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(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.

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- Developed improved germplasm of many forest tree species.
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High performing and disease resistant clone of *Melia* sp.

CYCUS v. 1.0

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

Wood Welding

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

Wood Welding Machine

Indian Council of Forestry Research and Education

New Initiatives

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

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

Heat storage based modified Solar Kiln

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

Head based storage Solar Kiln

Xylarium

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

Xylarium- Collection of Authentic wood samples

Tree hollowness detection technique based on ultrasonic waves

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

Measurement of hollowness in a tree using ultrasonic detector

Agroforestry models

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

Poplar based agroforestry model with wheat

Innovative Bamboo Bottles

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

Bamboo bottles

For further details please contact :
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WOOD POLYMER COMPOSITE

A Technology from IWST

- The technology provides an opportunity to replace up to 50-60% plastics by environment friendly natural fibers.
- Any type of woody material like lops and tops, branches, wood waste, saw dust, bamboo, lantana, jute, coir, etc. can be used for this purpose.

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संजय कुमार
SANJAY KUMAR

सत्यमेव जयते

FOREWORD

वन महानिदेशक एवं विशेष सचिव
भारत सरकार
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय
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MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

India is a land of art, festivals, colors, fragrances and handicrafts which make it rich in culture, history and traditions. Handicrafts are unique expressions and represent a culture, tradition and heritage of a country. Handicraft products can be utilitarian, aesthetic, artistic, creative, decorative, functional, traditional, religiously and socially symbolic. Indian handicrafts are known the world over for their rich variety and skilled work. Before industrial development, this art and industry was a potential economic advantage for the country. The wooden handicraft is draped with a vast cultural and ethnic diversity which is applied to a range of themes, techniques and crafts. These wooden handicrafts are unique in their own style and are claimed to be an absolute personification of the Indian heritage.

Wood has always been a major part of Indian handicrafts and various beautiful things are crafted out of it. Indian wooden handicrafts are renowned for their beauty and utility. Every region has its own style and varieties of products. The woods extensively used by Indian craftsmen used for handicrafts work are sheesham, walnut, sandalwood, teak, deodar, rosewood, red cedar, ebony to name a few. These woods are utilised depending on the availability in the region. India takes pride in manufacturing exquisite and handsome wooden handicrafts in diverse motifs. These wooden handicrafts are popular because of their exotic designs that represent the ingenious artistic creativity of our artisans.

In India, each state has its own style of wooden handicrafts which are majorly being produced cluster wise. This industry is localized segment of the domestic and international markets. Skilled carve traditional designs on wooden items enhance their look by painting with intricate metal/ivory inlay work as well as bright ecofriendly colours/dyes and lacquering. The magnetic appeal of Indian wooden handicrafts lies in its exclusivity. Some of the wooden handicraft clusters have also been GI tagged for their style and design uniqueness and are a major source of the foreign earnings. Along with the traditional and power tools, automated machines are also being tried by our artisans for higher productivity and exclusive designs. However, availability of raw material as well as IT-based business models and marketing are major impediments of this sector which need to be addressed. Also, there is lack of awareness about new traditions and among craftsmen and there is need of technological support and training. For all this, our focus should be on all-around development of this wooden handicraft sector in order to strengthen the economy.

Institute of Wood Science and Technology (IWST), Bengaluru (an Institute under the Indian Council of Forestry Research and Education) has been continuously encouraging the sustainable and rational utilization of wood material by developing and adopting the emerging technologies for the wood-based industries. Since inception, the Institute has continuously been involved in trainings and skill enhancement of the work force being engaged in wood processing for developing various wood-based sectors of the country. The Advanced Woodworking Training Centre (AWTC) of the Institute houses state-of-the-art machineries and is mandated to provide different kind of trainings and regularly conducts short-term certificate and long-term diploma courses in the area of wood working to attain global competitiveness in various sectors related with processing and wood products.

IWST has been successfully publishing a quarterly magazine "**Wood is Good: Grow More, Use More**" to share the scientific information and applied knowledge on wood and wood products, emerging wood-based technologies, experiences and success stories, industry perspectives, current and future trends with all the stakeholders. The magazine is widely circulated which has generated a lot of interest and created awareness among concerned industries and wood users about the latest developments in wood utilization as well as adoption of emerging technologies in various sectors. The present issue of the quarterly magazine of IWST is focusing on various aspects of woodworking and wooden handicraft sectors. I sincerely hope that this popular magazine will act as a source of information for this sector of the country to identify the potential, develop and capture the domestic and export markets. This would also provide a common platform to wood-based industries, researchers and other stakeholders to share their success stories, and achieve global competitiveness in this sector.

(SANJAY KUMAR)

Place: New Delhi
Date: 28th April, 2021

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Case Study
Educational tours of three wooden handicraft clusters of states of Andhra Pradesh, Karnataka and Tamil Nadu: Products, Issues and Opportunities

Recently, a team of IWST scientists and students visited three wooden handicraft clusters of South India, namely Laxmigaripalli Wooden Handicraft Cluster in Settigunta village, Kadapa, Andhra Pradesh, Kinnal Wooden Handicraft Cluster, Koppal, Karnataka and Thammampatti, Wooden Handicraft Cluster, Salem, Tamil Nadu with the purpose to collect data related to these clusters. The information was collected from the cluster association and from individual members to understand the issues and problems of the artisans of these clusters, their raw material usage patterns, recent changes in the design of wooden handicrafts being produced in these clusters, marketing issues and trends and future opportunities. In the light of the above, a brief description of these three clusters is given below:

1. Laxmigaripalli Wooden Handicraft Cluster, Settigunta, Kadapa, Andhra Pradesh

1.1 About the cluster

Laxmigaripalli is one of the wooden handicraft clusters in Railway Kodur Mandal of Kadapa district in Andhra Pradesh. It is 40 km away from the famous pilgrimage place Tirupati. The artisans of the village are unique in making of wooden toys of various kinds. The carving of wooden toys is traditionally coming from their past generations.

1.2 Raw materials

The raw material used for making the Raja Rani wooden toys is *Manilkara hexandra* (Khirni) (Fig 1.1) and it is available from nearby hills. It is the most convenient species for carving various types of wooden toys (Malik et al., 2012). Now a days due to scarcity of *Manilkara hexandra* (Fig.1.1) artisans are using other alternative species like *Mimusops elangi* (pagada), *Strychnos nux-vomica* (Musti), *Tectona grandis* (Teak) (Fig.1.2), *Prosopis juliflora* (Sarkartumma) (Fig.1.3). Table 1.1 & 1.2 show major species used in this cluster and their silvicultural characteristics.

Table 1.1 Major species used in the cluster

Traditional Species	*Manilkara hexandra* (Khirni)
Alternative Species	*Mimusops elangi (pagada),* *Strychnos nux-vomica (Musti)* *Tectona grandis (Teak)* *Prosopis juliflora (Sarkartumma)*

Fig.1.1 Manilkara hexandra

Fig.1.2 Tectona grandis

Fig.1.3 Prosopis juliflora

Table 1.2 Silvicultural characteristics of the tree species used in the cluster:

Species	Silvicultural characteristics
Manilkara hexandra	· In Indian Peninsula, it is one of the principal trees in the dry evergreen forests of the Carnatic region and surrounding country. · It is an important tree fruit crop growing under semi-arid conditions, gullied and ravenous lands. · It grows on Sand stone and lateritic soils. · The appearance of the tree with its large crown, which it spreads out above its companions. · It is ever green and slow growing species. · The young plant requires low shelter. · It is a light demander species.
Mimusops elangi	· The tree is distributed in Indian Peninsula along with Western Ghats from Bombay southwards, and on the East from the Northern Circars southwards, the Andamans and Burma. · It is a large ever green tree and with a dense crown.

	· Wood very hard, with dark red heartwood, heavy. · It appears to reproduce well in shade and to remain small until an opportunity offers for removal of the cover, it grows up at once. · The tree the growth rate is slow.
Tectona grandis	· Teak is indigenous through the greater part of Burma and the Indian Peninsula, In Siam and in Java and in other islands of the Indian Archipelago. · The majority of the Teak is situated on hilly areas and in alluvial soils. · The tree is capable of survive on variety of soils but require good sub soil drainage. · Teak is pronounced light demander. It will not tolerate suppression at any period of its life and requires complete overhead light as well as a fair amount of side room for its development. · Its seedling is sensitive to frost and drought. · The most suitable soil for the plant growth is the deep, well drained alluvium having comparatively high contents of calcium and phosphorus. · The most suitable soil for the plant growth is the deep, well drained alluvium having comparatively high contents of calcium and phosphorus. · It is a good fire hardy species.
Strychnos nuxvomica:	· This tree is indigenous to India and South East Asia. In India it is most commonly observed in moist deciduous and semi evergreen forests of West Bengal, Bihar, Maharashtra, Odisha. · It grows well on a wide variety of soils, ranging from loamy-sandy soils to lateritic soils. · It grows well in the Soils of pH value ranges from 5.5-6.0. · Seeds exhibit physiological dormancy and hence slow and erratic germination.

1.3 Major Products

The major wooden handicraft carving in the village is Raja Rani wooden toys (Fig. 1.4). These toys are made with *Manilkara hexandra*. Other wooden products are wooden idols of Hindu lords like Venkateswara, Krishna, Ganapathi (Fig.1.5), Lakshmi, Saraswathi and Wooden glass are carving by using red sanders. Dashavatharam (Fig.1.6) wooden idols are carving by using *Manilkara hexandra* on special demand from markets and customers.

1.4 Crafts processing:

The artisans immersed the raw wood material in water for one to two hours before starting the carving. The artisans are carving the wooden toys with various iron made hand tools like Adze, Saw, Hammer, Chisels of various sizes. The artisans are using rose wood powder for coloring the toys. The rose wood powder is added in boiled water then the carved toys are immersed in that water. Later, it is dried in open air and sun light and finally polished by the brown color polishing material for shining.

Fig. 1.4: Raja Rani toys

Fig. 1.5: Ganapathi idol

Fig. 1.6: Dashavathram idols

1.5 Constraints:

There is a raw material scarcity for the making of wooden toys for the artisans which is affecting the livelihood of artisans. The Artisans are using raw wood material from nearby hills. But the forest department do not allow them to bring raw wood material from the forests, because of restrictions on cutting trees in forest. The artisans are also facing marketing issues because they are not selling the toys by themselves but are being marketed by the middle men. The artisans do not get much profited in the cluster because of middle men activity.

1.6 Solution strategy:

Sufficient supply of raw material required for making of wooden toys is important for which forest department needs to help them to ensure proper and regular supply of raw wood material.

Credit facilities need to be provided to the artisans because it helps in raw material purchasing and also to overcome other financial issues.

Regular supply of red sanders is required for regular making of idols of Hindu lords and red sander glass. The red sanders need to provide to the artisans by government.

Inclusion of cultivating the *Manilkara hexandra* as agro forestry is most important for the future of present as well as future generations. This species is most convenient and unique for making wooden toys of various kinds.

For selling the toys, low rented rooms are needed in nearby pilgrimage places like Tirupati, Tirumala, Kalahasti etc. where the toys mostly purchased by pilgrims of various parts of the country. The artisans seek the support from the government in construction of rooms in pilgrimage places for selling the toys.

2. Kinnal Wooden Handicraft Cluster, Koppal, Karnataka

2.1 About the cluster

Kinnal Craft or Kinhal Craft is a traditional wooden handicraft located in the Kinnal village of Koppal district in North Karnataka. The village is famous for religious idols and toys. Light weight wood is used for making the wooden toys. In the year 2012, this craft was granted Geographical Indication (GI) Tag. The famous mural paintings in the Pampapateshwara Temple at Koppal city, as well as the intricate work on the world-famous wooden chariot at Hampi, are said to be the work of the Kinhal artisans family's ancestors (Dutta, 2020).

The handicraft flourished under the canopy of the Vijayanagara Empire, when the kings invited the people of the craft from across the country to come and carve in their capital, Hampi. After the decline of the Empire in 1665, the artisans migrated to different places and received the assistance of the Nawab of Koppal, Desais of Kinhal and Nawab Salar Ali Jung, of Hyderabad (Gowda et al., 2019). Currently, 80 families are involved in the wood carving out of which 45 are actively engaged.

2.2 Raw materials:

The most easily available light weight woods in this craft are *Givotia rottleriformis* syn *Givotia maluccana* (polike) and *Ficus racemosus* Syn *Ficus glomerata* (atthimara). They use *Tectona grandis* (Teak) occasionally based on the national and international demands. Table 2.1 and Table 2.2 show major species used in the cluster and their silviculture characteristics.

Table 2.1 Major species used in the cluster

Traditionally used species	*Givotia rottleriformis (polike)*
Alternative species	*Ficus racemosus (atthimara).*

Table 2.2: Silviculture characteristics of the tree species used in the cluster

Species	Silvicultural features
Givotia rottleriformis	· It is a fast growing moderately sized tree. · It is a deciduous, drought resistant, softwood producing and durable tree species. · The distribution of this plant is recorded only in limited areas of the forests of Karnataka, Tamil Nadu, West Bengal, Andhra, and coastal Sri Lanka.
Ficus racemosus	· It is a deciduous plant growing at fast rate up to 12 m. The flower is pollinated by Wasps and its hardy to zone. · It can grow in moist soil and semi-shade or no shade habitat. · The suitable pH for the plant growth is acid, neutral and alkaline.
Tectona grandis	· For threatened plant status this plant has not yet been assessed by IUCN Red List. · Its seedling is sensitive to frost and drought. · It is intolerant of suppression and weeds. · It is a strong light-demander and fairly fire resistant. Its seedlings and saplings are killed back by fire and frost. · The most suitable soil for the plant growth is the deep, well drained alluvium having comparatively high contents of calcium and phosphorus. · It can attain good growth on soils of pH 6.5 and an annual rainfall are 150 cm.

2.3 Major Products:

This craft is well known in making of toys (animals, fruits etc.), mythological characters and religious idols (Idol's head, statue of God and Goddess) (Fig. 2.5). The artisans paint the Gods and Goddess of Shaivism, Vaishnavism, scenes from the Mahabharatha, Ramayana, Skandapurana etc. Apart from the thematic craft, other toys like Bride and Bridegroom, Birds (Fig. 2.6), Palanquins Decorative Plates and Pedestals are made by the artisans.

2.4 Craft Processing:

Kinnal artisans follow air drying methods of wood seasoning. After shaping in a particular craft, the cotton cloth collages are put on the wood for structural support of toys. All the parts of the toys are first joined together with a mixture paste (tamarind seeds paste, sawdust and gunny bag powder) called Kitta (Fig. 2.1 & 2.2) and then pebble powder paste and liquid gum are used to join jewellery and ornamentation (Fig. 2.3). The finishing of end product is made by pebble paste layering (Fig. 2.4). However, several artisans continue to use natural colours, synthetic colours powder like lemon chrome, oxide green and burnt sienna are used in making paints others have shifted to market-made Asian paints. Red colour is mixed with white colour which is used for the skin colour while gold colour for crown, thrones, ornaments etc.

