the industry come under the MoI&C. This calls for creation of a common platform where the concerns of the industry can be discussed.

The quality of raw material available is also another concern for the industry. It is possible to grow specific genotype of a species for specific end use. This will enhance the product quality of end product. High productive quality planting material is to be given preference for planting. Farmers need to be provided with clones of high yielding varieties of species for promoting production. “Fast wood forestry”

experience may serve as an example here. It is recommended to promote clonal origin plantation that produces uniform growth, more survival rate, high wood yield and quality wood, with less land inputs. Efforts have been made to pursue BIS to establish standards for agroforestry and plantation grown wood.

To draw up to tap on the potential growth of the furniture and panel board industry promising India, need of the hour is to secure raw material availability first. Industries need to explore options for raw materials and aid capacity building of farmers. Investment in raw material exploration must be seen as a part of potential business. Strengthening coordination among concerned Ministries of Centre and State Governments, Government agencies, NGOs, Self-help Groups, farmers and industries is crucial to overcoming the challenge of raw material availability of the Industries. This can also be done by evolving PPP models with farmers, Government at different levels, industries and other stakeholders. There is also utmost requirement of technological partnerships with various organizations and institutions such as FRI, IPIRTI, IWST, ICFRI and ICAR and others.

Within the industry, a policy and research committee for raw material is established for sharing and understanding of business viabilities through systematically organized associations. Panel industry is an end user of agroforestry produce. Thus, the industry must link itself with various programs for climate change mitigation; carbon credits markets, Clean Development Mechanism programs. Industry players must themselves take upon the onus of creating awareness in the rural and farming communities for their raw material requirement.

The entire wood industry, both solid wood and composite wood industry, together with R&D institutions and farmers provide a road map to Central Government as to give a complete picture on how India can be self-sufficient in raw material availability and become a net exporter of wood based products in next decade. In the bus to Atmanirbhar Bharat envisioned by Honourable Prime Minister, raw material availability forms the front wheel!

SHORT TERM TRAINING COURSES @ IWST

Institute of Wood Science and Technology (IWST), regularly conducts 5 days and 3 days training courses on the following topics:

- Bamboo: Tissue Culture
- Sandalwood: Tissue Culture Techniques
- Sandalwood: Seed Handling, Nursery and Plantation Technology
- Wood Seasoning and Preservation
- Sandalwood: Farming and Management of its Health
- Extraction and Quality Assessment of Sandalwood and other Essential Oils
- Wood Modification
- Field Identification of Important Timbers
- Clonal Propagation of Melia dubia
- Sandalwood: Establishment and Maintenance of Healthy Nurseries and Plantations
- Insect Pest Management
- Bamboo Agarbatti Stick Making

For further details, please contact :

The Head, Extension Division
Institute of Wood Science and Technology
18th Cross, Malleswaram, Bengaluru - 560 003
Phone: +91-80-22190170, 190 | Email : extension_iwst@icfre.org | Website : http://iwst.icfre.gov.in

Simarouba glauca

"Lakshmitaru" - A multipurpose tree

S.K. Sharma

Institute of Wood Science and Technology, P.O. Malleswaram, Bengaluru-560 003
Email: sksharma@icfre.org

About species

Simarouba glauca DC, also known as paradise tree/oil tree is a multipurpose, fast growing, evergreen versatile oilseed tree. This species is a native of El Salvador and was introduced in India in 1960s from Brazil for its edible oil (Aceituno or acetone oil) from its seeds under the plant scheme of ICAR. It is medium sized evergreen tree growing up to 7-15 meter in height. It has got tap root system and cylindrical stem. Presently, large scale plantation of this species are being raised in the wastelands of Karnataka, Andhra Pradesh, Tamil Nadu, Maharashtra, Orissa, Chhattisgarh, Bihar and Gujarat. It can grow in degraded soil and can adopt wide range of temperature.

Besides its main use in oil production from seeds, all parts of the tree in one way or other are reported to be useful viz. its fruit pulp can be used in the preparation of juice, bark and leaves are medicinally important as they contain various chemicals which are useful in curing amoebiasis, diarrhoea and malaria. The leaf litter of the tree makes a good manure and hence improves the fertility status of the soil. It is reported to be a low-density timber. There is acute shortage of various conventional timbers in local wood industries particularly for handicraft, match stick and pencil making sectors. In order to fill the gap between demand and supply of wood in these sectors, suitability of wood from different species were studied by this Institute. Simarouba glauca, one of the low density and naturally insect resistant species, was studied for wood quality parameters in terms of physical and mechanical properties in order to recommend the species for different end uses. The research findings will help the farmers/ growers of Simarouba glauca by recommending the timber for various end uses. These recommended uses are other than the conventional uses i.e. seeds for oil and they in turn will get better price of their timber.

General Features

Wood is yellow in colour with no difference between sapwood and heartwood. Wood soft and light, even and medium coarse textured with straight to slightly interlocked grain. Wood is diffuse porous without any odour. The growth rings are indistinct.

Logs/billets of Simarouba glauca

Anatomical structure

Drying Behaviour

The purpose of wood drying is to bring down its moisture content to a certain level (generally 12 %) to minimize the dimensional changes and to avoid defects like warping, splitting, cupping etc. in the final product. The cut sizes of timber having average thickness of 1-2 inch can be air-dried in short period of 1-2 week(s).

Wood Properties

The girth at breast height (GBH) of 7-year-old plantations was found in the range of 60 to 90 cm. average values of various physical and mechanical properties of wood are given in Table 1. The wood specific gravity was found to be about 479 kg/m³ in air-dry condition. The low value of shrinkage shows that the wood is dimensionally quite stable and can be used for different purposes where high dimensional stability against changes in moisture levels is desirable such as handicrafts, light furniture etc. The timber is also known to be naturally insect resistant. Also studied the bark properties keeping in view the importance of bark as medicinal value. The average bark thickness was found to be 0.8 cm and its percentage varied between 17-22%.

Table 1. Physical and mechanical properties and their comparison with teak

Properties	Average Values
Specific gravity (at 12% MC)	479
Shrinkage %	9
FS at EL (kg/cm^2)	286
Bending strength – MOR (kg/cm^2)	504
Bending stiffness – MOE (kg/cm^2)	56,000
Maximum crushing stress (kg/cm^2)	265
Compressive stress at EL (kg/cm^2)	71.4
Shear strength (kg/cm^2)	76.3
Tensile strength(kg/cm^2)	28.3
Surface hardness (kg/cm^2)	327
Nail holding power (kg/cm^2)	42
Screw holding power (kg/cm^2)	198

The values of various physical and mechanical properties in both green and air-dry conditions were used in evaluating the composite suitability indices. The comparative suitability indices for different industrial and engineering uses of Simarouba glauca wood with respect to teak taken as 100 are given in Table 2. The value of retention of shape was about 94 as compared to teak (100). This is due to low shrinkage value. Based on the suitability indices, the timber can be classified as moderately heavy, weak, not tough,

Table 2. Suitability indices and suitability figures of *Simarouba glauca* wood

Comparative suitability indices in terms of teak taken as 100.	
Property	**Comparative Suitability Index**
Strength as a beam	54
Stiffens as a beam	57
Suitability as a post	55
Shock resisting ability	59
Retention of shape	94
Shear	72
Hardness	57
Refractoriness	87
Nail holding power	39
Screw holding power	46
Weight or heaviness	81

Composite suitability figures for various end uses	
Property	**Suitability figures**
Tool Handles	92
Furniture	73
Light Packing Cases	68
Door & windows shutters	65
Pallets	57
Oars and Paddles	55
Construction	55
Ammunition Boxes	47

soft and very steady. The suitability figures for various end uses on the basis of above properties are given in Table 2. Based on composite suitability figures, the timber is found to be more suitable for tool handles, furniture and light packing cases.

Wood Working Qualities

Various wood working qualities were evaluated and compared (Table 3) with Wrightia tinctoria (also known as Dudhi) which is one of the major species being used by handicraft sector in Southern India for making artifacts. The wood was found to take good polish, easy to cut, easy to turn the outer surface, satisfactory smooth finish, rough inner surface finish, consumes more lac and suitable for lacquerware. The timber found to have a very good potential as an alternate timber for handicraft sector for domestic consumption and hence will lessen the burden on *Wrightia tinctoria* which is in short supply.

Table 3 . Results on use of alternate wood for lacquerware craft

Sl. No.	Parameters	Simarouba glauca (Wrightia tinctoria taken as reference wood)
1	Seasoning	Required
2	Weight	Very light
3	Grain texture	Coarse Very fibrous
4	Machinability like	
	(a) Cutting	Easy to cut
	(b) Turning – outer dia	Easy to turn, leaves satisfactory smooth surface finish
	(c) Turning – Internal dia	Easy to turn, leaves very bad/rough surface finish
5	Moisture absorbing ability	More – as it is porous
6	Lac consumption	Consumes more lac Leaves rough finish
7	Suitability for lacquerware craft	Satisfactory for domestic use
8	Suitability for export items	Not suitable

Match Sticks

Matchstick from *Simaruba glauca* wood were prepared and demonstrated to cottage industries. The wood was found almost equivalent to other species which are in use for making the match sticks. It is found that 1 kg of *Simaruba glauca* wood results in making 10,000-11,000 match sticks

Wood Products

A few prototypes such as light furniture, turnery items and artefacts were made for demonstration. The timber was found to have potential as a very good alternate timber for handicrafts for domestic consumption.

GROWTH with SUSTAINABILITY

Sustainability is at the core of India's Paper industry. Paper is one of the most environmentally sustainable products as it is biodegradable, recyclable and is produced from sources which are renewable and sustainable.

Paper Industry is not only conserving the environment but also regenerating natural resources. Through the agro-forestry initiative of the Indian Paper Industry, more than 1.2 million hectares of land has turned green and thousands of jobs in rural India have been created.

Of the total demand for wood by India's Paper Industry, over 90% is sourced from industry driven agro-forestry. The industry is wood-positive, that is, it plants more trees than it harvests. Pioneering work has been carried out by the industry over the last three decades in producing tree saplings (e.g. Eucalyptus, Subabul, Casuarina, etc.) which are disease and drought resistant and can be grown in a variety of agro climatic conditions. Substantial amounts have been spent by the industry on plantation R&D, production of high quality clonal saplings, technical extension services and hand holding of marginal farmers.

Indian Paper Manufacturers Association

PHD House (3rd Floor), 4/2 Siri Institutional Area (Opposite Asian Games Village) New Delhi - 110 016 (India)
Tel : +91-11-26518379, +91-11-41617188, Email : sg@ipma.co.in / secretariat@ipma.co.in
Website : www.ipma.co.in

IPMA Members

Andhra Paper Limited
bilt
CENTURY
emami
ITC Enduring Value
JK PAPER LTD.
NAINI
ORIENT PAPER
PUDUMJEE
Seshasayee Paper and Boards
STAR PAPER
TNPL
TRIDENTGROUP
West Coast Paper Mills Ltd
YASH PAKKA

Status of poplar based Agroforestry *in North Bihar and challenges*

Aditya Kumar and Nitin Kulkarni
Institute of Forest Productivity, Ranchi-835 303 (Jharkhand)
Email: aditya9678@gmail.com, dir_ifp@icfre.org

In Bihar most of the farmers are small with land holding of less than 1 hectare. They cultivate rice, wheat, maize and pulses in their farm for subsistence. The practice of monoculture and injudicious use of agrochemicals depleted and deteriorated soil health and water resources in the state. To restore the soil health and increase productivity, it is required to shift towards integrated farming and utilize natural resources in sustainable manner. Through diversification in cropping pattern and crop rotation, the health of soil and ground water can be restored but only limitation is availability of irrigation facility. The most potent option to increase the return from farming is adoption of agroforestry. Agroforestry is one of the land husbandry systems which can be followed for diversification of agricultural systems. It is being promoted and popularized by the Government of India and wood-based industries that, requirements of fuel, fodder and timber for industries can be fulfilled from farms.

Bihar is a thickly populated state and on partition in November 2000, total forest area left was only 6.45 percent (ISFR, 2001). Due to high population density and more pressure on the forest, it was decided to increase tree cover outside the forest area. Another problem was to increase the per capita income of the farmers of Bihar and finally decided to adopt agroforestry to solve these problems. In agroforestry, the selection of species being utilized is very important, it must be fast growing, of short rotation age, having high market demand and give more income.

Poplar (*Populus deltoides*) is one of the most important agroforestry tree species and widely accepted by farmers worldwide. Polar based agroforestry is also considered best to meet the increasing demand of fuel-wood, fodder, timber and to reduce the pressure on forests. It was introduced initially during 1950s from United State of America by the FRI, Dehradun. By extensive research and genetic improvement programs more than 100 clones were developed and made available for planting under agroforestry. It was planted extensively under agroforestry in plains of North-West India, i.e., Western Uttar Pradesh, Punjab and Haryana and to some extent in the outer plains/ valleys of Uttarakhand and Himachal Pradesh. However, the adoption of poplar-based agroforestry was confined to North-Western India alone, and it was observed that net income from poplar plantations would be three times greater than agricultural crops alone.

Keeping these points in consideration, Institute of Forest Productivity (IFP), Ranchi under the aegis of Indian Council of Forestry Research and Education (ICFRE), Dehradun implemented a project entitled "Samudai Adharit Samanvit Van Prabandhan Evam Sanrakshan Yojana (SASVPSY)" in Vaishali and nearby districts of Bihar to promote agroforestry during 2006-2013. The project was conceived by ICFRE for promotion of economically viable poplar-based agroforestry model in North Bihar districts, having vast tract of Gangetic plains. Poplar was selected as leading species to be introduced along with traditional tree species viz. Kadamb, Semal, Gamhar etc. It was targeted to plant 76 lakh seedlings in farmers field spread over 1250 villages covering 35,000 farmers in all the 16 administrative blocks of Vaishali district and adjacent blocks of nearby districts. It was also targeted to develop forest nursery-based entrepreneurs among farmers and capacity building of farmer's in raising forest nurseries, plantation techniques, through on-site training and sending them on exposure visit to traditional poplar growing regions of the country. As "Seeing is Believing" and most effective way to motivate farmers and generate confidence, it was decided to establish demonstration plots showcasing the scientific methods of practicing poplar-based agroforestry at different places in the district. It was also decided to establish model nurseries, hedge garden of economical tree species and clonal seed orchard in the district for continuous supply of quality planting material to the farmers.

Project area

Vaishali district and nearby blocks of other districts were considered for the execution of project. The edaphic factors, climatic conditions and vicinity from the Patna makes Vaishali district most suitable for project execution. The whole district spread along the Ganga river and soil was of loamy and sandy loamy type, which was considered most suitable for poplar-based agroforestry. The overall climatic condition of the area was found more or less similar to the traditional poplar growing areas.

Geographical position of Vaishali district

Geographical position of Vaishali district

In implementation of the project the biggest challenge was to motivate farmers and make them ready to adopt scientific method of agroforestry and most importantly poplar-based agroforestry. Poplar was totally new species for the locals/farmers and they were hesitant in planting poplar in their farm. Traditionally they were planting semal and kadamb in their farm land but not at commercial scale. It was found that farmers were more interested in planting horticultural crops like Mango, Litchi, Guava, Papaya, banana etc. Although, the climatic condition and soil of the area were found very suitable for agroforestry and particularly for poplar-based agroforestry, but the adoption of any new system depends on user's awareness, attitude, risk bearing ability etc. so, it was needed to motivate and create awareness among the farmers.

To motivate the farmers and make them ready to adopt poplar-based agroforestry, a multi-pronged approach was adopted and following activities were performed:

i. Motivation and awareness generation program

Poplar and poplar-based agroforestry was not known to the farmers of Vaishali district and they were also unaware of its benefits. The tree planting or agroforestry was limited to big farmers only so, it was important to make them aware of benefits from the agroforestry.

To motivate and make them aware following steps were taken:

a. Village meetings: Initially village level meetings were conducted in which farmers were explained about the benefits of agroforestry by resource persons and experts. The experts were called from Forest Research Institute, Dehradun, Forest Training Academy, Haldwani, GBPUA&T, Pantnagar etc. Posters and pamphlets were distributed among the farmers. Efforts were made to sensitize them about choice of species and benefits of opting Poplar.

Village meetings for awareness generation

b. Involvement of NGOs: Five NGOs viz. "Pratigya Samjik Seva Sansthan, Hajipur, Vaishali", "Nari Kalyan Sanathan North Mandir, Patna" "Mahila Utthan Samiti, Samastipur", "Narayani Seva Sansthan, Hajipur, Vaishali", and "Voluntary Action for Research Development and Networking (VARDAN), New Delhi" were engaged for motivation and awareness generation under the project. Each NGO was given its area of jurisdiction for making farmers aware. Street drama and door to door meetings were conducted by NGOs. Essay competition, slogan writings, painting competitions were organized amongst school children for mass awareness.

c. Engagement of extension workers: Large number of locals were engaged as extension workers (more than 100), for making personal contacts with each and every household, a door to door campaign was launched in villages.

d. Socioeconomic survey: A socio-economic baseline study was conducted in the project area with the help of A. N. Sinha Institute of Social Studies, Patna before the implementation of the project to identify the target groups. The survey was conducted through the structured questionnaire with appropriate statistical design.

The mass campaigning and door to door contact resulted into the interest generation and adoption of poplar-based agroforestry by the farmers. Due to massive awareness campaign, poplar plantations could reach 25 rural administrative blocks, 1250 villages and 65,000 households in Vaishali district.