2.5 Issues of the cluster:

Marketing is the prominent issue for the artisans, as they are facing the problem of proper channel for selling their product in both domestic and international market.

Increasing price of raw materials as well as use of major raw materials (*G. rottleriformis*) as fuel in town. Gangavati is also creating a big hindrance in procurement and easily availability of raw materials. Due to over exploitation, this plant has become endangered (Rambabu et al. 2005).

Other issues of the artisans are their incomes affected by heavy rain fall in the village, so that they are unable to


Fig. 2.1 Kitta preparation


Fig. 2.2 Kitta paste applied on wood


Fig. 2.3 Pebble powder and gums


Fig. 2.4 Finished with pebble paste


Fig. 2.5 Statue of religious idols


Fig. 2.6 Peacock toy

get shelter for earning their livelihood in the month of June to September. Lacks of incentives for proper mobilization of all age group people to get engage in the cluster.

2.6 Solutions and strategy:

Proper marketing channels and effective platforms are required to the artisans, so that they can sell their handicraft products in both national and international market at desirable price.

Incentives are needed for procuring the raw materials for extensive mobilization of the men and women of the cluster.

Training and guiding is required to the artisans in various upgraded wood based research in wood research centres.

Villagers have always been demanding proper infrastructure developments for handicraft manufacturing centre to overcome the problem of earning their livelihood even in heavy rainfall.

Kinnal is an important wood-based handicraft cluster in the southern part of India due to its unique GI tag. G. rottleriformis has become endangered species due to over exploitation, therefore this craft is under threat in context of raw material availability. So, it is needed to conserve both plant species and craft. The artisans of this craft use polike and attimara species extensively in various wood-based products in comparison to any other tree. Therefore, Government based organization as well as NGOs like Crafts Council of Karnataka (CCK) and Karnataka State Handicrafts Development Corporation Limited (KSHDC/Cauvery) should be active and take effective steps to mobilize villagers in awareness program not only in preventing trees used in fire fuel but also helping the chitragars in search of a new resource of the same quality of the tree.

3. Thammampatti, Salem Wooden Handicraft Cluster, Tamil Nadu

3.1 About the cluster

Thammampatti is a small village situated at the bank of Swedha river in Gangavalli Taluk of Salem District between Pachaimalai and Kolli hills. It is about 63 km from the Salem city. The wood carvings in Thammampatti got GI status in 2020 and such a beautiful craft has been thriving in this small area for more than 75 years. There are about 100 artisans who have been engaged into this profession and many of them have also received the state and national award for their craftsmanship (Fig.3.1 & 3.2)

3.2 Raw materials

Generally, the trees used in this cluster (Table 3.1 and 3.2) is from in and around the village. There is no raw


Fig. 3.1 Craft work by Mr. Pon Ravi


Fig. 3.2 Mr. N. Durairaj (State and National awardee)

Table 3.1. Major species used in the cluster

Traditionally used species	*Samanea saman* (Thoongavaagai)
Alternative species	*Albizzia lebbek* (Vaagai)
	Tectona grandis (Teak).
	Ficus racemosa (Atti)
	Crataeva roxburghii (Mavilangai)

Table 3.2. Silvicultural characteristics of the tree species (Troup, 1975)

Species	Silvicultural characteristics
Samanea saman	· It is truly a tropical species · It requires well drained alluvial, fertile, neutral to moderately acid (>pH 4.6) soils for best growth but can also tolerate heavy clays (vertisols) and infertile or seasonally waterlogged soils. · It grows from sea level of up to 1500 m altitude
Albizzia lebbek	· It grows moderately fast · The tree is not wind-firm, because its root system is largely superficial. · It is easily propagated by seeds and can also be propagated through stem cuttings. It coppices well and produces root suckers. · A light demander, stands moderate shade in young.

Ficus racemosa	· Fairly drought resistant, is affected by very severe frosts · It is a medium sized deciduous tree with a crooked trunk and open, spreading crown · It is a light demander and prefers well-drained soil. · Suitable pH: acid, neutral and basic (alkaline) soils.

Fig. 3.3 Ganapati statue

Fig. 3.4 Devi statue

Fig. 3.5 Horse vahana statue

Fig. 3.6 Craft making process

material scarcity problem because the artisans are mostly willing to work whatever is available species to them.

3.3 Major products

Thammampatti wood carving includes diverse kinds of crafts such as idols of Gods of many religions but majority are idols of Hindu Gods, mythological stories or incidents, dasavataras, vahanas of various sizes, mythological creatures, door panels, temple doors and puja mandapam etc. (Fig. 3.3-3.5). Generally, the size of the product varies from 2 to 6 feet in length and of proportionate width with a beautiful antique finish.

3.4 Craft processing

The craftsmen in this cluster strictly follows the rules and measurement of iconography described in Shilpashastra (Fig. 3.6). The major steps involved in craft processing are:

3.4.1 Sourcing: Sourcing and transporting raw material is the first step in craft processing.

3.4.2 Seasoning: Eco-friendly wood carving and processing are the major attractions of this cluster. However, seasoning of wood is not followed, instead artisans prefer to work on wet wood or fresh wood.

3.4.3 Outlining: Outlining on the log using a template and cutting/chiselling the edges of the design is a very important step in craft making.

3.4.4 Carving: Dismantled pieces are then carved at edges. The process includes inscribing (making motifs on wood), undercutting (creating 3 dimensional layers), open or lattice work (creating see-through jail work), deep carving (creating raised designs of up to 5 inch depth), semi carving (thin panel design along the rim with central motif); shallow carving (motif chased in pencil to give a little depth).

3.4.5 Detailing: Making fine details using hand chisels.

3.4.6 Nailing and assembling: Assembling all parts using nails (in case of large product, smaller pieces are joined together and then carved) is first thing in this stage and after that the accurately made carpentry joineries; hinge joint, dove and tail joint are used for the completion of assembling work.

3.4.7. Finishing: In this stage, smoothening the surface, applying protective coating and finishing are done. Japan black mixed with kerosene oil is applied first because it gives antique finishing after this it keeps for drying and later polishing work are done. Generally, the artisans do two types of finishing and they use shellac thinner for it. The first one is the mat finishing and it is generally used for rough surface and the next one is glass finishing, In this, the thinner is coated like a glassy material so it start glowing, Women are also participated in the colouring and finishing activities So, it is a good sign of gender justice in this sector.

3.5 Constraints in the cluster

Marketing issues are considered the major constraints in this cluster due non-existence of permanent market or marketing channels for both domestic and international arena which is really a difficult problem to sale of these beautiful crafts. The involvement of middlemen is also a big issue because they collect crafts with a low price from artisans and market it at high prices. Earlier, one organization named poompuhar (Tamil Nadu Handicrafts Development Corporation) was helping the artisans by providing proper procurement of craft materials from artisans and has also created some marketing facilities for

them too but now it's in inactive stage. Increased price of raw materials and lack of credit availability from formal financial institutions also make hardships in the artisan's life in this cluster.

Solution and strategy

Relaxing the regulations for getting credit from financial institution is one of the major strategies to solve the raw materials procurement problems and financial security to the artisans.

To give proper awareness regarding export regulations to the artisans because it will help them in international marketing of the crafts.

Institute of Wood Science and Technology can conduct certain training programmes such as proper seasoning techniques, wood preservation and quality assessment of the wooden handicrafts etc. in this cluster because the young artisans are very much interested to know new tools and techniques.

Thus, Thammampatti is an important wooden handicraft cluster in the southern part of the country because of its unique GI tag but this cluster is facing a lot of problems for its existence in present competitive world. So, an integrated approach from the all stakeholders such as artisans, forest department, poompuhar and other government and non-government organisations are the need of the hour for conserving this unique craft.

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IWST Activities during January-March 2021

Training to IFS Officers on Advances in Wood Production and Utilization

One week training was conducted on "Advances in wood production and utilization" from 4th to 8th January 2021 in virtual mode for serving IFS officers in which 30 IFS officers (1990 to 2017 batch) form 18 States of the country participated. Shri Arun Singh Rawat, DG, ICFRE and Shri Bharat Jyoti, Director, IGNFA joined the panel discussion with participants on wood production and Utilisation related issues in the country. Trainees were also addressed by Dr. M.P. Singh, Director, IWST and the eminent wood based industries representatives, Shri Sajjan Bhajanka, President, FIPPI, Dr. K.D. Singh, IFS (Rtd) Former President, Academy of Forests & Environmental Science, Mr. Suneel Pandey, Vice President, ITC Ltd., Hyderabad, Ex-IFS Officer, Dr. H.D. Kulkarni, Former Vice President, ITC Ltd., Shri Peter Bradfield, Canadian Wood, Shri Jikesh Thakkar, Executive Director, AIPM, Shri O.P. Prahladka, Chairman, Handicrafts and Carpet Skill Development Council, Mr. Rahul Mehta, COO, Furniture & Fittings Skill Council and many more eminent speakers.

Training on Sandalwood: Seed handling, Nursery and Plantation Technology

A two days online training programme on `Sandalwood: Seed handling, Nursery and Plantation Technology' was organized by the Institute of Wood Science and Technology on 20th and 21st, January 2021. Sh. V.S. Shettappanavar, IFS, Group Co-ordinator (Research) inaugurated the programme. A total of 20 participants from Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu participated in the programme. The training covered various aspects of sandalwood with reference to nursery technology, management of plantations, growth and yield, utilization, marketing and policies pertaining to growing of sandalwood. The training was concluded with interaction session and with the closing remarks of the Group Co-ordinator (Research).

Visit of Minister for Agriculture, Horticulture & Allied sectors, Telangana State

A delegation from Telangana led by Shri. Singireddy T.R.S., Hon'ble Minister for Agriculture, Horticulture & Allied sectors along with APC & Secretary, Dir. of Horticulture, Vice Chancellor Shri. Konda Laxman Bapuji, Telangana State Horticulture University & other officers of the State officers visited the institute on 28.01.2021. The delegation visited tissue culture laboratory and had discussion with the Director and Scientists of IWST regarding cultivation and management of sandalwood and other aspects related to sandalwood farming.

Regional Research Conference on Forestry Research in Southern States of India

Institute of Wood Science and Technology (IWST), Bangalore along with the Institute of Forest Genetics and Tree Breeding (IFGTB) organised a Web Based -ICFRE Regional Research Conference "Forestry Research in Southern States of India" on 29th January 2021 which was inaugurated by Shri A.S. Rawat, DG, ICFRE. The DDG (Research), ICFRE and PCCFs of Karnataka, Tamil Nadu, Kerala, Andhra Pradesh, Goa, Andaman & Nicobar and Telangana expressed their views during inaugural session. Senior IFS officers from various Southern States presented/ discussed the research needs of forest departments. Academicians from various forestry colleges (Director, Indian Institute of Plantation Management, Director, Indian Institute of Horticulture Research, Director, French Institute of Pondicherry, Director, IPIRTI, Dean, Forestry College, Ponnampet, Dean, Forest College and Research Institute, Mettupalayam and Principal Scientist, CRIDA

Hyderabad made presentations about the issues and problems related to forestry/wood science. The representatives from wood and panel based industries (President, Wood Technology Association, Chairman, Kandla Timber Association, Technical Advisor, Federation of Indian Plywood and Panel Industry, President, Federation of All India Timber Merchants Saw Millers & Allied Industries, General Secretary, Federation of All India Timber Merchants Saw Millers & Allied Industries, Dr. K.D. Singh, Former President, Academy of Forests and Environmental and representatives of other wood industries,) actively participated and shared their views about industry related problems/needs where IWST and other ICFRE institutes can contribute by taking up the research problems in their ongoing programmes.

Webinar on Challenges in the Management of Phytoplasma Diseases

The Institute of Wood Science and Technology, Bengaluru in association with Entomological Society of India (ESI), New Delhi conducted a discussion meeting on "Challenges in the Management of Phytoplasma Diseases" on 5th February 2021 by webinar. Dr. N.K. Krishna Kumar, Vice President, ESI and Ex-DDG, ICAR introduced the theme of the meeting. The Director, IWST, Dr. M.P. Singh, IFS, delivered the presidential address and the Director General of ICFRE Shri. Arun Singh Rawat, IFS, inaugurated the programme and released the Technical Bulletin on "Phytoplasma Diseases in forestry". Following this, Prof. C.A. Viraktamath, Professor Emeritus, University of Agricultural Sciences, Bengaluru delivered the key note address on "Systematics and Ecology of the Vectors of Phytoplasma". About 100 participants attended the discussion meeting.

During technical session, the presentations made and discussed were "our understanding about phytoplasma disease research in India" by Dr. Govind P. Rao, Professor of Virology, IARI, New Delhi; "Global scenario on phytoplasma diseases in palms", by Dr. Vinayaka Hegde, Principal Scientist, ICAR-CPCRI, Kasaragod, Kerala; "Ever expanding boarders of phytoplasma invasion: Indian scenario of a fast dispersing vector borne pathogen of flower crops" by Dr. K.V. Prasad, Director, Directorate of Floriculture, Pune; "Current status of phytoplasma classification and taxonomy" by Dr. Amit Yadav, Scientist-D, National Centre for Microbial Resources, National Centre for Cell Sciences (DBT), Pune; "Genome editing in imparting resistance to phytoplasma" by Dr. R. Asokan, Principal Scientist, IIHR, Bengaluru; "Molecular mechanism underlying symptom development in phytoplasma associated diseases - The key players and their role" by Dr. Suman Lakhanpaul, Professor of Botany, University of Delhi; "Diagnosis of phytoplasma associated with the sandalwood spike disease" by Dr. Bikash Mandal, Professor of Virology, IARI, New Delhi; "Vector-phytoplasma relationships in palms and impacts on epidemiology" by Dr. Brian Bahder, University of Florida, USA; "Emerging phytoplasma diseases in forestry and the challenges in search of their insect vectors" by Dr. R. Sundararaj, Scientist-G and Head, FP Division, IWST, Bengaluru. In addition to this, a concept note on "Study on pathosystem of phytoplasma disease associated with host plantation forestry tree species in agroforestry system" was presented by Dr. A. Muthukumar, Scientist-E, IWST, Bengaluru.

Training on capacity building of State Forest Departments for developing state REDD+action plans

Two days training program was organised on March 15 & 16, 2021 for the forest officers on capacity building of state forest departments for developing state REDD+ action plans. A total of 15 Forest Officers from Karnataka Forest Department and 9 Forest Officers from Andhra Pradesh Forest Department participated in the programme. The training was organised on both online and offline mode. The resource persons from various organizations like ICFRE, Dehra Dun, IISc Bangalore, GKVK Bangalore, Centre for Study of Science, Technology and Policy (CSTEP) Bangalore and ATREE Bangalore were involved in imparting the training to the participants. The detailed discussions and exercise were made on methodology/steps involved in the preparation of REDD+ action plan.

Commemorating Word Wood Day

An E-Symposium "Wood: The sustainable and versatile building material" was organised on 19th March 2021 to commemorate World Wood Day. A total of 223 participants attended the symposium which included 11 panellists. The programme was divided into two sessions. The first session was on sustainability and second session was on Industry & Commercialization. The panellists also addressed the participants on use of wood as building material.

Session 1: Sustainability

The welcome address of the webinar given by Dr. Suneesh Buxy, Inspector General of Forest, MoEF&CC, Govt. of India. Dr. Buxy addressed the participants about the reduction of Co2 level in atmosphere by the use of wood than using of steel and other building material.

Dr. M.P. Singh, Director, Institute of Wood Science and Technology made presentation on 'Wood is Good: Grow more, use more'. Dr. Singh addressed the participants about the research being carried out by the Institute and also the technologies developed for the wood based industries by the Institute of Wood Science and Technology.

Mr. Praneesh Chibber, Country Director, Forestry Innovation Consulting India Pvt. Ltd. (FII) made presentation on certified wood from sustainably managed forests. Mr. Chibber addressed the participants about forest certification to promote the sustainable forest management through independent third party certification. Such important institutions are PEFC & FSC. He presented more information on Canadian Wood.

Mr. Arun Singh Rawat, DG, ICFRE, emphasised to grow desirable species for wood based industries as agro forestry. Engineered wood is as strong as steel and is being used as building material. Carbon produced from wood like activated carbon has numerous applications like water treatment, Co2 capture, energy storage, super capacitors, and heterogeneous catalysis. Another area is carbon nano tubes and other Carbon nano structure derived from wood. Isolated lignin has largest carbon content in wood materials.

Dr. Sanjay Kumar, DG Forest & Special Secretary, MoEF&CC delivered his speech on utility, promotion, ecological sustainability and helping global community in addressing the issues related to sustainable development. At present unfortunately most of the forest areas destroyed and becomes like deserts. The research and business community should come forward in developing newer technologies and products which could benefit whole sections of society in the best possible manner.

Session 2: Industry and commercialization

Ar. Gurupreet Singh made presentation on 'thinking timber'. He delivered his speech on responsibility of sustainable aspect of construction industry in India by building with certified wood from sustainable manage forests. India has long historical background through building with wood in Kerala, Himachal Pradesh, Nepal and Bhutan. Now there is need to revive this tradition which is part of us and it is possible to construct the building with engineered wood.

Mr. Peter Bradfield, Technical Advisor, Forestry Innovation Consulting India Pvt. Ltd. (FII) made presentation on Canadian Wood 'trends, potential and opportunities with wood in India'. He provided information about utility of Canadian wood in various wood sectors specially the construction sector.

Mr. P. Lakshminarayana, CEO, Nesca Homes, made presentation on 'building with wood in India'. He made his speech on the key mile stones achieved in wood as a building material and achieving of success in various countries. He presented information about the opportunities in India for wooden structures that almost 54% of the land is vulnerable to earthquakes.

Mr. Nasir Ali khan, CMD, MAK Projects, made presentation on 'A Developer's vision of a residential project in wood'. He pointed out about little supply of wood in Indian market whereas wood is a future of building construction material. Technologies like glulam and cross laminated timber (CLT) commonly referred to as mass timber allow wood to rival steel and reinforce concrete in terms of strength and durability.

Address on wood as building material:

Dr. Sailesh K. Agarwal, Executive Director, Building Materials and Technology Promotion Council (BMTPC) made presentation on wood as a building material. BMTPC established in 1990 to facilitate environment friendly energy–efficient, low cost and safer constructions. He explained about wooden made homes using rubber wood.

Mr. V.K. Jayaswal, DG, Central Public Works Department (CPWD) mentioned that it is the stage to replace the conventional building material concrete and steel as they have some disadvantages by wood. Wood has been in use as building material from thousands of years in various countries. Japan, Norway using wood as building material and in Kerala, Assam in India also using wood a building material.

Dr. S.K Sharma, Head, Extension Division of IWST concluded the webinar by giving vote of thanks to the organizers and all the participants.

Wood-Industry Meet

An industry meet was organized on 22nd March 2021 for developing industry institute partnership and working towards emerging issues in the wood-based sector. The meeting was chaired by Dr. Sanjay Kumar, DG, MoEF&CC, GOI. This webinar was organized to deliberate upon following points:

- Raw material and other policy related issues for wood-based industries
- To flag emerging research issues in the sector of wood-based industries
- Developing synergy between research organizations and wood-based industries by creating platform for regular interaction.

About 80 participants from various Industries, Research Organizations, Forest Departments, and other Stake Holders including officials from MoEF&CC participated in the webinar. The views of the distinguished speakers are given below, in the order in which they spoke in the webinar.

Dr. Sunees Buxy, Inspector General of Forests, MoEF & CC mentioned that this meet intends to create a platform for regular interaction between the wood based industries, research institutes and also the elite industries which are mainly using wood. He requested premier institutes of ICFRE to comment on how they can take lead in providing the genetically improved clones of fast growing species and bamboo suitable for the industry.

Shri S.D. Sharma, DDG (Research), ICFRE mentioned that the wood used for manufacturing products should ideally come from certified forest or trees outside forest in view of the rising concern about sustainability of wood. The council, through its institutes and center, is providing technical skills to the forest dwellers by helping them in enlarging their livelihood opportunities through better use of forest resources.

Shri Amrik Singh Anand, Sr. Technocrat and Progressive Farmer mentioned that the Agri-wood (AW)-Agroforestry (AF) industrial plantations can become a tool to reduce imports of wood and wooden products. It can also help in improving the quality of panel products and also open new avenues of exports. There is a need of developing protocols for seeds/seedlings/saplings of approved species/clones. He emphasised the need to establish an independent Wood Council to look after all aspects of AW-AF industry plantations.

Shri Sajjan Bhajanka, President, FIPPI mentioned that for anyone to start an industry solely based on their organized plantation timber, they don't require any license. He further mentioned that sun drying of wood veneers can save enormous amount of energy, because, after sun drying the moisture content reduces from 50% to 10% with around 40% weight loss. So, if that moisture loss is utilized, better veneer can be manufactured in the farming area and moving material from these to plywood factory and to other units would reduce the logistics cost.

Shri Anupam Gupta, APCCF, UP Forest Department mentioned that the new policy by the GOI came up in 2016-18, according to the amendment to wood based industries in 2018. But before the process began, there were issues related to licensing and registration. Registration was basically for those kinds of industries which were not using round timber. Even before the formal notification of UP Govt. was issued, the stay of registration policy was obtained and cases are pending in Court.

Shri A.S. Mehta, President, Indian Paper Manufacturers Association emphasised the need to provide farmers with remunerative income, so that they are incentivized to undertake plantations for which we need to provide the right kind of clones/wood species with shorter maturities, which would provide good income and better net revenue than other crops.

Shri Naval Kedia, President, Federation of All India Timber Merchants Saw Millers & Allied Industries, mentioned that all all transit pass system should be abolished for imported wood. Machinery in sawmill should be allowed to increase production when there is more demand. Along with farmers, local saw millers should also be allowed what timber they need in that area. Small industries/saw millers or association should be consulted for what timbers should be grown in their areas.

Shri Jikesh Thakkar, Executive Director, Association of Indian Panelboard Manufacturers mentioned about the differences in rules of state forest departments. He further stated that if some kind of autocracy or other kind of help is provided by the institutions or MoEF&CC, it would be highly appreciated. In framing of any policy, if wood based industries involvement is there at MoEF&CC, it would be highly appreciated, as there is a need of networking among all the institution and association. He emphasise the need of forming Wood Council of India kind of thing.

Shri Subhash Jolly, President, Wood Technologists Association mentioned that if there is more timber (plantation) in one state or region, it should be transported to the states where there is less availability of such timber, and transportation subsidy needs to be given by the government to farmers, or farmers should be empowered to hold their plantation by giving them loans against plantation, so that they can hold the plantation when its prices are less and sell when prices are high.

Shri Naresh Tewari, All India Plywood Manufacturers Association mentioned that from the small country like Vietnam, the plywood and MDF are exported, why not from our country. By doing this, agroforestry will get a boost and industry will also get a boost and self-reliant India will also get a boost. On every platform, I am saying to amended government policy so that we can move forward.

Shri Navneet Gajjar, President, Kandla Timber Association emphasised to change the forest rules which were made during the British times. He mentioned that in Gujarat, there is state level meetings held in 3-4 months and in state level meeting, all issue are solved one by one. In Gujarat, the Government has eased rules as compared to other states and is supportive for timber industry. Many new units of plywood saw mill nowadays have no problem.

Representative from Chennai Timber Association said that most of the timber imported is being used by saw millers. If forest licence, forest permits etc. are relaxed for imported timber, no destruction is done to India's forest and lot of wood and wood related problems will be solved. There are many species which are not being allowed to be imported in India. Those species which are cheaper also need to be allowed, so that we can bring the cheaper material and do value addition and export it.

Shri Sunil Pandey, Vice President, ITC Hyderabad emphasised that industry and R&D institutions must come forward to develop disease resistant and site specific plant material. Uniform felling and transit rules across the country can probably help the farmers, and the industry also. On the R&D side, we need more collaboration to do with the clones which are as productivity as in Brazil and then the industry side to really have the farmer producer organisation.

Shri Arun Kumar Bansal, Former ADG, MoEF & CC emphasises about the role of Ministry of Commerce on the import and export policy and other issues. There is role of Ministry of Agriculture and Farmers Welfare, because entire agroforestry is their domain. So, there is need talking about industries, research institute partnership, and collaboration whatever you may like to call it. But there is definitely need for inter-ministerial collaboration for the wood based industry sector, and the resource is an industry issue.

Dr. C.N. Pandey, Federation of Indian Plywood & Panel Industry, complimented for providing the platform for the industry as well as research workers, scientist and policy makers. He emphasised the need for review and provision for the agroforestry wood and farmer's produce which need to be looked into by the policy makers. There is urgent need to have agro-wood forest policy revision, and it should have a farmer produce act to take care of the movement of timber and all other issues.

Shri Joydeep Chitlangia, Managing Director, Duroply Industries mentioned that wood based industry should be transferred to the Ministry of Commerce. There is need to form wood development council which can be a meeting ground for the industry and the government. So, whatever issues are there between the two those are always discussed at that platform and there is a way forward. As some people have suggested there is a need to create a common forum, where there are law makers, and there are the users of the product, and industry.

Dr. Sanjay Kumar, DG (Forest) & Special Secretary, MoEF & CC mentioned that best possible way of conserving and developing forest would be to provide many opportunities for the wood and wood based industries to grow. We need to provide standing ground for all the stakeholders of the sectors to grow in a harmonious manner. Whatever legal policy or procedural impediments are there, we are ready to address them and ready to talk to our colleagues in various sectors. He said that clear vision of the government is 'minimum government maximum governance'.

Dr. M.P Singh, Director, IWST stated that there is need to promote the use of wood in all the sectors. He emphasised to start a wood forum. There is need to support the industry for the mobilisation of the raw materials, especially the productivity aspect. Government has a role for the policy aspect and he was confident to come out with the draft very soon and will share with the industry to resolve the issues.

Dr. Vimal Kothiyal, Assistant Director General (RP), ICFRE presented a formal vote of thanks and thanked all the dignitaries and participants from the industries, forest officers and other organizations. He thanked Shri Arun Singh Rawat, DG, ICFRE for having this idea of industry meet. He stated that all the points which were discussed during the meeting have been noted down for further necessary action at ICFRE level.

Institutional forum for Wood based Industries in India

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Agro-Forestry and farm forestry have taken a deep root in the country and growing Trees outside Forests (ToF) is the single most important tool to achieve the target of having one-third area of the country under green cover. Besides making the country self-sufficient in wood and wood products, this will help in creating employment, expanding skill-base of people, enhancing income of farmers and the rural populace, saving precious foreign exchange, and achieving the Nationally Determined Contribution targets for carbon sequestration. To sustain the Agro-Forestry drive in India, it is imperative that enough processing industries *viz*. veneering, pulping, plywood, MDF & particle boards are set. This would ensure that increased supply of such short duration timber is sustained, integrated to industries, and enables farmers to get remunerative prices for their produce.

This column aims to systematically highlight issues related to wood based industries. The first issue of this magazine carried an article broadly outlining the steps to be taken for revival of wood based industries. It was emphasized that if wood based industries are to be a major source of raw material, not only does agroforestry need to be promoted, but the ecosystem for transported and processing such timber also needs to be relaxed/liberalized. Second issue carried my article depicting the journey of raw materials for plywood and panel industries from forest produce to AgriWood in the last two decades. The third article in the series pitched for enacting an Act to promote and facilitate growing of Trees outside Forests.

The present article aims at underscoring the need for an effective institutional forum for wood based industry, as has been proposed in GROWING TREES OUTSIDE FORESTS (PROMOTION AND FACILITATION) DRAFT ACT 2021.

Present status of the institutional forum available to wood based industries and its effectiveness:

The Ministry of Environment, Forest and Climate Change, Government of India, vide Resolution dated 11th November, 2016 had issued the Wood Based Industries (Establishment and Regulation) Guidelines, 2016, which were amended vide Resolution dated 11th September, 2017. Presently, the State Level Committee under Wood Based Industries (Establishment and Regulation) Guidelines, 2017 consists of the following:

a)	Principal Chief Conservator of Forests / Head of Forest Department	Chairperson
b)	A representative of the Regional Office of the Ministry of Environment, Forest and Climate Change	Member
c)	A representative of State Forest Department not below the rank of a Conservator of Forests dealing with preparation of Working Plans/Working Schemes	Member
d)	Director/Additional Director of Department of Industries	Member
e)	Representative of each Autonomous District Council constituted in accordance with the provisions of the Sixth Schedule to the Constitution, in case such Council exists in the State	Member
f)	Representative of the Forest Development Corporation, in case any such Corporation exists in the State	Member
g)	An office not below the rank of Conservator of Forests working in the Forest Head Quarters	Member

The state Level Committee may nominate any other officer working in territorial wing of the Forest Department not below the rank of CF.

The State Level Committee (SLC) shall :-

(I) Assess the availability of timber in the state by way of appropriate study on demand and supply as and when it decides. SLC shall devise suitable mechanism for sustainable use of timber in a way that does not affect the forests of the area adversely.

(ii) Approve the name of wood based industries which

may be considered for grant of fresh license or enhancement of the existing licenses capacity in case the SLC is satisfied that timber is available legally for the said new Wood Based Industries (such as Trees outside Forests etc).

(iii) Ensure that the amount lying with the respective State Forest Departments (recovered from wood based industries) is utilized for the purpose of afforestation only.