Another challenge was to make farmers aware of techniques and methods of poplar nursery raising and planting under agroforestry. To solve this problem a huge training program was launched in two dimensions. One is to give on-farm training and another to send innovative farmers to traditional poplar growing areas of the country. 314 persons were trained through rigorous training programs at farm level and through trainings at UFTA, Haldwani and FRI, Dehradun and promoted them as master trainers to give trainings to the local farmers. It was also decided to arrange farmers visits to the ply wood industries at Yamuna Nagar, Haryana and make them aware of its economic importance and utilization.

ii.Training

Initially trainings were provided to trainers and 314 persons including persons from NGOs, extension workers, contractual workers of project, State Forest Department personnel etc. were trained and utilized as master trainers. Initially trainings and meetings for villagers were conducted at Jadua, Hajipur. The trainings included both class-room and field trainings. The hands-on (in-farm) trainings were organized in nurseries and villages in which more than 7000 farmers were participated. The farmers were sent to Uttarakhand Forestry Training Academy, Haldwani, Forest Research Institute, Dehradun, GBPUA&T, Pantnagar for exposure visit where they were shown local farmers field and arranged interaction meeting with local successful poplar growers. 1000 farmers were sent on study tours in 40 batches for exposure to the poplar-based agroforestry, its economic importance and utility.

Exposure visit of farmers to GBPUA&T, Pantnagar

iii.Establishment of demonstration plots

As "Seeing is Believing" so, to showcase the feasibility of poplar-based agroforestry in Bihar and specially in Vaishali district, demonstration plots were established. In demonstration plots different agroforestry techniques and models were displayed. Demonstration plots were established at Goraul, Jadua Hajipur and in Patepur village.

Apart from demonstration plots, Agroforestry Extension cum Training Centre was established at,

Demonstration plots at Goraul

Demonstration plots at Patepur

Jadua Hajipur to showcase the recent developments in Agroforestry research and techniques. A bamboo common facility Centre was also established with the help of IPIRTI, Bangalore to facilitate the farmers and give training for value addition and preservation of wood and bamboo.

iv. Supply of quality planting material

The biggest challenge was to supply the quality planting material of poplar, gamhar, shisham, semal, teak, kadamb etc. to the farmers for planting under agroforestry. For mass propagation of planting material, a model nursery was established at Jadua

Raising of Poplar ETPs in Kisan nursery

Hajipur with the facilities of mist chambers and hardening chambers. The nursery of non-poplar species was raised in model nursery and distributed among farmers for planting. For raising poplar nursery, initially 50,000 ETPs were procured from WIMCO Seedling Ltd, Rudrapur (Uttarakhand) during 2006-07. Subsequently, during 2007-08 eight (8.0) lakh ETPs were procured from Central Tarai Division, Haldwani. The procured material was utilized for raising poplar nursery at Jadua Hajipur.

To plant more than 60 lakh of poplar ETPs in farmers field it was necessary to raise poplar ETPs at mass scale therefore, a scheme called Kisan nursery was initiated under the project. To raise poplar ETPs under kisan nursery, farmers were motivated, suitably trained and assisted with appropriate guidelines at each and every stage of nursery raising. The poplar cuttings were provided by the institute free of cost and quality ETPs grown by farmers were buy-backed (@ Rs 5.00/ETP). Through kisan nursery, during 2007 to 2013 a total of 83.5 lakh poplar ETPs were raised by 535 farmers (approx) on 750-hectare land and buy-backed by the institute. The buy-backed poplar ETPs were distributed among farmers for raising nursery and planting under agroforestry.

v. Planting of trees in farmers field under agroforestry

Farmers were supplied quality planting materials raised under Kisan nurseries and the institute nursery. They were assisted in layout of plantations, intercropping of suitable crops; inter cropping of suitable crop combinations, silviculture of Poplar for better productivity and other technical know-how. The farmers were distributed about 2000 augurs (tool for pit digging) to facilitate a large number of plantations in limited period of time. More than 84 lakh plants were planted in farmers field including 68.5 lakh ETPs of Poplar and rest other tree species under agroforestry (Table 1).

vi. Growth of poplar in Bihar

Bihar was a non-traditional zone for poplar cultivation so, it was important to study the pattern of its growth and development. Therefore, its growth data was recorded annually and presented in Table 2.

After four years of planting, average height was recorded about 50 feet and girth of 2 feet. To obtain better growth, it was necessary to identify the Bihar specific and productive clone/s of poplar. Within the 5 years of its introduction in Bihar, it was popularised among the farmers and became first choice to be planted under agroforestry.

Table 2: Year-wise average growth of poplar in Vaishali district of Bihar

Growth Year	Average Girth (Inch)	Average Height (Ft)
Jan, 2007	5.8	17.0
Jan, 2008	9.9	22.5
Jan, 2009	14.5	27.4
Jan, 2010	17.9	36.0
Jan, 2011	24.0	48.9

vii. Buyers sellers meet

Since, Vaishali was a newer area for Poplar based agroforestry so, it was needed to create trust and confidence among farmers regarding assured market of their products. Keeping this in mind a buyers-sellers meet was organised on 27th -28th July, 2010 at Patna, which facilitated the interaction among poplar growers in the area and owner of plywood industries. In the meeting plywood industrialist from Yamuna

Table 1: Year-wise and species-wise distribution of plants (in Lakhs) for planting under agroforestry in Vaishali (Bihar)

FY	Poplar	Teak	Mahogany	Gamhar	Semal	Kadamb	Jamun	Bamboo	Others	TOTAL
2006-07	0.05	-	-	-	-	-	-	-	-	**0.05**
2007-08	1.22	0.28	-	0.03	-	-	-	-	-	**1.53**
2008-09	23.82	1.60	0.65	0.66	0.13	0.20	0.01	0.06	0.72	**27.85**
2009-10	21.94	3.90	0.14	0.27	1.00	0.28	0.37	-	1.64	**29.54**
2010-11	14.55	0.13	0.001	0.001	0.03	0.31	0.04	-	0.12	**15.18**
2011-12	4.62	1.35	0.50	-	0.30	0.30	0.03	-	0.02	**7.12**
2012-13	2.25	0.19	0.14	0.18	0.01	0.12	-	0.06	0.32	**3.27**
Total	68.45	7.45	**1.431**	**1.141**	**1.47**	**1.21**	**0.45**	**0.12**	**2.82**	**84.54**

Nagar, Haldwani, Roorkee, Kolkata and local industrialist from Bihar were participated. They were also taken to the farmer's field to assess the marketability and quality of plantations. The industry people expressed satisfaction and even granted agreement to purchase trees from the farmers.

Seeing the success of poplar-based agroforestry in Vaishali district, Govt. of Bihar excluded Poplar from the purview of transit pass and decided to replicate the Vaishali model in entire state and taken it in mission mode by launching Hariyali Mission. Under the mission it was targeted to plant more than 600 lakhs of plants under agroforestry with poplar as a major species.

Under the Hariyali mission the task of giving training and exposure to the farmers was given to Institute of Forest Productivity, Ranchi. Institute has organized, on-field training for more than 50,000 farmers and arranged Kisan study tours for farmers and sent more than 3000 farmers in 140 batches to the traditional areas of poplar-based agroforestry for exposure. The Kisan study tours were sent to UFTA, Haldwani, GBPUA&T, Pantnagar and CAFRI, Jhansi where they not only get class room training but also taken to the field of local farmers and wood-based industries. In North Bihar till 2018-19 a total of 500 lakh poplar ETPs and approx. 900 lakh other tree species were planted under agroforestry and farm forestry. More than 50 percent survival of planted tree species were recorded in Bihar with an average growth of 24-30-inch girth and more than 50 feet of height of poplar after 4 years of planting. The growth of poplar and other tree species were found encouraging in Gangetic plains and in Kosi areas viz. Vaishali, Bhagalpur, Purnea, Araria, Supaul, Darbhanga, Madhubani, Mujaffarpur, Begusarai etc.

Marketing issue

Due to non-availability of any big plywood industry or paper industry in Bihar, marketing of trees grown under agroforestry is biggest challenge for farmers. Despite of organizing Buyer-Sheller Meet in 2010, marketing of woods grown under agroforestry has not been fastened. Small industries and saw mills have limited capacity to buy the produce hence farmers getting less return. It is required to establish the peeling unit at different places in the state. Potential areas to establish the peeling units are Purnea, Darbhanga, Bhagalpur and Vaishali. Recently, Government of Bihar amended the industrial policy for Bihar and included wood-based industry in priority list. The government announced incentives for establishing wood-based industries in Bihar viz. land registration fee reimbursement, cheaper electricity, land diversion, incentive on bank loan interest etc. apart from these, government also assured all possible support for wood-based industries.