(iv) Examine and make appropriate recommendations on any other matter referred by the State Government to the Ministry of Environment, Forest and Climate Change.

(v) Transfer of license on sale/succession etc. shall be done only with the approval of SLC.

(vi) No license to a wood based industry shall be granted or renewed without obtaining prior approval of SLC. However, a SLC may delegate the power of renewal of license of a wood based industry to the Divisional Forest officers of the concerned Forest Divisions.

(vii) Following industries / processing plants not using round logs of domestic origin or operating without a band saw or re-saw or circular saw of more than 30 cm diameter shall not require license. Industries / processing which use:

- Sawn timber, cane, bamboo, reed, plywood, veneers or imported wood, procured from legitimate sources.
- Block board, MDF or similar wood based products, procured from legitimate sources.
- Round log/timber from species declared as agro-forestry/agricultural crops and/or exempted from the purview of the felling and transit regime in the concerned state/UT, and procured from legitimate sources
- However, SLC of the concerned State may allow installation of circular saw of diameter upto 60 cm in such industries having specialized requirement.

(viii) Such industries shall be registered with the Forest Department of the concerned state /UT and shall be regulated, details of which are to be prescribed by the concerned state/UT.

The SLC has not been able to provide institutional support to wood based industries at the state level. It became a licensing authority rather than a guiding and promoting body for ever emerging challenges of wood based industries. The institute has been organizing Institute-Industry meetings with wood based industries. During the meets, it has become evident that plywood, panel and other allied industries don't have any institutional forum where government and industries can come together to discuss their issues for the speedy development of this sector. The institute has tried flagging those issues to the appropriate government platform but expected results are not yielding due to lack of institutional mechanism. During the last meeting with the industry on 22nd March 2021, the exasperations amongst the industry representatives were quite apparent.

During the meets, it has become evident that plywood, panel and other allied industries don't have any institutional forum where government and industries can come together to discuss their issues for the speedy development of this sector.

However, it was pointed out by Mr. Jaydeep Chitlangia, Managing Director, Duroply Industries, that most major industries are covered by the Ministry of Commerce and most of them have a development council. The development council serves as a platform for industry and government representatives to meet and resolve the issues arising through discussion. Now, the wood based industry is covered by the Ministry of Environment, Forest and Climate Change. The mandate of the Ministry of Environment, Forest and Climate Change is very different from that of the Ministry of Commerce and Industry. At present we don't have any platform for the wood based industry. As various experts have suggested, there is a need to create a common forum consisting of subject matter experts, government representatives users of the product, and industry representatives.

Development Council as a statutory institutional framework:

On further examination, it became evident that most of scheduled industries under Industries (Development & Regulation) Act 1951 have Development Council constituted under section 6 of Industries (Development & Regulation) Act 1951, which says that:

Section (6) Establishment and constitution of Development Councils and their functions:

(1) The Central Government may, by notified order, establish for any scheduled industry or group of scheduled industries, a body of persons to be called a Development Council which shall consist of members who in the opinion of the Central Government are-

(a) persons capable of representing the interests of owners of industrial undertakings in the scheduled industry or group of scheduled industries;

(b) persons having special knowledge of matters relating to the technical or other aspects of the scheduled industry or group of scheduled industries;

(c) persons capable of representing the interests of persons employed in industrial undertakings in the scheduled industry or group of scheduled industries;

(d) persons not belonging to any of the aforesaid categories, who are capable of representing the interests of consumers of goods manufactured or produced by the scheduled industry or group of scheduled industries.

(2) The number and the term of office of, and the procedure to be followed in the discharge of their functions by, and the manner of filling casual vacancies among members of a Development Council shall be such as may be prescribed.

(3) Every Development Council shall be, by virtue of this Act, a body corporate by such name as may be specified in the notified order establishing it, and may hold and transfer property and shall by the said name sue and be sued.

(4) A Development Council shall perform such functions of a kind specified in the Second Schedule as may be assigned to it by the Central Government and for whose exercise by the Development Council it appears to the Central Government expedient to provide in order to increase the efficiency or productivity in the scheduled industry or group of scheduled industries for which the Development Council is established, to improve or develop the service that such industry or group of industries renders or could render to the community, or to enable such industry or group of industries to render such service more economically.

(5) A Development Council shall also perform such other functions as it may be required to perform by or under any other provision of this Act.

(6) Functions which may be assigned to Development Councils include-

a Recommending targets for production, co-ordinating production programmes and reviewing progress from time to time.

b Suggesting norms of efficiency with a view to eliminating waste, obtaining maximum production, improving quality and reducing costs.

c Recommending measures for securing the fuller utilisation of the installed capacity and for improving the working of the industry, particularly of the less efficient units.

d Promoting arrangements for better marketing and helping in the devising of a system of distribution and sale of the produce of the industry which would be satisfactory to the consumer.

e Promoting standardisation of products.

f Assisting in the distribution of controlled materials and promoting arrangements for obtaining materials for the industry.

g Promoting or undertaking inquiry as to materials and equipment and as to methods of production, management and labour utilisation, including the discovery and development of new materials, equipment and methods and of improvements in those already in use, the assessment of the advantages of different alternatives and the conduct of experimental establishments and of tests on a commercial scale.

h Promoting the training of persons engaged or proposing engagement in the industry and their education in technical or artistic subjects relevant thereto.

i Promoting the retaining in alternative occupations of personnel engaged in or retrenched from the industry.

j Promoting or undertaking scientific and industrial research, research into matters affecting industrial psychology and research into matters relating to production and to the consumption or use of goods and services supplied by the industry.

k Promoting, improvements and standardisation of accounting and costing methods and practice.

l Promoting or undertaking the collection and formation of statistics.

m Investigating possibilities of decentralising stages and processes of production with a view to encouraging the growth of allied small scale and cottage industries.

n Promoting the adoption of measures for increasing the productivity of labour, including measures for securing safer and better working conditions and the provision and improvement of amenities and incentives for workers.

o Advising on any matters relating to the industry (other than remuneration and conditions of employment) as to which the Central Government may request the Development Council to advice and undertaking inquiries for the purpose of enabling the Development Council so to advise, and

p Undertaking arrangements for making available to the industry information obtained and for advising on matters with which the Development Councils are concerned in the exercise of any of their functions.

Schedule industry: Any industry engaged in the manufacture or production of any of the articles mentioned under each of the following heading or sub-headings, namely:-

1. METALLURGICAL INDUSTRIES: A. Ferrous : (1) Iron and steel (metal). (2) Ferro- alloys. (3) Iron and steel castings and forgings. (4) Iron and steel structurals. (5) Iron and steel pipes. (6) Special steels. (7) Other products of iron and steel. B. Non-ferrous : [(1) Precious metals, including gold and silver, and their alloys. (1A) Other non-ferrous metals and their alloys.] (2) Semi-manufactures and manufactures.
2. FUELS : (1) Coal, lignite, coke and their derivatives. (2) Mineral oil (crude oil), motor and aviation spirit, diesel oil, kerosene oil, fuel oil, diverse hydrocarbon oils and their blends including synthetic fuels, lubricating oils and the like. (3) Fuel gases-(coal gas, natural gas and the like).
3. BOILERS AND STEAM GENERATING PLANTS: (1) Boilers and steam generating plants.
4. PRIME MOVERS (OTHER THAN ELECTRICAL GENERATORS): (1) Steam engines and turbines. (2) Internal combustion engines.
5. ELECTRICAL EQUIPMENT: (1) Equipment for generation, transmission and distribution of electricity including transformers. (2) Electrical motors. (3) Electrical fans. (4) Electrical lamps. (5) Electrical furnaces. (6) Electrical cables and wires. (7) X-ray equipment. (8) Electronic equipment (9) Household appliances such as electric irons, heaters and the like. (10) Storage batteries. (11) Dry cells.
6. TELECOMMUNICATIONS: (1) Telephones. (2) Telegraph equipment. (3) Wireless communication apparatus. (4) Radio receivers, including amplifying and public address equipment. (5) Television sets. (7) Teleprinters.
7. TRANSPORTATION : (1) Aircraft. (2) Ships and other vessels drawn by power. (3) Railway locomotives. (4) Railway rolling stock. (5) Automobiles (motor cars, buses, trucks, motor cycles, scooters and the like). (6) Bicycles. (7) Others such as fork lift trucks and the like.
8. INDUSTRIAL MACHINERY : A. Major items of specialised equipment used in specific industries: (1) Textile machinery (such as spinning frames, carding machines powerlooms and the like) including textile accessories. (2) Jute machinery. (3) Rayon machinery. (4) Sugar machinery. (5) Tea machinery. (6) Mining machinery. (7) Metallurgical machinery. (8) Cement machinery. (9) Chemical machinery. (10) Pharmaceuticals machinery. (11) Paper machinery. B. General items of machinery used in several industries, such as the equipment required for various unit processes : (1) Size reduction equipment - crushers, ball mills and the like. (2) Conveying equipment- bucket elevators, skip hoist, cranes, derrick and the like. (3) Size separation units-screens, classifiers and the like. (4) Mixers and reactors-kneading mills, turbo mixers and the like. (5) Filtration equipment-filter presses, rotary filters and the like. (6) Centrifugal machines. (7) Evaporators. (8) Distillation equipment. (9) Crystallisers. (10) Driers. (11) Power driven pumps-reciprocating, centrifugal and the like. (12) Air and gas compressors and vacuum pipes (excluding electrical furnaces). (13) Refrigeration plants for industrial use. (14) Firefighting equipment and appliances including fire engines. C. Other items of Industrial Machinery: (1) Ball, roller and tapered bearings. (2) Speed reduction units. (3) Grinding wheels and abrasives.
9. MACHINE TOOLS: (1) Machine Tools.
10. AGRICULTURAL MACHINERY: (1) Tractors, harvesters and the like. (2) Agricultural implements.
11. EARTH-MOVING MACHINERY: Bulldozers, dumpers, scrapers, loaders, shovels, drag lines, bucket wheel excavators, road rollers and the like.
12. MISCELLANEOUS MECHANICAL AND ENGINEERING INDUSTRIES: (1) Plastic moulded goods. (2) Hand tools, small tools and the like. (3) Razor blades. (4) Pressure Cookers. (5) Cutlery. (6) Steel furniture.
13. COMMERCIAL, OFFICE AND HOUSEHOLD EQUIPMENT: (1) Typewriters. (2) Calculating machines. (3) Air conditioners and refrigerators. (4) Vacuum cleaners. (5) Sewing and knitting machines. (6) Hurricane lanterns.
14. MEDICAL AND SURGICAL APPLIANCES: (1) Surgical instruments- sterilisers, incubators and the like. 15.
15. INDUSTRIAL INSTRUMENTS. (1) Water metres, steam metres, electricity metres and the like. (2) Indicating, recording and regulating devices for pressure, temperature, rate of flow, weights, levels and the like. (3) Weighing machines.

16. SCIENTIFIC INSTRUMENTS: (1) Scientific instruments.
17. MATHEMATICAL, SURVEYING AND DRAWING INSTRUMENTS: (1) Mathematical, surveying and drawing instruments.
18. FERTILISERS: (1) Inorganic fertilizers. (2) Organic fertilisers. (3) Mixed fertilisers.
19. CHEMICAL (OTHER THAN FERTILISERS): (1) Inorganic heavy chemicals. (2) Organic heavy chemicals. (3) Fine chemicals including photographic chemicals. (4) Synthetic resins and plastics. (5) Paints, varnishes and enamels. (6) Synthetic rubbers. (7) Man-made fibres including regenerated cellulose rayon, nylon and the like. (8) Coke oven by-products. (9) Coal tar distillation products like naphthalene, anthracene and the like. (10) Explosives including gun powder and safety fuses. (11) Insecticides, fungicides, weedicides and the like. (12) Textile auxiliaries. (13) Sizing materials including starch. (14) Miscellaneous chemicals.
20. PHOTOGRAPHIC RAW FILM AND PAPER : (1) Cinema film. (2) Photographic amateur film. (3) Photographic printing paper.
21. DYE-STUFFS : Dye-stuffs.
22. DRUGS AND PHARMACEUTICALS : Drugs and Pharmaceuticals.
23. TEXTILES (INCLUDING THOSE DYED, PRINTED OR OTHERWISE PROCESSED): (1) Made wholly or in part of cotton, including cotton yarn, hosiery and rope. (2) Made wholly or in part of jute, including jute twine and rope. (3) Made wholly or in part of wool, including wool tops, woolen yarn, hosiery, carpets and druggets; (4) Made wholly or in part of silk, including silk yarn and hosiery; (5) Made wholly or in part of synthetic, artificial (man-made) fibres, including yarn and hosiery of such fibres.
24. PAPER AND PULP INCLUDING PAPER PRODUCTS: (1) Paper - writing, printing and wrapping. (2) Newsprint. (3) Paper board and straw board. (4) Paper for packaging (corrugated paper, kraft paper, bags, paper containers and the like). (5) Pulp - wood pulp, mechanical, chemical, including dissolving pulp.
25. SUGAR: (1) Sugar.
26. FERMENTATION INDUSTRIES: (1) Alcohol. (2) Other products of fermentation industries.
27. FOOD PROCESSING INDUSTRIES: (1) Canned fruits and fruit products. (2) Milk foods. (3) Malted Foods. (4) Flour. (5) Other processed foods.
28. VEGETABLE OILS AND VANASPATHI: (1) Vegetable oils, including solvent extracted oils. (2) Vanaspathi.
29. SOAPS, COSMETICS AND TOILET PREPARATIONS: (1) Soaps. (2) Glycerine. (3) Cosmetics. (4) Perfumery. (5) Toilet preparations.
30. RUBBER GOODS: (1) Tyres and tubes. (2) Surgical and medical products including prophylactics. (3) Footwear. (4) Other rubber goods.
31. LEATHER, LEATHER GOODS AND PICKERS : (1)Leather, leather goods and pickers.
32. GLUE AND GELATIN (1) Glue and gelatin.
33. GLASS: (1) Hollow ware. (2) Sheet and plate glass. (3) Optical glass. (4) Glass wool. (5) Laboratory ware. (6) Miscellaneous ware.
34. CERAMICS: (1) Fire bricks. (2) Refractories. (3) Furnace lining bricks - acidic, basic and neutral. (4) China ware and pottery. (5) Sanitary ware. (6) Insulators. (7) Tiles. (8) Graphite Crucibles.
35. CEMENT AND GYPSUM PRODUCTS: (1) Portland cement. (2) Asbestos cement. (3) Insulating boards. (4) Gypsum boards, wall boards and the like.
36. **TIMBER PRODUCTS: (1) Plywood. (2) Hardboard, including fibre-board, chip-board and the like. (3) Matches. (4) Miscellaneous (furniture components, bobbins, shutters and the like)**
37. DEFENCE INDUSTRIES: (1) Arms and ammunition.
38. MISCELLANEOUS INDUSTRIES: (1) Cigarettes. (2) Linoleums, whether felt based or jute based. (3) Zip fasteners (metallic and non-metallic). (4) Oil Stoves. (5) Printing, including litho printing industry.

Therefore, a draft for constitution of Development Council for Plywood, Panel Board, Laminates and Agro-waste based board Industries on the lines of the Development Council for Pulp, Paper and Allied Industries constituted under this section was submitted to Secretary, Department for Promotion of Industry and Internal Trade (DPIIT), Ministry of Commerce and Industry.

Is development Council a substitute for Wood Council?

Let's first understand the constitution and functions of the proposed Wood Councils.

Constitution of proposed Wood Council of India, and Wood Councils at the state and the regional level:

1. The Central Government shall prescribe for the constitution of the Wood Council of India to provide for improved linkages between tree growers, traders or agents, wood based industries or enterprises, research institutes and related government representatives.
2. The Wood Council of India shall be under the Chairmanship of Minister-in-charge, Ministry of Environment, Forests and Climate Change
3. The Secretariat of the Wood Council of India shall function at the Indian Council of Forestry Research and Education, Dehradun.
4. Wood Councils shall be constituted at the state level by resolutions of respective state Government. The Statef Wood Council shall be under the Chairmanship of the Chief Minister of the respective State. The State Wood Council may constitute Regional Wood Councils for effective interface with tree growing farmers and wood based industries.
5. The State Wood Councils shall function under the overall guidance of the Wood Council of India, and the decisions of the Wood Council of India shall be binding on them.
6. The regional or district-level Wood Councils shall function under the overall guidance of their respective State Wood Councils, and the decisions of their respective State Wood Councils shall be binding on them.

Functions of State-level and regional-level Wood Councils:

1 The State Wood Council shall provide a forum for deliberation and collaboration amongst wood based industries, government representatives, forestry institutions and other stakeholders for the establishment of interface between the wood industry and tree growers in the state. It shall facilitate vertical integration of the above-mentioned linkages between all stakeholders;

2. The State Wood Council shall be the final authority on the establishment of farm wood based industries to maintain sustainable demand of such wood in the State.
3. The State Wood Council shall be the final authority on demarcation and designation of trade area for trader, agent and sponsor so as to encourage tree growers (farmers) to grow trees on their lands.
4. The State Wood Council shall be empowered to provide for upgradation and deployment of tools and techniques for on-site harvesting, conversion, peeling, veneering, impregnation, modification, seasoning, storage and other such value additions to farm wood, notwithstanding any other provisions in any other Acts.
5. The State Wood Council shall take steps for the promotion of wood technology innovations and enterprises. Intensive marketing and branding campaigns such as "Wood Is Good", "Grow More Wood- Use More Wood" will be taken up for promotion of growing trees and usage of wood products.
6. The State Wood Council shall facilitate growing of all industrial wood species, native or exotic, purely on productive considerations of demand and supply for the mutual benefits of tree growers and industries, without any restrictions.
7. The State Wood Council shall promote systems for certification of improved planting material and accreditation of nurseries with the help of forestry institutions.
8. The State Wood Council shall endeavour to remove the widespread mismatch between demand and supply of farm wood at the state and the regional level while guiding the establishment and distribution of wood based industries through appropriate promotion policy and guidelines to ensure less transportation cost of the farm wood.
9. The State Wood Council shall encourage and promote capacity building and skilling of urban migrants and rural labour for wood based industries in areas such as wood working and wood processing.
10. The State Wood Council may fix minimum and maximum price of local farm wood in trade areas based on market chain analysis, or facilitate price assurance to tree growers and an assured supply of raw material to the industries by putting in place mutually beneficial farming agreements between the

tree growers (farmers) and sponsors (forest-based industries).

11. The State Wood Council may develop the state's own electronic trading and transaction platform for intra-state trade and commerce in a trade area following the chain of custody regime electronically.
12. The State Wood Council shall ensure the establishment of information technology-based systems for the issuance of Certificate of Origin and Ownership (COO) to all tree growers and for establishing an Indigenous system of legality of farm wood standard (Vocal for local):
    - To authorise local bodies, or any other entity, to be second party certifiers for the issuance of COO to the first party (tree growers).
    - To authorise a body or institute of Indian Council of Forest Research and Education, an autonomous body of Government of India as third-party certifiers for such farm wood.
    - To provide for registration of wood based industries exempted from requirement of license.
    - To make provision for chain of custody and accounting of such wood as raw materials to the industries under legality framework.
13. The State Wood Council shall guide the state level Committee in the exercise of its powers and the discharge of functions.
14. The State Wood Council shall encourage State Forest Development Corporation and other state agencies to undertake plantations of long rotation tree species on government or community lands, which don't find favour under Agro-Forestry / farm forestry. At least 10% of forests of each Forest Division should be under Plantation Working Circle to provide timber from long rotation tree species on scientific and commercial basis.
15. The State Wood Council shall meet at least twice in a year, where a report of the functioning of the State Level committee (SLC) shall be placed before the council by the Chairman, SLC.
16. The State Wood Council shall examine and make appropriate recommendations or reference on any matter related to wood based industries to the central government.

Conclusion

Wood based industries should have one statutory body, namely Development Council, with a distinct focus on functioning and product development, and defined objectives. This body should be constituted under DPIIT, Ministry of Commerce and Industries. However, this statutory body under DPIIT is no substitute for the proposed Wood Councils at the centre and state level. Wood Councils will provide all solutions to the growing, harvesting and trading related problems being faced by farmers at large, and wood based industries in particular. In absence of an Act such as the proposed GROWING TREES OUTSIDE FORESTS (PROMOTION AND FACILITATION) ACT 2021, it would be expedient to incorporate the provisions of constitution and functioning of Wood Councils into the Wood Based Industries (Establishment and Regulation) Guidelines, 2016.

THE INDIAN ACADEMY OF WOOD SCIENCE

Working Office: Institute of Wood Science & Technology Campus,
P.O. Malleswaram, Bengaluru-560 003 (India)
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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: ……..
Date: ……..

(Signature of the Applicant)

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. 5000
Foreign:		
Corporate	N. A.	US $ 2,500
Institutional	US $ 50	N.A.
Individual	US $ 20	US $ 200

(To be Photocopied for Use)

Timbers for handicrafts and their properties

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Handicrafts form an integral part of India's rich and unique customs. Wooden handicrafts are made by decorating or carving the wood to create beautiful items. The art of making crafts from hands is known as handicrafts. Wooden handicrafts of India are renowned for beauty, durability and utility. These handicrafts include furniture, boxes, beads, finely engraved figures, dolls, toys, photo frames, decorative vases and showpieces. Artifacts like carving and inlay work made out of conventional timbers such as rosewood, sandalwood, red sanders, walnut, teak and others in India are famous throughout the world. Apart from these timbers, utility items made out of bamboos, canes and reeds are equally famous both within and outside India. As artisans are facing shortage of primary timbers due to over exploitation, alternate timbers have to be chosen which have potential for use for the handicrafts. The timbers used by an artisan for making handicrafts basically depends upon the properties, working qualities and colour of the wood. Keeping this in view, information on twenty wood species which have potential use in handicraft works are compiled and detailed information on tree size, general properties, working qualities and uses are listed below along with photomicrographs of anatomical structure.

Acacia auriculaeformis

Local name/common name: akashmoni (Beng.), earleaf acacia, earpod wattle, northern black wattle.

An evergreen tree with dense foliage and an open spreading crown reaching to a height about 9-11 m and sometimes more.

Properties: Sapwood and heartwood sharply distinct, sapwood white or yellowish white; heartwood yellowish-brown to golden brown when fresh, brown to dull brown on exposure, often with darker streaks; normally hard and heavy (sp. gr. 0.722 air-dry) with shallowly interlocked- grained and medium fine texture. The timber resembles teak in appearance.

Working qualities: It is reported that the timber can be turned to a smooth finish. Seasoned wood takes lacquer coat well and gives natural finish. The craftsmen feel that the wood is harder than conventionally used dudhi (*Wrightia tinctoria*) and tools need sharpening quite often.

Uses: Based on performance, *A. auriculaeformis* as given to Channapatna toy industries, is suitable for handicraft work like carving, lacquer work, etc.

Acacia mangium

Local name/common name: black wattle, Hickory Wattle. A species native of Australia and South Pacific, but cultivated throughout India. Under favourable conditions this species grows to a height of 30 m with straight bole and under adverse conditions to a height of 7-10 m.

Properties: The sapwood and heartwood are distinct. Heartwood is pale yellow brown with a narrow sapwood, moderately hard and moderately heavy (sp.gr. 0.515 to 0.683 air-dry), shallowly interlocked grained and medium fine texture, lustrous without any odour.

Uses: Based on performance, *A. mangium* is suitable for handicraft work like carving, lacquer work etc.

Azadirachta indica A. Juss. (Trade name- Neem)

Local names: neem (Beng. & Hindi.), limba, libado (Guj.), bevu, bevina (Kan.), veppu (Mal.), limba nimbay (Mar.), vepa (Tam.), yapa (Tel.).

A medium sized to large tree, upto 2-2.5 m in girth.

Properties: Sapwood yellow to yellowish-grey turning pale yellowish brown on exposure; heartwood reddish to reddish brown darkening on exposure; wood somewhat lustrous; hard to very hard; usually heavy (sp.gr. 0.72-0.83 air-dry); interlocked- grained; sometimes exhibiting ribbon-grain effect on the longitudinal surface; usually medium to somewhat coarse textured; when fast grown fine in texture; aromatic when fresh.

Working qualities: The wood is not difficult to saw and work and can be carved and turned well.

Uses: The wood is mainly used for carving images of gods and for toys.

Buxus wallichiana Baill. syn. ***B. sempervirens non-Linn.*** **(Trade name - Boxwood)**

Local names: paper, papri, paprang, shamshad, shumaj.

An evergreen or small tree reaching to a height of 9 m and a girth of about 1-1.5 m with a clear bole up to 2.5 m.

Properties: Wood yellowish-white when freshly cut, becoming dull yellow or yellowish-brown on exposure; usually hard and heavy (sp. gr. 0.78-0.95 air-dry) giving silky lustre when fresh, straight to somewhat shallowly interlocked- grained, very even and extremely fine-textured.

Working qualities: The timber is not difficult to saw and turns beautifully and used for carving.

Uses: It is a popular wood for turning, carving and employed for making toys, combs, mathematical instruments and fancy boxes for butter, honey, snuff, etc.

Dalbergia latifolia **Roxb. (Trade name-Rosewood)**

Local names: sirsai, sitsal (Hindi), biti, karimbeetti (Kan.), karitti, veetti (Mal.), shisham, sisu (Mar.), thodagathi, itti, iruppottu (Tam.), yerugudu, jittegi, virugudu chava (Tel.).

A tree of very large to medium sized varying in its size depending on the locality it is grown with a height up to 40 m and a girth of 6 m.

Properties: The sapwood is yellowish-white with a pinkish cast. The heartwood varies in its colour ranging from light purplish-brown to dark purple with darker streaks. The timber has a pleasant smell when fresh. The wood is hard and heavy (sp. gr. 0.70-1.22 air dry) with medium coarse texture and straight to shallowly interlocked -grained.

Working qualities: Even though the timber is hard, it is comparatively easy to work with hand and machine, and can be brought to an excellent finish and takes a beautiful polish.

Uses: The timber is one of the most popular wood for carving. Carved articles like elephants, jewellary boxes, book stands, chess pieces are made from this timber. It is also used for musical instruments.

Dalbergia sissoo **Roxb. (Trade name- Sissoo)**

Local Names: shishma, (Assam, Guj., Hindi), agara, agaru (Kan.), iruvil (Mal.), gette, yette (Tam.), errasissu, sinsupa (Tel.).

A tree with somewhat crooked bole, attains a height of 30 m in height and 2.5 m in girth, but timber with clear length and in large girths are usually not available.

Properties: The sapwood is pale yellow or greyish-white sharply demarcated from the golden brown to deep brown heartwood with darker streaks. It is a hard and heavy wood (sp. gr. 0.63-0.83 air-dry) with medium coarse texture and straight to interlocked grain.

Working qualities: The wood is very similar to rosewood in properties.

Uses: The timber is one of the most popular in North India for furniture and cabinet making as well as for carving and engraving. Also used for leaves of doors and windows.

Eucalyptus citriodora **Hook.**

Local names/common names: Lemon-Scented Gum, Lemon Scented Eucalyptus

A tall slender tree, usually 30-45 m in height and up to 1.2 m in diameter.

Properties: The sapwood is creamy white to dull yellow and heartwood is light brown to greyish-brown with streaks; moderately hard to hard, moderately heavy to heavy (sp. gr. 0.52- 0.82 air-dry) interlocked grained, lustrous with oily feel, without any odour, medium-course textured.

Working qualities: The timber planes and turns with little hard to smooth finish and gives glossy finish after polishing. Consumes less lac.

Uses: The timber is suitable for making export artifacts and for lacquer ware crafts.

Gmelina arborea Roxb. (Trade name-Gamari)

Local names: shwan, sinog (Guj), shivan (Hindi. Mar.), shivani, umi (Kan.), kumbil (Mal.), gamhari (Or.), gumadi (Tam.), Gummer tek (Tel.).

A tree of variable habit; in Bengal and Assam it is usually 12-18 m in height with a clear bole of 4.5-7.5 m and a girth of 1.5-2 m.

Properties: Heartwood not distinct from sapwood in colour. Wood pale yellow to cream coloured or pinkish-buff when fresh, turning yellowish-brown on exposure; soft to moderately hard; light to moderately heavy (sp.gr. 0.39-0.66 air-dry), lustrous when fresh, usually straight to irregular or rarely wavy-grained and medium coarse-textured.

Working qualities: The timber is easy to saw and work and fairly good in turning and boring. Moderate glossiness can be achieved using artificial films.

Uses: Used for bentwood articles. It is a popular timber for turnery articles and toys.

Gyrocarpus americanus Jacq. (Trade name-Tanaku)

Local names: kadubende (Kan.), thanaku (Tam.), tanaku (Tel.)

A large deciduous tree with a height of 18-30 m and 1.5- 3 m in girth.

Properties: Heartwood not distinct from the sapwood; wood greyish white darkening to light yellowish-grey or light brown on ageing; soft; very light (sp.gr. 0.26-0.35 air-dry); lustrous; straight-grained and coarse-textured.

Working qualities: It is a difficult timber to saw because of wooly nature of the fibres and can be worked only with very sharp tools.

Uses: Used for making toys, imitation fruits, carved animals and other utility items.

Haldina cordifolia syn. *Adina cordifolia* (Roxb.) Hook.f. ex. Brand (Trade name- Haldu)

Local names: Hardu, karam (Hindi.), kadambe (Kan.), heddi, honangi, kalamb (Mar.), manja kadamba (Mal.), manja-kadambai (Tam.), bandaru, dodaga (Tel.).