काष्ठ आधारित उद्योगों से होगा लाभ

पटना | हिन्दुस्तान ब्यूरो

उपमुख्यमंत्री सुशील कुमार मोदी ने कहा कि नई औद्योगिक प्रोत्साहन नीति में पहली बार काष्ठ आधारित उद्योगों को प्राथमिकता क्षेत्र में शामिल किया गया है। इससे राज्य के किसानों के करोड़ों पेड़ों को अब बाजार मिलेगा। 2012-13 से 2018-19 के बीच कृषि वानिकी को प्रोत्साहित किया गया, जिसके परिणामस्वरूप किसानों ने निजी भूमि पर 5 करोड़ पॉपुलर सहित अन्य प्रजाति के 8.82 करोड़ पेड़ लगाए हैं। साथ ही बांस की खेती को प्रोत्साहित करने को दो-दो टिशचू कल्चर लैब भी स्थापित की गई हैं।

कहा, इससे लुगदी व कागज उद्योग, दियासलाई, प्लाईवुड, प्लाईबोर्ड, लेमिनेट व विनीयर, टिम्बर व चिरान तथा बांस आधारित उद्योगों को भी बढ़ावा मिलेगा। कृषि वानिकी का उद्देशय किसानों की आमदनी में वृद्धि करना है। पिछले 8-10 वर्षों में लगाए गए पेड़ अब परिपक्व हो गए हैं, जिन्हें बेचकर किसान अच्छी आमदनी प्राप्त कर सकते हैं। राज्य में फर्नीचर, गृह निर्माण, पैकिंग, कृषि सामग्री, खेल के सामान, प्लाईवुड, विनीयर व दियासलाई उद्योग के विकास की असीम संभावनाएं हैं।कृषि रोड मैप के तहत बड़ी संख्या में सागवान, शीशम, महोगनी व गम्हार आदि के साथ करीब 5 करोड़ से अधिक पॉपुलर के पेड़ लगाए गए हैं।

औद्योगिक नीति

- कृषि वानिकी के तहत राज्य के किसानों को मिल सकेगा बाजार
- निजी भूमि पर लगे पोपुलर समेत अन्य प्रजातियों के 8.82 करोड़ पौधे

उद्योग लगाने पर मिलेंगी कई सुविधाएं

नई औद्योगिक प्रोत्साहन नीति में काष्ठ आधारित उद्योगों को शामिल करने से इन्हें बैंक ण पर ब्याज अनुदान, वैट की प्रतिपूर्ति व उद्योग लगाने के लिए खरीदी गई जमीन की रजिस्ट्री शुल्क का रिम्बर्समेंट, जमीन समपरिवर्तन व विद्युत से संबंधित सुविधाओं आदि का लाभ मिलेगा। न्यूनतम 25 लाख या उससे अधिक निवेश करने वाले और 25 या उससे अधिक कामगार वाले काष्ठ आधारित उद्योग इन लाभों को ले सकते हैं।

Agroforestry for wood based industry

A new proposal

H.D. Kulkarni

Sarvabhauma Forestry Consultancy Services, Hyderabad (Retd. Vice President, ITC Ltd., PSPD).
Email: sudhaharsh17@gmail.com

(The author is indebted to more than 45 persons belonging to various professions such as scientists, technocrats, foresters, industrialists and farmers from the WhatsApp group on Agroforestsry who inspired to make this agroforestry proposal and shared their views and gave valuable inputs on agroforestry and wood based industry)

With the present economic down turn facing India in 2020, the Wood Based Industry (WBI) is affected the most. Government of India's efforts to reverse the trend by promoting positive policy towards MSME sector and to become "Atmanirbhar" is a welcome step and more such steps are required to be undertaken. For generating the required quality and quantity of wood from agroforestry for WBI is one such step in that direction. India has to become Atmanirbhar in production of wood so that large quantity of wood based products are exported and at the same time substitute / reduce imports of wood and wood products for conserving the precious foreign exchange. India has the required land mass, the sun shine, the rain fall, indigenous fast growing tree species and enterprising farmers to translate this dream.

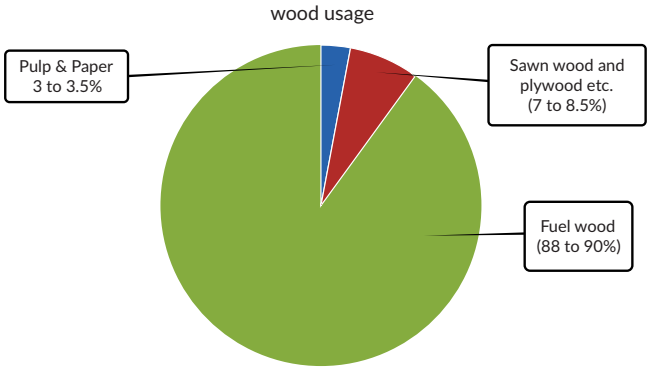
Wood production and consumption

The WBI consists of housing, construction, packaging, furniture, handicrafts, sports, railways, ship building, mining, bioenergy, pulp and paper, plywood and panel industries and consume large amount of wood for producing wood products. Despite large volume and importance of wood production and trade in India, reliable information on wood is scanty. The sector is largely unorganized and poorly monitored by the government, especially the domestic trade. The total estimated annual production of wood from natural forests is 3.175 million m^3. The annual production of wood from Trees outside Forests (ToF) is 44.34 million m^3 hence, the total annual production of wood is 47.51 million m^3 (CSE, 2017; NCCF, 2017).

Annual total estimated wood production (million m^3)

Timber	Wood production
Natural forests	1.205
FDC's	1.97
ToF	44.34
Bamboo	5.38
Sub-Total	52.90
Imports	18.01
Sub-Total (Timber)	70.90
Fuelwood	385.25
Total	456.15

Out of the total wood produced in India, 3 to 3.5% is used by pulp and paper, 7 to 8.5% by plywood and sawn wood and the remaining 88 to 90% is used as fuelwood (CSE, 2016).



Annual total estimated wood consumption (million m^3)

Wood consuming sector	Wood consumption
Construction, Furniture & Agricultural implements	48.0
Plywood and Panel	8.47
Paper and Paperboard	12.52
Total	68.9

As far as the annual consumption of wood is concerned, fuel wood alone amounts to be approximately 90% of the total wood production in India. House construction, Furniture and Agricultural implements; Plywood and Panel and Paper and Paper board consumption is at 68.9 m^3.

The estimated wood requirement (2020 yr.) of plywood industry for production of 10 million m3 plywood in India, with a conversion ratio of 60% from timber to plywood is 17 million m^3 and @ conversion factor of 1m^3 = 0.8 tonnes, the wood quantity works out to 13.6 million AST. The demand for Round wood Equivalent (RWE) is expected to increase from 58 million m^3 in 2000 to 153 million m^3 in 2020 (NCCF, 2020). By growing Indian timber trees for production of wood and wood related products there is an opportunity to save INR 48099.9 Crores.

Agroforestry plan

Agroforestry blends the practices of forestry and agriculture and can provide many ecological and economic benefits and leads to productive and sustainable land use practices. The most common agroforestry practices are alley cropping, silvihorticulture, silvipasture, riparian buffers, windbreaks and multi-story cropping. In addition to plant selection, site design and management are also key factors. Agroforestry and farm forestry have taken deep roots in India. The Trees outside Forests (ToF) are contributing to the increase in country's tree cover and are enhancing ecosystem services, besides meeting bulk of the country's demand of wood. All is not well on wood production, consumption, export and import in the present juncture. There is a need to further enhance agroforestry plantations in India for meeting the future quality wood demand of the WBI. A rigorous and committed action plan is required. Therefore, a new proposal is being made for consideration of the government to give further impetus to agroforestry.

Policy

The main policy parameters for agroforestry for wood based industry will be:

1. Food, wood and environmental security.
2. Plant trees to commensurate with consumption.

The idea is to create enough plantations to meet the demand of wood based raw material on continuous and sustainable basis for the wood based industry. The National Forest Policy 1988 and National Agroforestry Policy 2013 will be the guiding polies to take forward the agroforestry plantations. In the National Forest Policy 1988, the WBI have been advised to encourage agroforestry for raising plantation to meet their raw material demand.

Objective

1. Make WBI self- reliant on raw material front through agroforestry plantations and sustaining the regular supply of wood to WBI.
2. Development and deployment of a uniform quality timber for plywood and panel industry from Melia dubia and other suitable indigenous species. Make in India approach for production of top class quality plywood and decorative product for export.
3. Enhancing/doubling the income of farmers.
4. Substitute/reduce import dependence and save precious foreign exchange.
5. Access environment-friendly/green markets both within and outside the country.
6. Providing livelihoods to the millions of people.
7. Enhance environmental/ global services - increasing country's green cover, carbon stock, biodiversity and thus ecosystem services (water, clean air, aesthetics etc.,).