Properties: Sapwood pale yellow or yellowish white merging with heartwood. Heartwood deep yellow when

fresh turning brownish or reddish-yellow on exposure. Wood moderately hard; moderately heavy (sp.gr. 0.58-0.73 air-dry); lustrous; usually straight- grained but sometimes broadly interlocked, fine textured.

Working qualities: The timber is very easy to saw and work with both hand and machine. It is one of the best turnery and carving woods. To retain the natural colour and texture of the timber, polish made of white shellac is advisable.

Uses: The wood is largely used for toys, pen holders, combs, rulers, handles, ornamental caskets, engraving blocks and picture frames. It is used as an alternate to sandalwood for carving purposes.

Juglans regia Linn. (Trade name- Walnut)

Local names: akhar, akhrot, khor (Hind.)

A large deciduous tree about 24-30 m in height and 3-3.5 m in girth. Burrs are frequently found on walnut trees which are extremely valuable.

Properties: Sapwood greyish-white and often broad, heartwood variable in colour from light brown or greyish-brown to dark brown with few or no markings or marked with dark irregular smoky streaks sometimes beautifully mottled, moderately hard, light to moderately heavy (sp. gr. 0.42-0.68 air-dry); rather lustrous when fresh and beautifully figured particularly near the central zone, straight to sometimes irregular-grained and medium coarse-textured.

Working qualities: The timber is easy to work by both hands and machines.

Uses: It is employed for fancy goods and turnery articles, used for carving beautiful specimens for international exhibitions. In Kashmir it is used for lacquer work. It is an approved timber for high class furniture and cabinet making.

Maesopsis eminii Engl. (Trade name - Musizi)

Local name/common name- umbrella tree.

The tree grows to a height ranging from 20-45 m and girth from 0.5-1 m.

Properties: No distinction between sapwood and heartwood. Heartwood reddish brown in colour; moderately hard; moderately heavy (sp. gr. 0.434 air-dry); somewhat interlocked grained to straight grained; lustrous producing silver grain effect on radial surface; medium coarse textured.

Working qualities: The timber turns and sands well on powered lathe without chipping and yields sharp edges. With lacquers, the finish obtained will be smooth and glossy. The timber is easy to saw and planes to a fairly smooth surface.

Uses: Wood is excellent for making carved items and turnery products and to make export artifacts.

Pterocarpus marsupium Roxb. (Trade name- Bijasal)

Local names: Honne (Kan.), venga (Mal.), vengai (Tam.), yegi yegisi (Tel).

A deciduous tree varying considerably in size according to locality. The tree attains its best development in South India particularly Mysore where the largest trees reach up to 30 in height and up to about 5 m in girth. In Bihar, Orissa, Central India, it is only a moderately-sized tree.

Properties: Sapwood pale yellowish-white, sharply differentiated from the heartwood which is usually golden brown with darker streaks but occasionally reddish-brown darkening on exposure; moderately hard to hard; moderately heavy to heavy (sp. gr. 0.65-0.97 air-dry); interlocked-grained and medium coarse-textured; the timber gives a yellow stain on moistening and imparts a characteristic yellowish-blue fluorescence in cold water.

Working qualities: Not a difficult timber to saw but due to the interlocked grain it is not easy to bring to smooth surface. Takes a good polish with considerable amount of filling.

Uses: It is used for making toys, musical instruments, decorative articles, turnery and carved articles.

Santalum album Linn. (Trade name- Sandalwood)

Local Names – Gandha, srigandam (Kan.), chandanam (Mal.), chandanam, sandhanam (Tam.), chandanam, srigandam (Tel.).

A medium sized tree usually semi parasitic, grows to a height of 6-15 m and 90-120 cm in girth.

Properties: Sapwood white to pale yellow, heartwood yellowish brown to dark brown, hard, heavy (sp. gr. 0.84-0.94 air-dry) lustrous, even and very fine textured, heartwood having a characteristic pleasant odour.

Working qualities: The wood saws easily and finishes to a smooth surface and takes a satin-like polish.

Uses: It is one of the finest wood for carving and other fancy articles. The sapwood can be utilized as a substitute for *Wrightia tinctoria* for making small articles like dolls, jewellary cases and garlands.

Simaruba glauca

Local names/common names: Paradise tree, Laxmi taru.

An evergreen, small to medium-sized tree growing up to 15 m in height, with a narrow crown.

Properties: The wood is yellow in colour with no difference in sapwood and heartwood. Wood soft and light, (sp.gr. 0.430 air-dry) even and medium coarse textured with straight to slightly interlocked grained, without any odour.

Working qualities: The timber was found to take good polish, easy to cut, easy to turn the outer dia, satisfactory smooth finish, rough inner surface finish, consumes more lac and suitable for lacquer ware craft.

Uses: The timber is found to have potential as an alternate timber for handicrafts for domestic consumption. It is suitable for making light furniture, turnery items and handicrafts.

Swietenia mahagoni Jacq. (Trade name - Mahogany)

A large to very large evergreen tree, attains a height up to 45 m and 3-3.5 m in girth, the average being 1-2 m.

Properties: Sapwood yellowish-white to pale brownish-grey; heartwood usually pinkish when fresh, darkening on exposure to red-brown to brick red often with a satin or golden lustre; moderately hard and moderately heavy (sp. gr. 0.63-0.76 air-dry) straight to interlocked-grained and medium coarse to somewhat fine-textured.

Working qualities: Turns very well without any defect, boring can be well without any defect, planes to smooth surface, sands well, excellent for carving, easy to work and takes lacquer and wax polish well. It possesses excellent colour and figure.

Uses: Used for turnery articles and toys, inlay work, jewelry boxes and carved wood work.

Tecomella undulata (Smith) Seem. syn *Tecoma undulata* G. Don.

Local names: rugtrora (Hind.), lahura (Punj.), rohera, roira (Rajasthan).

A small tree or a shrub with 2-3 m in height, but can grow up to 12 m if protected.

Properties: Wood grey or buff, moderately hard, moderately heavy (sp. gr. 0.500 - 0. 610 air dry) straight-grained and medium fine textured.

Working qualities: The wood is tough, strong and works and takes polish well.

Uses: It is used for carving work and furniture.

Tectona grandis Linn. F. (Trade name- Teak)

Local names: segun (Beng.), saga, sagach (Guj.), sagwan, sagon (Hind.) tega (Kan.), tekku, thekku (Mal.), saga, sagwan (Mar.), tekku, tekkumaram (Tam.), adaviteeku, peddateeku (Tel.).

A deciduous tree with a rounded crown which under favorable condition attains large size with a clean cylindrical bole often becoming buttressed and fluted towards the base.

Properties: Sapwood white or pale yellow; heartwood light golden-brown when fresh, turning brown or dark brown on exposure, with an oily feel and characteristic odour reminiscent of old leather when fresh, moderately hard, moderately heavy (sp. gr. 0.51 – 0.77 air-dry); usually fairly straight- grained, but the samples from the drier regions often exhibit rather irregular grain; coarse and uneven-textured.

Working qualities: Relatively easy wood to saw and work and behaves very well in most of the common wood working operations. It is one of the best timbers for mortising, fairly good for boring. The timber can be glued satisfactorily on freshly machined or newly sanded surface. Teak does not corrode iron, copper, aluminum etc. and has fairly good resistance against acids. It takes nail and screws fairly well. It takes polish well and by the application of artificial films of finish glossiness can be achieved.

Uses: Engraving, carving, vases, god statues, toys, photo frames, home décor, boxes, furniture etc.

Toona ciliata (Roxb.) Roem. syn *Cedrela toona* Roxb. (Trade Name-Toon)

Local names: tun (Beng.), tun (Hindi), mandrake, tundu (Kan.), vembu (Mal.), mahanim (Mar.), tunumaram (Tamil), nandichettu (Telu.).

A large deciduous tree commonly attaining a height of 21-30 m and with a girth of 2-3 m.

Properties: Sapwood pinkish to pale brown or yellowish grey. Heartwood usually pinkish to red when fresh, has pleasant cedary odour. Usually soft and light (sp.gr. 0.37- 0.61 air- dry); lustrous; mostly straight-grained, occasionally interlocked- grained; moderately fine and slightly uneven textured usually with pleasing figure.

Working qualities: The timber is easy to saw and work. It can be polished to a smooth surface. It takes polish well but requires considerable amount of filling.

Uses: It is used for making toys, musical instruments, carvings and cigar boxes.

Wrightia tinctoria R. Br. (Trade name- Dudhi)

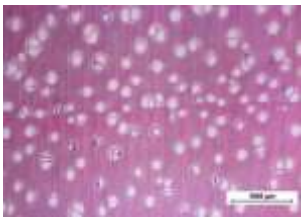
Local name: Alamara, beppale, kadmillm (Kan.); nilapala, pala (Mal.); palai, thanthapalai, veppalai (Tam.); akupala, pala, reppala (Tel.).

A small crooked tree upto 9 m in height with girth upto 90 cm.

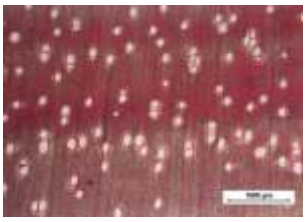
Properties: Wood white when fresh, turning yellowish-grey or yellowish-brown with age, heartwood not distinct; soft, light to moderately hard and moderately heavy (sp. gr. 0.48-0.69 air-dry); usually straight-grained, rarely shallowly interlocked or wavy-grained, very fine textured.

Working qualities: It saws, works and machines with ease. It turns beautifully and finishes to a very smooth surface and can be carved easily.

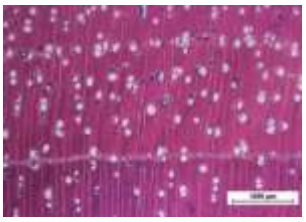
Uses: The timber is used locally for all classes of turnery articles and is made into toys, cups, spoons, combs, screens, etc., also it is used for lacquer work on turnery articles in Rajputana. Karnataka and Andhra Pradesh are famous for the toys made out of this wood.



Acacia auriculaeformis



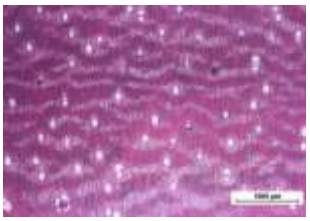
Acacia mangium



Azadirachta indica

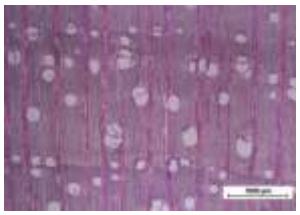
Buxus wallichiana

Dalbergia latifolia

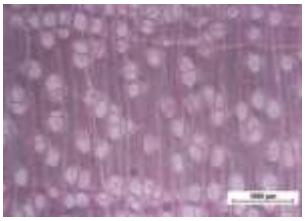


Dalbergia sissoo

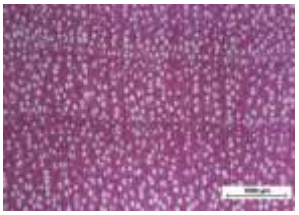
Eucalyptus citriodora



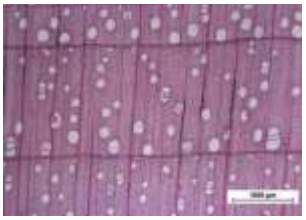
Gyrocarpus americanus



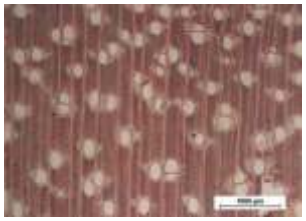
Gmelina arborea



Haldina cordifolia

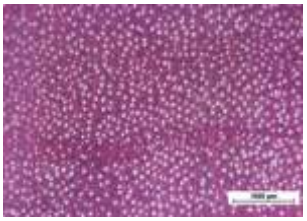


Juglans regia

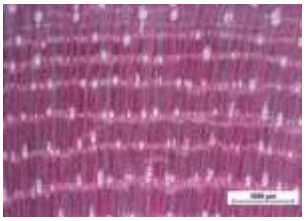


Maesopsis eminii

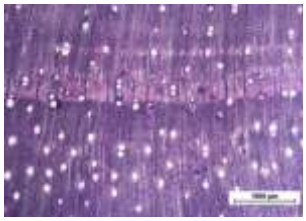
Pterocarpus marsupium



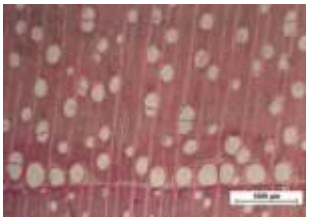
Santalum album



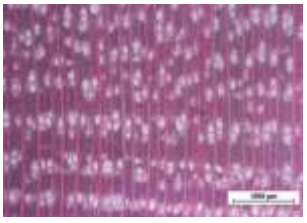
Simarouba glauca



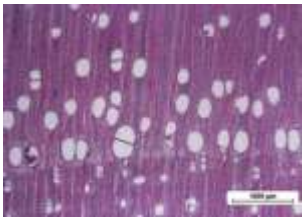
Swietenia mahagony



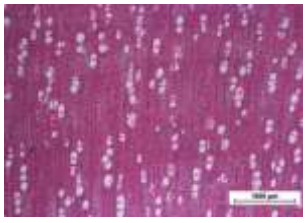
Tectona grandis



Tecomella undulata



Toona ciliata



Wrightia tinctoria

Photomicrographs of cross section of woods

Acacia auriculaeformis

Dalbergia latifolia

Wrightia tinctoria

Azadirachta indica (neem)

Eucalyptus citriodora

Simarouba glauca

Tecomella undulata

Santalum album

Dalbergia sissoo

Acacia mangium

Juglans regia

Selected handicrafts / articles made using different wood species

Further reading

Kumar P., Sujatha M., Shashikala S. and Rao R.V. (1995). Handicrafts- Traditional and alternate timbers. Wood News, Vo. 5: 17-20

Kumar P., Sujatha M., Shashikala S. and R.V. Rao (1996). Wood handicrafts - Part- II Traditional and alternate timbers. Part-II. Wood News Vol.5 (3):21-29.

Kumar P., Sujatha M., Shashikala S. and R.V. Rao (1996). Wood handicrafts - Traditional and alternate timbers. Part-III. Wood News, Vol 5 (4):23-30.