Duration of the agroforestry project

As the rotation age (harvest period) of most of the commercial timber species is more than 7 years hence, the duration of the project for Action Plan development shall be for 10 years considering different soil types, amount of rainfall and its distribution.

Institutional mechanism

A Special Purpose Vehicle (SPV) in the form of Agroforestry Board (stand-alone organization) is proposed for promotion of agroforestry plantations for meeting the raw material demand of the wood based industry on continuous and sustainable basis. Successful examples of Tobacco Board, Coffee Board, Rubber Board, Jute Board, Spices Board etc., exist in India. On the similar lines “Agroforestry Board” shall be formed. The WBI shall take the lead as one of the key stakeholder in formation of Agroforestry Board. The Agroforestry Board shall facilitate the growth of agroforestry as a commercial viable business for the farmers through ease-of-doing business and closing the gap in free and fair market-based wood sector in the country. The Agroforestry Board shall provide policy inputs to Government (GoI and States) to remove hurdles in raising plantations, logging and free movement of commercially important timber across

the country. The agroforestry Board shall create and disseminate market information (demand, supply and price) and techno commercial inputs for the farmers with economics of different agroforestry/ farm forestry models/options. Further, The agroforestry Board shall facilitate an organized, transparent and efficient supply chain and markets that should result in to better price discovery for the benefit of all the stakeholders. This would in long-run remove the cycle of erratic and deep price declines leading to farmers selling wood under distress. The Institutional Framework for agroforestry Board shall comprise of a Central office with Chairman (National Coordinator) and State offices with State Coordinator for planning and implementation of agroforestry programme. This agroforestry Board shall be part and parcel of the Ministry of Agriculture, Government of India. However, other important sectors like Forest, Medicinal Plant, Horticulture, Biodiversity etc., shall represent in the agroforestry Board for integrated programs of agroforestry.

Chairman (National Coordinator) Office and its Role

- Policy, legal and institutional framework.
- Develop guidelines for agroforestry. Suggest around 5% area in each state to be brought under agroforestry in which intercropping to be made feasible for at least half of the age of retaining trees on farmland.
- Inter-sectoral linkages with sister organizations and others like financial institutions for refinance schemes etc.
- Coordination with International (like World Agroforestry Centre), national and state level institutes for R & D support on agroforestry.
- Coordination with international agencies for attracting funds for promoting agroforestry in deficit locations along with coordination with industrial sector to develop local wood based industry to sustain the production and consumption of wood on sustainable basis.
- Coordination with industry for CSR funds, wood requirement, wood certification etc., matters.
- Marketing intelligence and balancing demand supply chain
- Capacity building and interlinking different industries for their demands of raw material

State Coordinator and its Role

- Look after Agricultural development including agroforestry, industrial clusters, wood marketing etc.
- Listing and upgradation of agroforestry species from time to time. Balancing agroforestry plantation programme with demand and supply i.e., Keep tract on wood balance based on pattern of planting and harvesting on regular basis to avoid glut and wood deficit (For example, Tobacco Board regulates tobacco cultivation on annual basis and do not permit tobacco cultivation more than the sanctioned quantity of production and stop issuing license to growers).
- Monitor planting stock quality and its supply.
- Monitoring expansion of agroforestry plantations, their harvesting etc., matters.
- Coordinate with other state units for wood supply / demand during wood deficit and surplus situations so that farmers and industry continue to maintain a sustained balance in wood production and harvest.
- Develop wood trading parameters and enforcing their implementation. Facilitate dialogue between industry and farmers.
- Develop social networking of local technical support system for important contract operations like planting, pruning, felling and transportation of agroforestry produce and also fixing and revising rates from time to time. Draw guidelines for Contract farming.
- Dispute resolution mechanism.

The agroforestry Board shall also set up the following divisions:

1. Nursery division

a. To raise quality planting material and supply to the enlisted growers.
b. Available site specific clones of various species and genetically improved seed material is to be involved in raising the planting material in the nursery.
c. Plants to be raised in Root trainers in the nursery for better survival and growth in plantations.

2. Plantation division

The division shall appoint NGOs/agencies and entrust them with plantation operations.
The NGO shall maintain all the relevant records concerning plantations. NGO/agencies will also liaise with growers, industry, market and government.

3. Marketing division.

This division shall help in regulation of market price for the agroforestry products and assist the growers in obtaining the correct market price. This division will also participate in the district level market committee meetings from time to time for fixation of the prices, minimum support prices (MSP) etc. Alternatively, the division shall hold dialogue with growers and industry

and other users and regulate/evolve price control mechanism.

4. Extension and Training division

The Extension and Training division will provide necessary help and assistance to the farmer by imparting the knowledge on package of practices for growing successful plantations. This division shall also provide necessary training to the stakeholders on various aspects of agro-forestry plantations such as – species, package of practices, plantation maintenance, disease and pest management, fire control, logging, transport etc., aspects.

Over all, the agroforestry Board shall act as facilitator and service provider on policy inputs to the governments to make agroforestry farmer friendly. Collaboration with wood based industries in creating information base, organizing supply chains and wood trading platforms (spot/forward/futures trading). Wood based Industry and their associations shall play an active part and bear responsibility for promotion of agroforestry.

Plan A-1 Target 1000 ha/year (Total land for 7 years is 0.14 million ha)

Year	Plywood industry		Participation of 20 states	
	Wood (AST - Lac)	Plantation (Area – Ha)	Wood (AST - Lac)	Plantation (Area – Ha)
1	1.5	1000	30	20000
2	1.5	1000	30	20000
3	1.5	1000	30	20000
4	1.5	1000	30	20000
5	1.5	1000	30	20000
6	1.5	1000	30	20000
7	1.5	1000	30	20000
Total	10.5	7000	210	140000

Benefits	
Estimated Number of farmers	If 4 ha/farmer land is consider then 35,000 farmers will be involved in agroforestry.
Economic - Estimated creation of wood asset	@ Rs.1,50,000/ha/year or Rs. 7000/tonne (ICFRE 2012 – Annexure 1), the total amount works out to 14,700 Cr. from 210 lac tonnes worth of wood generated from 140000 ha over a period of 7 years.
Foreign exchange	Save / Earn precious foreign exchange by reducing import of timber and its products and by producing indigenously wood and its products for export.
Societal - Estimated employment generation	Nearly, 63 million person days employment is generated from 140000 ha plantation (1ha = 450 person days – Nugent et.al 2003) over a period of 7 years. The activities involve from nursery till harvest of plantation.
Environmental - Estimated CO_2 Capture	The 140000 ha plantations will capture 32.85 million tonnes of CO2e from the atmosphere (Kulkarni, 2013).
Soil & water conservation	The soil & water is conserved in the plantations and addition of leaf litter will improve the soil condition.
Greening of land	The Trees outside forests (ToF) will add to the forest tree cover and contribute achieving 33% forest tree cover for India.
Reduce pressure on natural forests	The wood requirement is met through plantations and it will save the natural forests.

Plan A-2 Target 5000 ha / yr. (Total land for 7 years is 0.7 million ha)

Year	Plywood industry		Participation of 20 states	
	Wood (AST - Lac)	Plantation (Area - Ha)	Wood (AST - Lac)	Plantation (Area - Ha)
1	7.5	5000	150	100000
2	7.5	5000	150	100000
3	7.5	5000	150	100000
4	7.5	5000	150	100000
5	7.5	5000	150	100000
6	7.5	5000	150	100000
7	7.5	5000	150	100000
Total	52.5	35000	1050	700000

Benefits	
Estimated Number of farmers	If 4 ha/farmer land is consider then 175,000 farmers will be involved in agroforestry.
Economic - Estimated creation of wood asset	@ Rs.1,50,000/ha/year or Rs. 7000/tonne (ICFRE 2012 – Annexure 1), the total amount works out to 73,500 Cr. from 1050 lac tonnes worth of wood rated from 700000 ha over a period of 7 years.
Foreign exchange	Save/Earn precious foreign exchange by reducing import of timber and its products and by producing indigenously wood and its products for export
Societal - Estimated employment generation	Nearly, 315 million person days employment is generated from 140000 ha plantation (1ha = 450 person days – Nugent et.al 2003) over a period of 7 years. The activities involve from nursery till harvest of plantation.
Environmental - Estimated CO_2 Capture	The 140000 ha plantations will reduce (offset) 164.28 million tonnes of CO_2 from the atmosphere (Kulkarni, 2013)

Wood demand and land requirement for agroforestry

The pulp and paper sector presently requires 0.7 million As Such Tonnes (AST) wood per annum (In 2012-13 the wood requirement was 11 million). The estimates of wood requirement for plywood and allied industries is around 17 million m^3. At conversion factor of $1m^3$ = 0.8 tonnes, the required wood quantity works out to 13.6 million AST per annum. The estimated land requirement for growing 13.6 million AST wood per year is approximately 90,666 ha (considered average wood yield at 7 years is 150 AST/ha) and for total 7 years cycle, the total land mass to grow plantation works out to 6,34,667 ha. The estimated land requirement for pulp and paper is 3.65 lac ha and for plywood and other WBI of 6.35 lac ha which will total to nearly 1 million ha. This is in addition to the present / existing area under agroforestry.

Action plan - Plantation Targets

Plan A-1

To make a humble beginning, to start with a minimum of 1000 ha plantation particularly of plywood species by major states dealing with plywood industries is to be fixed. For pulp and paper, already the agroforestry / farm forestry plantations exist and it is an on-going process. The pulp and paper industry on an average promote plantations to the tune of 20,000 to 40,000 ha/yr. approximately. Nearly, 100 million (10 Cr.) plants are produced in the nurseries established by the industry as well as private parties (private nurseries). The 1000 ha will generate a minimum of 1,50,000 AST (@150 AST/ha) wood at 7 years of harvest period and if 20 states participates in agroforestry activity then 30,00,000 AST wood can be generated and it nearly meets 1/5 of the requirement of the total 13.6 million AST wood per annum.

Plan B Target 142857 ha/yr. (Total land for 7 years is 1 million ha)

Year	Plywood industry		Other wood based industry		Participation of 20 states Total	
	Wood (AST - Lac)	Plantation (Area - Lac Ha)	Wood (AST -Lac)	Plantation (Area - Lac Ha)	Wood (AST - Lac)	Plantation (Area - Ha)
1	136	90666	78	53000	215	142857
2	136	90666	78	53000	215	142857
3	136	90666	78	53000	215	142857
4	136	90666	78	53000	215	142857
5	136	90666	78	53000	215	142857
6	136	90666	78	53000	215	142857
7	136	90666	78	53000	215	142857
Total	952	634666	548	365000	1500	1000000
%	63.5		36.5		100	

Benefits	
Estimated Number of farmers	If 4 ha/farmer land is consider then 2,50,000 farmers will be involved in agroforestry.
Economic - Estimated creation of wood asset	@ Rs.1,50,000/ha/year or Rs. 7000/tonne (ICFRE 2012 – Annexure 1), the total amount works out to 105,000 Cr. from 548 lac AST worth of wood generated from 10 lac ha over a period of 7 years.
Foreign exchange	Save/Earn precious foreign exchange by reducing import of timber and its products and by producing indigenously wood and its products for export.
Societal - Estimated employment generation	Nearly, 450 million person days employment is generated from 10 lac ha plantation (1ha = 450 person days – Nugent et.al 2003) over a period of 7 years. The activities involve from nursery till harvest of plantation.
Environmental - Estimated CO_2 Capture	The 10 lac ha plantations will capture 234.69 million tonnes of CO_2 from the atmosphere (Kulkarni, 2013).

Presently, the plywood industry is drawing wood from the existing poplar and eucalyptus plantations which will continue and it will also not hit the growers of poplar and eucalyptus in the long-run. First, 1000 ha humble target is to be achieved successfully with the desired species and later it can be scaled up gradually.

Plan B

To undertake 1 million ha agroforestry plantations over a period of 7 years is an ambitious target to achieve. However, with participation of at least 20 states the plantation area per state will be 7142.85 ha/yr. (7142.85 ha x 20 states = 142857 ha). However, all the Indian states and Union territories can participate as per their requirements.

ICFRE (2012) and NCCF (2017) reported that the land under poplar plantation is 3,62,700 ha and pulpwood plantation for pulp and paper industry is 7,40,000 ha which is 11,02,700 ha (1.1 million ha). If all the 1.1 million ha plantations exist today, it will meet entirely the wood demand of WBI. However, the figure of 1.1 million ha is a cumulative figure for the past 2 decades and most of the area might have been either harvested, reverted to agriculture or put to other land uses. Out of 1.1 million ha, if one has to consider the present standing crop, it will be in the range of 3 lac ha approximately and hence, additional agroforestry plantations of 7 to 10 lac ha is necessitated to meet today's and future raw material demand of the wood based industry. The action plan of planting 1 million ha is therefore, proposed to meet the requirement of raw material of WBI. The Plan however, does not take into consideration extra raw material requirement arising due to expansion of capacity by the industry or from the future green field mills establishment. If new mills come up, then the plan has to be revised suitably.

Species to be promoted in agroforestry

For a tree to qualify for agroforestry, it should have the qualities of fast growth, provide litter or organic matter to enrich the land, fodder for cattle, fuelwood and timber for domestic needs. Apart from these, it should have least negative effects on the production of other agricultural crops. The spectrum of Indian tree species with respect to timber, utility and studied so far is presented below:

The spectrum of Indian tree species with respect to timber, utility & studied so far is presented below:

Number of wood species	4000
Number of species with timber value	1600
Number of species studied so far	500
Number of species of commercial value	160
Number of species lesser known in utility perspective	350

The proposed agroforestry plantation strategy here emphasizes involving small number of tree species (limited to 10 species) with a rotation age (harvesting period) of 7 years and productivity of 20 to 30 tonnes/ha/yr as farmers will grow only those trees which generate higher returns and integrate well in his farming system. Industry will also pick up a species that is cost effective and enable them to recover material cost from the product manufactured by them. Prior consent of the wood based industry is to be obtained for growing the chosen species under agroforestry. However, a maximum of 5 species and 5 areas are to be identified keeping in view the agro-ecosystem. The target and area for agroforestry may vary from state to state. Developing wood production without local demand may have an adverse impact as transportation to long destination may result in low net returns to growers. Hence, it is better to develop state wise wood based clusters with wood based industries. List of priority species proposed are given hereunder and depending up on the agro-ecological zones, 5 species out of 22 fairly fast growing indigenous tree species are to be chosen. Poplar, Eucalyptus, Casuarina and Subabul however continue to be grown in agroforestry. The list of priority species is given below

1. *Melia dubia and Melia composita*
2. *Albizzia procera*
3. *Ailanthus excelsa*
4. *Gmelina arborea*
5. *Grevillea robusta*
6. *Swietenia macrophylla & Swietenia mahagoni*
7. *Artocarpus hirsutus*
8. *Albizzia falcataria*
9. *Khaya senegelensis & Khaya anthotheca*
10. *Melia azedarach*
11. *Parkia biglandulosa*
12. Salix spp.
13. *Anthocephalus cadamba*
14. *Lannea grandis*
15. *Morus alba*
16. *Kydia calycna*
17. *Duabanga sonneratioides*
18. *Prosopis cineraria*
19. *Dalbergia sissoo*
20. *Cedrala tuna*
21. Poplar
22. Eucalyptus, Leucaena, Casuarina

Some important species require attention for introduction in agroforestry for meeting the demand of cottage industries (agarbathi industry, chopsticks, tooth peck, cork, prop sticks for supporting against lodging of agri-horti crops), Essential Oil industry (Sandalwood) and Bamboo and cane based products industry. Farmers are voluntarily growing *Bambusa balcooa*, *Oxytenanthera stocksii*, *Melocanna bambusoides* and other bamboo species. More bamboo plantations if promoted can stop import of bamboo and its products benefiting farmers and industry. Very few sandalwood *(Santalum album)* and Red sandars *(Pterocarpus santalinus)* plantations on large area have come up in farm land. Sandalwood tree also is a good agroforestry tree species but is slow growing and also needs to be promoted. Few fast growing species such as *Broussonetia papyrifera* (paper mulberry), *Acacia mangium*, *Thespesia populnea*, *Millingtonia hortensis* can be introduced in agroforestry in specific areas. *Acacia nilotica*, *Alnus nepalensis*, *Ulmus villosa*, *Ceiba pentandra*, *Gliricidia sepium*, *Pongamia pinnata*, *Sterculia urens* are important tree species to be grown in agroforestry. Growing of Indian tree species especially for plywood manufacture like *Melia dubia*, *M. composita* etc., under agroforestry will replace imports of Gurjan, Luring, Beech, Okoume, and Radiata pine.

Growing of long rotation timber species

Imported timber is mainly of large dimensions which are presently not grown under agroforestry in India. Strategically, Forest Development Corporations of various states shall be entrusted with the responsibility to grow timber trees (Both commercial timber trees and import substitution timber trees) which have relatively longer rotation period as farmers hardly grow them. Very few farmers (such as absentee land lords) could venture in to growing trees of longer rotation but they are exceptions. A separate mechanism between FDC's and the WBI (PPP model/SPV) is required to be evolved and made operational

Land use pattern in India - current statistics

From the total area of 3,287,263 sq km of India's geography, 60.5% (1988749.115 sq km) of area is agricultural land , including 52.8% being arable land;

4.2% being of permanent crops and 3.5% being permanent pasture (CSE, 2017). This indicates that there is enough land available for practicing agroforestry.