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The sheesham village of India: The art and the issues

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Saharanpur is a small city of Uttar Pradesh and is also popularly known as 'Sheesham village of India'. Its wooden arts and crafts are famous all across the globe. The North and the northeast of the district are surrounded by Shivalik hills which separates it from the Dehradun district of Uttarakhand state. The river Yamuna forms its boundary in the west which separates it from Karnal and Yamunanagar districts of Haryana. In the East, lies the district of Haridwar (Uttarakhand) and in the south lies the district Muzaffarnagar. As per the census of 2001 and 2011, the populations of Saharanpur district were 2149291, 3467332 respectively. The city boasts of more than 400 years old rich heritage of wood craft. The woodcraft of Saharanpur survived and flourished throughout the long historical timeline because it is regarded as material symbol of unique cultural ethos of the place. Wood-working and manufacturing is spread all over the city. Khata-kheri is the main centre of manufacturing and is also known as wooden city. Habibagarh and Pul-kambohan are some other places in the city where the clusters of artisans can be found. Most of the wood working expertise is passed on as paternal art from father to son. This tradition has resulted into huge generation of self-employment. Over more than 1.5 lakh people are employed in wood craft.

The Art

The wood craft of the place is known for its intricate designs and carvings on sheesham wood. The wooden articles have popular designs which include religious idols, artefacts, wood carved mirrors, furniture, cupboards, tables, trays and chests, toys, the pillars, ceremonial arches, raths and carriages, furnitures, photo-frames with intricate patterns, designs of jali, angoori, floral, figurative articles etc. Heavily carved wooden chests, centre tables, short stools, swings, devans, decorative boxes, wall hanging etc are rich in geometrical patterns inspired by history an medieval architectural styles. Apart from sheesham wood (*Dalbegia sissoo*), Mango (*Mangifera indica*), Babool (*Acacia nilotica*), Haldu (*Adina cordifolia*), Papdi (*Holoptelea integrifolia*), Toon (*Toona ciliata*), Teak (*Tectona grandis*), Pine (*Pinus roxburghii*), silver oak (*Grevillea robusta*) are the woods being used by the artisans.

A carved wooden idol

Floral patterns and designs

The motifs and deigns used in Saharanpur art work is influenced from the Kashmiri art work. A wooden product which is famous worldwide is folding screen. Wooden Folding Screen (WFS) is considered as free standing furniture for the utility and embellishment of living space with aesthetic notion. It is associated with elaborated carving; inlay and outlay work with traditional motifs under the influence of Persian tradition as well as Mughal taste.

Wooden Folding Screen

Wooden Folding Screen making in progress

Art of inlayed wood is mastered by the Saharanpur artisans. Inlay work is an ornamentation technique which involves embedding pieces of different materials (metals, plastics, stones etc) on wood surfaces.

Jali making using jig saw

Metal inlay work over wood

Tarkashi is another art in which various decorative wooden articles are inlayed with brass or silver wires. Vine-leaf pattern carving on sheesham wood is a famous art belonging to Saharanpur. It is often associated with tarkashi for ornamentation.

The type of products produced here has mostly become a part of lifestyle products of home accessory market. This market is strongly influenced by fashion trends, consumer purchasing patterns and economic conditions in general. Exports makes a substantial part of the production of the woodcarving industry with the main destinations being the USA, Europe, Brazil, Canada, China, Singapore, Sweden and Kuwait. The export of wood carving furniture and handicraft products to various countries is carried out by more than 100 organised exporting units in the district of exports worth Rs. 500 Crores.

Most of the artisans are not aware of designs, patterns, product development, requisite change in production facilities for a variety of materials, production techniques, and related expertise to meet the competitiveness and challenges in exports market. One of the major problems with the wooden handicrafts industry is that they are hand-made and it takes time, hard work and skill in production. The machine-made goods are comparatively cheaper. China and Vietnam are the major competitors in wooden handicraft segment due to machine-intensive production. However, due to intricacies in hand-carved artefacts, Saharanpur still enjoys the edge over machine made handicrafts.

Process involve in wood product manufacturing

Wood carving is done entirely by hand. During initiation of product making fist the wood as per the size of the form to be made is cut from the block. The piece is cleaned and smoothened. Design is first made on paper and transferred the wood using ink. Extra wood is chipped off according to the design. Fine strokes with hammer are made on the chisel placing it on the area to be shaped. The carved wood is smoothened and painted.

The following steps are involved in production of carved wood products:

Wood Sourcing and sawmilling: Sourcing and transporting raw material to saw mill for further conversion into the planks of various required thicknesses is done.

Preservation and Seasoning: Chemical preservative treatment is mostly done for exports purpose. The exporters use industrial wood drying kilns for seasoning. However, other artisans pile the sawn timber in shade for a season or two to air dry the timber.

Outlining: Carpenter outlines on the wood logs/ sawn wood using templates for cutting/chiseling the edges of the design.

Slicing: The first step of carving is to cut the timber into different shapes and sizes. This is called 'lakdicheerna' and is done using an electric saw. Thereafter, the wood is ready for to be worked upon by the carving artisans.

Carving: Carving is done either completely by hand or in combination with an electric saw. The saw is usually employed to make geometric patterns in wooden boxes. The whole operation is started with drawing the pattern intended to be carved on a piece of paper and pasting it over the surface. Holes are drilled to carve out the spaces with precision. Carving is done completely by hand to make various designs. Though the tools used are extremely simple (saw, plane, fine-grained hard stone,

Wood grinding is manually done to make intricate shaped articles

Wooden hammer, various types of chisels and scooping tools are used in carving

Making of intricate carving patterns in progress

chisels etc), the carvers use them aptly to produce some astonishing results with minute details, keeping the intricacies and subtle light and shade effects, desired curves, expression, and texture.

Inlaying: Brass is extensively used for inlaying floral, geometric and typographic patterns on wood. This is done by cutting strips of metal and then die-pressing them to get the desired shape. These pieces are then sold by weight to the carvers who make grooves for them beforehand. The metal is driven into the wood, adhesives and fine nails are used for strength and durability. The waste strips are recycled for re-use. Sometimes bones and plastic are also used for inlay work. Apart from embedding brass into the wood, the artisans have started combining wrought iron with wood. This is either to lend strength to the structure of the product (like chairs, tables, beds, etc.) or pure aesthetic value (like in vases, lanterns, candle holders, etc.).

Polishing: Sanding and buffing are done on the wood to bring smooth and shiny surfaces. Polishers rub putty to even out the unfinished edges and cracks. When the putty dries, the wooden piece is smoothened further with sandpaper and coated with paint or polish, depending on the desired finish. Polish finishes include the regular natural, walnut, and rosewood.

Assembling: Rivets, metal hinges or any other elements are used to give the product its final touch followed by assembling several components.

The wood craft of Saharanpur are small scale and cottage level industries. These small units unfortunately use mostly outdated machinery, inadequate tools and manual labour for manufacturing. This often results in low output and high cost.

Apart from embedding brass into the wood, the artisans have started combining wrought iron with wood.

The Issues

Lack of access to good quality raw material is posing a threat to this handicrafts cluster. The challenges were intensified when CITES (Convention on International Trade in Endangered Species) put sheesham wood in appendix II in its CoP-17, held in 2016. This meant that each shipment having sheesham and rosewood products would need a CITES Export certificate. Export Promotion Council for Handicrafts (EPCH) was appointed as the competent authority to issue the comparable documents in lieu of the CITES. The exporters are required to produce a shipment certificate known as 'VRIKSH' which is issued by EPCH. The issuance of certificates includes an audit by EPCH establishing chain of custody and legality of the procured wood by the exporters. This additional financial and paper work burden on the exporters resulted in decline of the exports. This also leads to delays in shipping time due to paperwork. As *Dalbergia sissoo* is an agro-forestry species, this also discourages farmers who grew the species to their farmlands. Apart from this, the species has relatively very long rotation age and its dark colour heart wood is highly preferred by the consumers. The state forest corporations are not able to supply good quality raw material in abundance. Due to all these reasons the price of sheesham wood has gone unreasonably high.

Another international development which adversely affected the cluster was arrival of the concept of forest certification. Forest certification is a voluntary, market based mechanism that supports sustainable forest management worldwide. Most of the big retailers of the markets of Europe, USA etc are enforcing for certified wood. Very small proportions of the public/ private owned forests/ plantations in India are producing certified timbers as per the two largest internationally accepted forest certification programs: Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). To get certified wood, the manufacturers have to pay additionally higher prices (price premium) as compared with the uncertified wood. Moreover, after getting the certified material, they have to undergo an audit for chain of custody (CoC) certificate. The cost of CoC audit is borne by the manufacturers resulting in additional cost increase. This has led the manufacturers towards increased use of imported timbers which are available with the CoC certificate. Many timber importers and foreign timber suppliers see certification as

opportunity to tap Indian market and to get distinctive competitive advantage. The artisans/ manufacturers of Saharanpur are also opening up for imported timbers.

The handicrafts sector mostly being unorganised, the artisans are mostly neglected and prone to exploitation by the market. The artisans are mostly less educated and have lack of access to credit and finance, appropriate tools and technology, information and technical knowledge and design trends. Demonetisation combined with increased taxation on products has negatively affected the artisans. The recent lock-down due to corona virus pandemic resulted in shut down the manufacturing for two and a half months. This has also increased the plight of the artisans and many of them have turned towards alternative livelihood for supporting their families.

Central and state government ministries/agencies have been making active efforts to revive the wood carving industry of Saharanpur. Ministry of textiles has recently upgraded a Common Facility Centre (CFC) at Saharanpur. EPCH has been instrumental in solving the problem arisen with sheesham wood certification. Moreover, technology up gradation, quality and design improvement, standards and specifications, product development, innovation are some of the jobs being undertaken by EPCH apart from organising national and international trade fairs on handicrafts.

The Geographical Indications of Goods (Registration and Protection) Act (1999) provides for the registration of handicrafts as Geographical indications (GI) tag. A geographical indication is a signature that can be used on goods with a specific geographical origin and possessing qualities, reputation or characteristics that are essentially attributable to that place of origin. As the carved wood handicrafts of Saharanpur is considered as a result of traditional art and knowledge, carried forward by a communities from generation to generation, it was give geographical indication tag under registered product name 'Saharanpur Wood Craft'. This means that no third party who manufactures wooden handicrafts somewhere else can claim it unduly.

One District One Product (ODOP) is the flagship scheme of the Uttar Pradesh government working on this handicrafts cluster. This scheme targets district-specific industries which manufacture products unique to the region. Under this scheme the artisans of Saharanpur are given training and other facilities. ODOP cell's Memorandum of understanding (MoU) with Amazon.in and other e-commerce giants is expected to bring a positive change.

The scientific research organisations have a great responsibility to help to sustain and flourish this cluster to preserve the traditional art. There is an urgent need of developing improved varieties of sheesham in terms of lower rotation age and better quality timber. Improved and cheaper wood drying and preservation technologies can help the artisans to maintain the quality. Relationship model which exists between poplar, eucalyptus growers around Yamunanagar plywood/panel industrial hub, is needed to establish also for Saharanpur region.

Exploring alternate wood species for handicraft sector- a regional perspective and Institute's initiatives

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Wood has always been a major part of Indian handicrafts and various beautiful things are crafted out of it. Woodworking industry is growing at a rapid pace where various kinds of woods are being used, preferably those available locally or equivalent imported woods. India has set up over around 100,000 registered woodworking units in this sector and the number is increasing with the passage of time[1]. The wooden handicraft of India is draped with a vast cultural and ethnic diversity which are unique in their style and represent rich Indian heritage. In the rural India, furniture and other household utensils are carved out of wood in different shape and exhibit unique styles. Like other handicraft sectors, the wooden craft sector is highly creative and produces large variety of products. The wood-based handicrafts sector is, however, highly labour intensive, cottage based and falls under decentralized industry category. Most of the wooden handicraft manufacturing units are located in rural, semi-urban (small towns) and urban areas all over the country having huge market potential. This sector is one of the major sources of income for rural communities/artisans including a large number of women and people belonging to the weaker sections of society.

The production of wood handicraft products is mostly done on small scale in clusters in different states of the country. There is huge demand for the wooden handicrafts in both national and international market. To match the demand and supply with quality, there is need to have greater support in terms of raw materials, skilled manpower and upgraded wood processing techniques along with innovativeness and uniqueness. Also, there is lack of awareness about new traditions among craftsmen and there is need of proper technological support and training.

Brief Overview of Traditional Woodcraft of India

Since olden times of civilization, the wooden handicrafts reside at a considerable position in Indian society and culture. Handcrafted with talent and proficiency, they reproduce incomparable creative virtues. Most of the states of India are a symbol of traditional wooden handicrafts. Mostly, each state of the country presents and contributes only one of its kinds of arts and treasure of wooden handicrafts. These wooden handicrafts also represent the local cultural heritage, traditions and religious beliefs. Slowly, the changes are also been seen in concepts and designs. With time, many developments have also taken place in this sector. Several wooden handicraft clusters have also come up in each state representing their unique products. Many different varieties of wood species have traditionally been used by the artisans depending upon their requirements and local availability. Details of some potential species being used in handicraft sector are listed in Table 1.

North-West India:

Major woodcrafts of North-West India are distributed in the following states:

Chhattisgarh: In this state, the artisans engaged in woodcarving/wood handicraft industry are from different communities. Various types of furniture and other attractive wooden carving/crafts are also made by skilled and experienced hands. Artisans from Bastar area have excellent skills in variety of wooden craft work and their skills have been recognized at national and international levels. The Badhai community is skilled in woodcraft work including agricultural instruments, decorative and totemic pillars. Similarly, Muria community has woodcarving skills and is best in craftsmanship. They generally express their culture and religious faiths into crafts, music culture of community and wildlife. The craft work heavily depended as hand-made as there is no machinery usage or rarely used in particular areas only. Fine quality of sal, teak and other types of locally available woods are mostly used for making the wood crafts. The woodcraft industry at Bastar also uses local wood species such as Bija (Pterocarpus marsupium), Sheona etc. Among furniture items, Deewan (cot with box) is very famous and attractive since it involves the art of carving and other designs of interest.

(*Source: https://en.wikipedia.org*)

Woodcraft in Bastar has beautiful and unique form of art that was mastered by tribal and it helps their livelihood.The wood-crafting work has been protected under the Geographical indication (GI) of the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement. It is listed as "Bastar Wooden Craft" of GI Act 1999 of the Government of India with registration confirmed by the Controller General of Patents Designs and Trademarks.

Gujarat: Famous for woodwork in carved chests, almirahs, and wooden swings. The wooden swings vary

(*Source: https://cultureandheritage.org*)

from plain Hewn wood to lavishly embellished ones. There is also a tradition of embedding indigenously made gold, silver, and bronze hues on wood in a place called Sankheda village in Gujarat. The districts of Saurashtra and Vadodara are renowned for their lacquer work. Some important items of lacquer work include toys, parts of bedstead, low stools and chairs (their seats done in either a mesh of ropes or leather). These are characterized by a colorful, smooth and glossy exterior and often fitted with tiny bells which emit a soft tinkling sound. Surat has a tradition of marquetry-work, which is locally called sadeli. This was acquired by the local craftsmen by means of their interactions with West Asia. In this technique different material such as ivory, ebony, sandalwood, metal, having varying textures and colors are used. Originally, this technique was used for decorating the doors of palaces; today it is also applied to boxes. In recent years, colour innovation has been adopted with black, blue, green, ivory, copper, silver and burgundy shades. Now with the adoption of chemical pigments, instead of the traditional organic dyes and pulp of kewda leaves (fragrant screw pine) as a colouring base, the palette has many colours to offer for painting the furniture. However, tinfoil patterns with transparent lacquer coating is the basic traditional method which is continued, with polishing done with agate. The product is protected under Geographical Indications of Goods (Registration and Protection) Act (GI Act) 1999 of the Government of India.