Agroforestry models

1. For heavy crowned trees, Bund planting shall be encouraged. Nearly, 20% of agroforestry plantations shall comprise of bund planting.

2. Alley cropping plantation model shall be taken up for narrow crowned trees. Nearly, 25% area is to be earmarked for trees while, 75% area for food crops. Nearly, 30% of plantations shall be promoted under this pattern.

3. Block plantations shall be promoted where the grower does not want to take up agricultural crops. Nearly 20% plantations shall be promoted under block plantations.

The above 3 types of plantations can come under rain-fed or irrigated conditions where ever water availability is there for irrigation. Plantations shall also be raised under Drip irrigation for effective utilization of water. It is to be borne in mind that excessive irrigation and fertilization does not help in achieving required tree growth and will act inimical against tree growth. It may create fungal diseases in the plantations. However, experiments on optimal irrigation and fertilization have shown that nearly 40% more wood can be produced.

4. The balance 30% plantations can come up with mix of the several existing agroforestry models along with silvi-horticulture, silvi-pasture systems.

5. Well known models - poplar and eucalyptus be continued.

Crop component for Poplars based agroforestry model

- During rabi season, wheat, mustard, potato, berseem, marigold, oats, grows well during six years of rotation except oats which does well up to 2nd year.
- During kharif season crop's viz., arvi, mentha, mung, maize, sorghum during first year. Crops viz., mentha, mung, bajra, sorghum, cowpea, arvi during second year and bajra, cowpea, arvi during third years. Kharif crops become uneconomical after 3rd years of rotation age of poplar during kharif season.
- Annuals i.e. turmeric, sugarcane and ginger does well under poplar up to 3rd year of age.

Crop component for eucalyptus

During rabi season, wheat, mustard, potato and fodders like barseem and oats can be successfully grown at least during first two years. During kharif season, fodders like sorghum and bajra can be grown successfully after the first year of planting. Out of fodders, cowpea and bajra yield higher than sorghum during initial two years. However, after 4 year of plantation (4 x 2m), yield of these intercrops reduces drastically because of dense shade. This is the stage when trees attain sufficient height and girth to be sold as poles thus could be harvested.

Economics of growing selected species in agroforestry in India

Farmers grow agroforestry plantation voluntarily on their farms as it is profitable for them. The short and long term rotation tree crops have a favourable benefit – cost ratio with high internal rates of returns (CSE, 2016).

Species	Poplar	Eucalyptus	Kadamba	Teak
Rotation year	7	10	8	20
No of trees/ha	500	1250	320	475
Expenditure/ha-Rs.	82,292	1,13,215	43,776	2,09,715
Benefit (Rs.)	2,72,553	2,66,220	68,124	4,19,961
B:C Ratio	3.31	2.33	1.6	2.0
IRR%	68	32	31	30

ICFRE (2012) gives Benefit: Cost ratio for poplar of 2.13:1 with intercropping and 1.92:1 without intercropping. Hence, agroforestry is a profitable venture to the farmer.

Economics to allure the farmers for adoption of agroforestry

1. The economics of the agroforestry models in each of the agro climatic zones required to be monitored regularly. It should be on the basis of Internal Rate Return to help the farmers select the various options among the agroforestry models and cropping systems available to the farmer. The breakeven price equivalent to the most prevalent cropping system in the region shall be considered while fixing the price.

2. Extent planting of the tree species should be regularized on the basis of demand and supply

principal to maintain prices structure in the region. Besides this, price of each species should be regulated through legal mechanisms.

3. Minimum support price (MSP) like agriculture be extended to agroforestry plantations. MoU shall be established between the growers and the industry.

4. Special incentives shall be given for the wood procured by the industry on per tonne basis, if the grower meets the demand of quality/size of timber prescribed by the industry.

5. Incentives shall also be given if the grower becomes member for facilitating Forest Certification. This incentive is to be given for procurement of certified wood on per tonne basis to the farmer.

Export ban of timber

There is complete ban on export of logs or sawn timber of indigenous species out of the country. This ban may be lifted so that farmer can grow wood from agroforestry plantations for export and add to the Nations exchequer.

Contract farming in agroforestry

Contract farming in Indian agroforestry is being applied for the last 3 decades but it is still evolving. Contract farming has been practiced since 1984 in agroforestry when WIMCO seedlings Ltd., introduced poplar in north India. WIMCO – NABARD and ITC – NABARD contract farming with Bi and Tri partite agreements met the objectives in creating awareness on poplar and eucalyptus cultivation (Dhiman, 2013) in India. It was also practiced in the last decade in agriculture in few crops. But the success was not achieved up to the desired level in all the cases. There are several contracts such as contract for growing nursery plants; growing plantations; managing plantations; growing inter crop; sale of standing harvestable trees and for harvesting trees and its trade. However, contractual agreement in agroforestry is the main binding force between contracting parties to remain engaged in the scheme. The agroforestry contract farming is mainly implemented through Bi and Tri partite agreements. In case of default, the contract between the farmers (growers) and the buyers (industry) is enforceable through legal mechanism (Consumer Dispute Courts). The Contract Farming Act 2018 and Tamil Nadu Contract Farming Act are now available for implementation.

Forest transit permit rules

Most of the states in India have exempted a good number of species grown under agroforestry. However, certain species which are now chosen may not be exempted under transit permit rule and the concerned farmer/industry should represent to the respective state government for inclusion of the species in the list of exempted species (for example *Albizzia procera* is not exempted from transit permit rule in certain states). Exemption of all timber species grown by farmers in agroforestry is to be made and all the restrictions related to felling permits and transit permits are to be removed which will pave the way for promotion of agroforestry.

Agroforestry plantation data

The data on supply of seed/seedlings from the nursery, plantation data is required to be maintained. All the data is to be captured in MIS/DDS and inventory for agroforestry plantation is maintained. The remote sensing technique to be employed and the area geo tagged.

Plantation R & D

ICFRE's regional institutes such as FRI, IWST and IPIRTI shall be entrusted with R&D related to plywood/veneer/particleboard/MDF etc. Research and development on plywood, strength properties, natural durability, treatability, wood working qualities etc., is to be taken up on 10 species to be involved in agroforestry plantations.

The ICAR/ICFRE's regional Institutes, SFRI's, CAFRI, CRIDA, State Universities and the wood based industry with plantation R&D set up shall be entrusted with the following research work.

1. Standardization of nursery protocol for production of quality seedlings.
2. Development of clonal propagation protocol and shortlisting of at least 15 best clones per species for commercial cultivation.
3. Development and standardization of species wise package of practices.
4. Standardization of agroforestry model for maximum productivity and output.

Agroforestry Board shall assist in introduction of species such as *Pinus tecunumanii* from Africa (Tanzania, South Africa) as it is a choice species for plywood industry in Africa. The harvest period is at 7 to 8 years. Many other important exotic timber species are to be introduced and their trials conducted.

Logging

Due to shortage of labour, various field operations like felling, debarking, billeting etc., shall be done through machines. This will also save wood which is lost during axe or saw felling. Reduced impact of logging international guidelines are required to be followed.

Finance

The Agroforestry Board can help in obtaining finance from the industry or from the bank for raising plantations through Bi partite (agreement between grower and industry) and Tri partite (agreement between grower, industry and bank) agreement. If industry promotes the plantations under its direct finance scheme or with the government help in the form of loan, at the time of sale of the produce, a clause in the agreement be inserted that 60% benefit be given to the grower and 40% retained for promotion of agroforestry plantations which will act as a Revolving fund.

For R & D on development of clones of desired species for plywood, a CESS fund shall be created by levying 0.5% on purchase of all agroforestry timber. The other way is, that every wood based industry shall directly contribute to the CESS fund certain amount (say Rs. 5 lac per unit) for plantation R&D. As there are more than 4000 units, a sizable amount (Rs.20,000 lac) can be generated for R&D purposes. Funding can also come from the CSR funds. Innovative models for financing agroforestry plantations need to be evolved given the long gestation period and high risk for the farmers. Concessional credit, Government incentives, corporate financing, CSR Funds, CAMPA Funds to be made available to the farmer. Price assurances are some of the means to make plantations financially viable and hence can act as sustainable farming option.

Insurance

The agroforestry plantations required to be insured against pest and diseases and natural calamities. Provision for payment of insurance premium be made either by individual grower, by the industry or by the bank which advances the loan amount to the grower. Insurance for drought, flood, pest and disease, fire and theft can be obtained. The insurance company insures the few perils at higher premium cost.

Carbon benefits

At the outset, let us understand that no carbon benefits are going to be there for agroforestry plantations. There is no regulatory market mechanism like CDM exist now. Voluntary markets are also not buying the CERs / VERs and even if they buy the price the buyers quote is less than 30 shillings. Hence, it is not worth getting the project VER certified spending huge amount. Let the Wood based industry not spend its valuable time and resources looking for carbon benefits. Instead, the wood based industry can show the carbon capture (carbon sequestration) benefits for attaining carbon neutral, positive or negative status under sustainability reporting exercise of CSR. For example, ITC reports in its sustainability report that its emissions are not only offset by carbon sequestration from plantations promoted by the company but it sequesters more than its emissions. The wood based industry has to maintain year wise plantation data to show that the company is promoting agroforestry plantations. Moreover, the growth data is required to be collected every year for working out the total wood (biomass) production which forms the basis for calculating CO_2 capture. Apart from this, the emission figures need to be compiled for arriving at the carbon status.

Extension and Training

Establishment of demonstration plots: This will boost the tree farming among farmers because “seeing is believing”. These demonstration plots shall be established with different species either in blocks or in different agroforestry models. These plots will serve as a powerful tool for extension and training as the farmers can pick and choose the species and agroforestry model for planting in their land. Necessary help and assistance to the farmer be given by imparting the knowledge on package of practices for growing plantations successfully. Training shall also be provided to the stakeholders on various aspects of agroforestry plantation such as - species, package of practices, plantation maintenance, disease and pest management, fire control, logging, transport etc., aspects. Extension and training material shall be provided in local language to the growers.

Conclusion

A Special Purpose Vehicle (SPV) in the form of “Agroforestry Board” is proposed for promotion of agroforestry plantations for meeting the raw material demand of the WBI on continuous and sustainable basis. This strategy to enlarge agroforestry plantations appears to be the solution for meeting the entire demand of quality wood on sustainable basis for the WBI. High yielding, short rotation agroforestry plantations in addition to restoring marginal lands to high sustainable productivity, will also create opportunities for significant value addition through local processing of plantation wood and save large amounts of scarce foreign exchange used to import of wood and wood based products. Therefore, agroforestry can bring "Brown revolution" in India and lead to a Win – Win Situation.

Wood Technologist Association (WTA) is India's apex non-government organisation of plywood & other wood-panel based industries, providing a unique platform for all stakeholders: Government - Research Institutions – Industry – Machine Manufacturers - Technologists - Agroforestry Farmers, to interact and introduce path-breaking measures for progress of the industry.

WTA strives to make true the vision of Hon'ble Prime Minister Shri Narendra Modi of making wood-sector "ATAMNIRBHAR" and for past 12 years has been relentlessly pursuing the cause of its stakeholders, addressing their key issues and seeking suitable policy-changes with Government agencies (MoEFCC, FRI, IPRITI, FIPPI, IWST and others).

WTA, led by President: Shri S.C. Jolly & a team of professionals' technologists / field-experts, also collaborates with international wood-chambers / associations for mutual co-operation & adoption of best practises in the industry. WTA has organised host of conferences, seminars, training workshops, awareness campaigns and Industry-meets for taking forward initiatives of the industry.

WTA is a member of:

1. Bureau of Indian Standards (BIS) CED-9 CED-20 Committees.
2. President WTA (Shri S.C. Jolly) is a Member of Managing Committee of FIPPI.
3. President WTA (Shri S.C. Jolly) is a Member of Steering Committee of IPRITI.
4. President WTA (Shri S.C. Jolly) is a Life Member of IWST, Bangalore.
5. WTA, since the past decade, is in continuous dialogue with Ministry of Environment, Forests & Climate Change (MoEF&CC) and made representations to their Hon'ble Ministers: Shri Jairam Ramesh, Shri Anil Madhav Dave, Dr. Harsh Vardhan and recently to Shri Prakash Javdekar for bringing forth relevant issues of plywood industry.
6. WTA submitted Memorandums to MoEF&CC on various occasions for considering demands of the Industry /Stakeholders for driving suitable policy-changes like reduction in GST, lease of barren-land to farmers for enhancing green cover by plantation drives, research & development on Melia Dubia as substitute of face-veneer, foreign-currency savings through reduction in imports, transportation-subsidy and similar issues. Recently, on WTA's perusal, the e-Transport facility for farmers was agreed upon by Government of India.
7. WTA and FRI (Dehradun) collaborated under Green India Mission to organize Industry-Institute- Farmer- Meets at Ludhiana (Punjab), Yamunanagar (Haryana) and Pantnagar (U.P).
8. WTA's key role in agroforestry was explained to Shri C.K. Mishra (Secretary, MoEF&CC) by Shri Manoj Gwari (Secretary, WTA) at a meet organized at Forest Research Institute, Dehradun.
9. WTA hosted international delegations from Malaysia, China and Ghana for partnership - dialogue with Indian Plywood Business Groups. In a recent visit of Sarawak Timber Association from Malaysia, WTA coordinated and organized their meetings with IPIRTI and other agencies.
10. WTA, under aegis of Shri S.C. Jolly, started the National WhatsApp Group: "Agroforestry" bringing together key decision-making administrators, leading industrialists and other subject-matter experts, during the COVID times for suggesting and implementing the way-forward for overcoming challenges being faced. The patronage and active-participation of all members including Additional Secretary Dr. Alka Bhargava, Dr. Arun Rawat (DG, ICFRE & Director, FRI), Dr. M.P. Singh (Director IPIRTI & IWST), and other eminent personalities (Industry Association heads, Senior-Industrialists & Technical experts) has brought out innovative & viable solutions.
11. WTA participated and organized multiple webinars in which leading subject-experts shared views / opinion about how to tackle the problems being faced by each stakeholder
12. WTA (Shri G. Rajput, V.P) participated in R&D work with Senior Scientist Shri D.P. Khali, FRI.
13. WTA organized numerous hands-on trainings with the Industry for aspiring Technologists.
14. WTA assists in industry placement of Technologists pan-India as per their skill-set.

WTA, in coming times, endeavors to take forward the best-interest of Indian Plywood Industry!

WOOD TECHNOLOGIST ASSOCITAION
5B-F, Professor Colony, Yamuna Nagar, Haryana (India)
E-mail ID: woodtech_india@rediffmail.com Contact: +91-78958 87383

AVDANCED WOODWORKING

TRAINING CENTRE

Advanced Woodworking Training Center (AWTC) started in 2003 as an Indo-Italian joint project between Institute of Wood Science and Technology (IWST), Bengaluru, Italian Trade commission (ICE) and the Italian Woodworking Machinery and Tools Manufacturer's Association (ACIMALL). The Centre, presently being run by IWST, is regularly offering throughout the year following two advanced woodworking training courses.

A. **One Year Diploma Course in Advanced Woodworking**

B. Certificate Course in Wood Product Designing and Development
Level 1: Conventional Woodworking and Finishing (4 Weeks)
Level 2: Product Designing and Development on CNC Router (4 Weeks)
Level 3: Product Designing and Development on PYTHA 3D (2 Weeks)

Aim of the Course: To enhance the skill in the area of woodworking to attain global competitiveness by using state of the art machineries. Upon successful completion of training, the trainees will be able to handle advanced woodworking machines for product development. The centre will also liaison with wood based industries for placement.

Target Group: Individuals/students/carpenters/persons working in wood based industries.

IWST is a premier research institute under the aegis of Indian Council of Forestry Research and Education (ICFRE), of the Ministry of Environment, Forests and Climate Change, Government of India. Being the only institute in the country dedicated to the cause of Wood Science & Technology, the institute is recognized as Center of Excellence in Wood utilization. With a specialized team of scientists, the Institute is carrying out frontier research in wood identification, processing, wood composites, wood modification, wood protection, wood energy, wood quality assessment and tree improvement.

For further details, please contact :
Officer-in-Charge, AWTC,
Institute of Wood Science and Technology,
18th Cross, Malleswaram, Bengaluru - 560 003
Phone: +91-80-22190148, 170, Email: awtc_iwst@icfre.org

My reputation is built on the quality of my work.

I CHOSE CENTURYPLY.

OUR PRODUCT PORTFOLIO: PLYWOOD | LAMINATES | VENEERS | DOORS | MDF

Follow us on: CenturyPlyOfficial CenturyPlyIndia CenturyPly1986

For any queries, call us on **1800 5722 122** or **SMS 'PLY' to 56070**

wood *is* good

GROW MORE, USE MORE

Published by

Institute of Wood Science and Technology
Indian Council of Forestry Research & Education,
(An Autonomous body under Ministry of environment, Forest & Climate Change),
P.O. Malleshwaram, Bengaluru – 560 003, Karnataka, India
E-mail: dir_iwst@icfre.org | Website: http://iwst.icfre.gov.in

Designed by : Samvida Communications (OPC) Pvt. Ltd.
Contact: Meghana S Belavadi, meghana@samvida.biz, +91 9886201993