Jammu and Kashmir: This state has been a virtual hotspot of wood (mainly walnut and deodar) carving almost

(*Source: http://www.kashmir-tourism.org*)

since ancient times. Here the commonest dwellings are lined with wood, their ceilings worked in geometrical patterns and windows possessing lattice work. The crowning glory of Kashmir - the houseboats, and the shikaras are made entirely of a specially treated wood that does not warp in spite of constant contact with the water.Kashmir walnut wood carving is wood carving work that is manufactured in the Jammu and Kashmir state, India. Walnut carving is protected under the GI of TRIPS agreement. It is listed at item 182 as "Kashmir Walnut Wood Carving" of GI Act 1999 of Government of India with registration confirmed by the Controller General of Patents Designs and Trademarks. The Juglans regiatree that grows widely in Kashmir region is used for wood carving, and Kashmir is one of a few places for availability of walnut trees. Walnut wood is used to make tables, jewelry boxes, trays, etc. Famous for its exclusive Kashmir houseboat made out of a specially mollified wood that does not soak in water. Also, houses in Kashmir are made of wood with latticework windows and geometrically patterned ceilings

Madhya Pradesh: The artisans work on different varieties of wood – teak, dhudi, sal and kikar with great sensitivity and skill, turning them into fabulous works of art and crafts. Gwalior, Sheopur-Kalan, Rewa and Budhni are the main centres of wood lacquering in the state. The famous wooden articles are painted and lacquered toys boxes, bedposts, cradle frames and flower vases, to name a few.

(*Source: www.mptravelogue.com*)

Orissa: Wood carving is a major indigenous craft of this state which includes painted wood carvings, plain wood carvings and teak furniture. Wooden boxes, antique trunks, doors made of teakwood are found mainly in Puri.

(*Source: http://www.kashmir-tourism.org*)

These furniture items are made in different varieties of decorations and painting, using vegetables and mineral colors. Articles in white teak also occur in profusion in Bhubaneshwar and Cuttack.

Punjab: The wood workers in the city of Hoshiarpur specialize in inlaying wood with ivory. Their intricate designs received patronage from the local royalty, for several hundred years. The outstanding items are basic furniture, trays, and mirror frames. Gained immense popularity for carving inlaying ivory which is now replaced with plastic to cut down on the cost. Wooden furniture, trays, and mirror frames are usually crafted using intricate designs that were claimed to be the royal patronage ages back.

(*Source: dir.indiamart.com*)

Rajasthan: This state is well known for the quality of its wood carving and wooden art pieces as well as for use in furniture. Jaipur is known worldwide for its original woodcrafts. There this art has survived mainly due to the royal patronage. Barmer and Jaisalmer districts also boast of wood carving traditions. For instance, teakwood is often carved in form of, or decorated with animal figures, geometric and floral forms. These appear abundantly on rafter ends, pillars and brackets, openwork jali (lattice) screens, windows, doors and door frames. Jodhpur is one of the biggest woodcraft industries of the country. Among the major preferred wood species include Shisham, Mango, Babul/kikar, Neem etc. Hard timber species such as Vilayati Babul/Vilayati Khejri (Prosopis juliflora) can also be used as alternative to currently used wood.

(*Source: www.rajasthancraft.com*)

Uttar Pradesh: Wooden toy-making is a traditional craft in the Varanasi (Banaras) district of Uttar Pradesh, India. Banaras is also known for lacquered toys and miniature utensils for children to play with. Bright and colourful lacquered toys are made by clusters of skilled craftsmen. These toys were given the Geographical Indication tag in 2014, along with other lacquer ware produced in this region.According to the craftsmen, their ancestors specialized in ivory carving that enjoyed good patronage during the reign of the Mughal emperors and the British. After ivory was banned by the Government of India, they shifted to woodcarving. Designs such as the fretwork, jali or the anguri work are very popular. Trays, lamps, tea-coasters, cigarette boxes, and tables made of sheesham are well-known. Mainpuri is famous for woodwork on ebony or black sheesham inlaid with brass wire. Teak is also used heavily for manufacturing traditional as well as contemporary designed products-screens, boxes, tables, trivets, bookends, etc.

(*Source: dir.indiamart.com*)

South Indian Traditions:

South Indian craft is most influenced by the diversity of religious beliefs. The craft industry has established itself commercially in the nation, whilst reflecting a long history of foreign rule. Different wood species such as teak, rosewood, to name a few are extensively used by the craftsmen. For wood workers, crafting wooden statues for temples has been a major source of income. The woods mostly used for ornamental work in South India are sandalwood (with its delicate natural fragrance), rosewood, red sander, teak etc. The forests of this region provide extensive supplies of raw materials, mostly rosewood.

Andhra Pradesh: The main wooden handicraft clusters are in Etikoppaka, Nirmal and Kondapalli. Nirmal and Kondapalli are famous for making wooden toys while Etikopakka is known for lacquerware made of wood. The main species being used for handicraft items are mainly *Wrightia tinctoria*, *Adina cordiflia*, *Gmelin aarborea*, sandal, rosewood etc. Kondapalli toys are the toys made of wood in Kondapalli of Krishna district. It was registered as one of the geographical indication (GI) handicraft from Andhra Pradesh as per Geographical Indications of Goods (Registration and Protection) Act, 1999. These toys were one of the variety of toys assembled in the houses during the festivals of Sankranti and Navratri and is referred as

(*Source: https://yehaindia.com*)

Bommala Koluvu. Makku paste of tamarind seed powder and sawdust is used to join pieces together, add details and finish the toys. The later step involves coloring with either oil or water colours or vegetable dyes and enamel paints are applied based on the type of the toys. The artisans mainly work on producing figures of mythology, animals, birds, bullock carts, rural life etc., and most notable one is Dasavataram, dancing dolls etc.

Telangana: Nirmal toys are traditional Indian wooden

(*Source: http:||www.sahasa.in*)

toys made in the town of Nirmal in the Adilabad district in the newly formed state of Telangana in India. Nirmal Art, encompassing a 400-year-old tradition of making soft wood toys and paintings, occupies a place of pride in the world of handicrafts. While the foundry supplied heavy artillery to the army of the Nizam of Hyderabad, the Naqqash craftsmen and artists brought out exquisite wooden toys and duco paintings under the name of Nirmal Art. The foundry was closed soon after Hyderabad's accession but the art form has survived many ups and downs, the most impacting being the loss of its patron, the Nizam. Elegant toys and paintings continue to be produced by the Naqqash artisans at this town.

Karnataka: The important handicraft clusters are in

(*Source: https://speakzeasy.wordpress.com*)

(*Source: www.cauverycrafts.com*)

Channapatna, Mysore, Kinhal (Kinnal) and Sagar. The species being used by artisans for handicraft purpose areHale, Beach wood, Cedar, Eucalyptus, Jamun, Mathi, Nandi, Neem, Pine wood, Rubber wood, Silver oak, Teak, Haldu, Ficus spp. Out of above-mentioned wood, *W. tinctoria* is used in maximum quantity. It refers to a wide variety of lacquered wooden items which are prepared through the process of lac-turnery. Wooden lacquer miniature toys are special on several accounts: for the safety value of the materials used, for their link with objects and activities that are embedded in cultural memory and reality of the subcontinent, for their cost effectiveness. This toy industry is mainly dependant on Hale wood which is close grained; moderately hard it can be easily turned into fine shapes by hand or machine. The wood does not require any chemical treatment.

Channapatna toys are a particular form of wooden toys (and dolls) that are manufactured in the town of Channapatna in the Ramanagara district of Karnataka. This traditional craftis protected as GI under World Trade Organization, administered by Government of Karnataka. As a result of the popularity of these toys, Channapatna is known as Gombegala Ooru (toy-town) of Karnataka. Traditionally, the work involved lacquering the wood of the *W. tinctoria* tree, colloquially called Aale mara (ivory-wood).The origin of these toys can be traced to the reign of Tipu Sultan[1] who invited artisans from Persia to train the local artisans in wooden toys making. For nearly two centuries, ivory-wood was the main wood used in the making of these toys, though rosewood and sandalwood were also occasionally used. Rose wood, yellow wood and ebony are used as raw materials and designs depicting are carved into them after which various artifacts from paint to gold silver, plastic coated with hydrogen peroxide, sandalwood are inlaid into the wood after carving depicting nature and Hindu mythological epic stories.

Kerala: Handicrafts Development Corporation of Kerala Ltd, a Kerala Government undertaking, functioning under Industries Department, Govt. of Kerala, promotes the

(*Source: www.keralahandicrafts.in*)

developmental, marketing and welfare activities in the handicrafts sector of Kerala.The corporation has been running a Common Facility Service Centre at Thiruvananthapuram for the benefit of wood-based artisans to improve their crafts and also to eliminate drudgery. Many other innovative marketing programmes are also being pursued by it to enhance penetration of handicrafts to various strata of society. The continuing training and developmental activities are being implemented through the assistance from the various organizations. The major species being used for artifacts are mainly rosewood, sandalwood and a few locally available woods suitable for handicrafts. The state also specializes in arena handicrafts that along with representing their customs and beliefs also portray their spiritual values and emotions.

Table 1: Wood species having potential for handicrafts sector

Scientific name	Common name	Suitable properties for handicraft	Uses
Acacia auriculiformis	Kari jali	Turns well with smooth finish. Seasoned wood takes lacquer coat well and gives natural finish.	Suitable for handicraft work like carving, lacquer work, etc.
Adina cordifolia	Yellow teak	Easy to saw and work. Polishes well, absorbs colour uniformly and can be stained to any colour.	Mostly used for turnery items, toys, penholder, combs, scales, ornamental caskets, handles.
Ailanthus excelsa	Maharukh	It is an easy wood to work on machines or by hand.	It is used for making toys.
Albizialebbek	Kokko	They take an excellent polish, but the large pores require careful filling before polishing.	It is used for carving, turnery, toys and picture frames.
Alstoniascholaris	Chatian	It is very easy to saw and work. It peels and turns well and takes a fairly good finish	It is used for making toys.
ArtocarpusheterophylIus	Kathal	It turns well and easy to work.	It is used for making turnery articles.
Artocarpushirsutus	Aini	Easy to saw, plane, turn and finish, but due to interlocked fibres, requires careful working to bring out smooth finish.	Aini is used for general carpentry work and for making turnery articles.
Azadirachtaindica	Neem	Easy to saw and work. It turns well and can be brought to a fair finish. Small knots produce attractive figure.	The wood is mainly used for carving images of gods, and for toys and the like.
Bauhinia malabarica	Kanchan	Works to a smooth surface and takes good polish. It offers little difficulty in sawing or working with tools.	Timber is used for making toys.
Chloroxylonswietenia	Satinwood	Finishes well and turns excellently. It glues well and takes a fine and lasting polish.	It can be used for carving, turnery and other fancy items.
Cinnamomumzeylanicum	Cinnamon	Easy to saw and work and can be finished to fine smooth surface and takes a high and lasting polish	Used for turnery articles.
Dalbergialatifolia	Rosewood	Turns well and takes a very good polish but require a filler.	Most popular woods for carving, engraving, turnery articles
Diospyrosebenum	Ebony	The timber takes a very good polish, and very little grain filling is required.	Heartwood is highly priced for a variety of small ornamental articles and toys.
Eucalyptus camaldulensis	Eucalypts	Easy to saw and plane. After plaining, sanding, filling and sanding again, a smooth surface is obtained. With 2-3 coats of polish, very smooth fine and glossy surface can be obtained.	Based on artisans' reports, it possesses excellent wood carving properties. The results of turning and shaping were very good.

Gardenia latifolia	Gardenia	It turns very well, finish to a beautiful smooth surface and take a fine polish.	Good for turnery articles such as combs, rulers, toys, penholders, brush backs etc.
Gmelinaarborea	Shivani	It is easy to saw and work is fairly good in turning and boring	Used for bentwood articles, popular timber for picture frames, toys and turnery articles.
Holarrhenaantidysenterica	Kurchi	Easy to saw and machine. It turns extremely well to a very clean finish, cutting freely along and cross grain.	It is used for carved boxes and picture frames.
Holoptelea integrifolia	Kanju	Easy to saw and work Smooth clean and sharp edges in turning and clean bores can be obtained.	It is used for making carved articles.
Hymenodictyonexcelsum	Kuthan	Easy to saw, work and can be brought to a fine finish. Takes stain very uniformly and can be stained to any desired colour.	It is used for making toys.
Lagerstroemia microcarpa	Benteak	Easy to saw and work. It finishes to a fine smooth surface, takes a good polish.	It is used for making turnery articles.
Leucaena leucocephala	Subabul	Colour being light yellow, pleasing finishes can be obtained by polishing with shellac or lacquer.	The timber is good for carving.
Maesopsis eminii	Musizi	It turns and sands well without chipping and yields sharp edges. With lacquers, finish obtained will be smooth surface.	Wood is excellent for making carved items and to make export artifacts.
Mangiferaindica	mango	It is soft and easy wood to saw and machine, finishing to a moderate surface, and with proper filling takes a good and lasting polish.	Suitable for carving and turnery and used for making various types of wooden utensils.
Melia azedarach	Persian lilac	Easy to saw and work and can be brought to a smooth finish. It takes good polish provided filling is done before polishing.	The main use is for toys, small articles and turnery articles.
Pterocarpus marsupium	Bijasal	Takes good polish but requires considerable amount of filling.	Wood is used for carving purpose.
Sterculia urens	Gular	Easy to saw, work and finish well.	Used for making carved toys.
Swieteniamahagoni	Mahogany	Timber has good natural appearance and working qualities. Easy to work.	Turnery articles, toys, inlay work, jewelry boxes and carved wood work.
Tectonagrandis	Teak	Easy to saw and work. Best for mortising and fairly good for boring. It glued satisfactorily and takes polish well	Teakwood is best suited for carving, turning, toy making etc.
Toona ciliata	Toon	Very easy timber to saw and work both by hand and on machines. It can be finished to a fairly smooth surface and takes a good polish if properly filled.	It is employed for making toys, musical instruments, carvings and cigar boxes.
Trewianudiflora	Gutel	A very easy wood to saw and work to a nice smooth surface.	Used for making carved images.

IWST's Initiatives

Institute of Wood Science and Technology (IWST) with its national mandate on wood science and technology has been serving various wood-based industries for rational and sustainable wood utilization. Efforts have been made to search for the alternate/substitute wood species for the traditionally used ones, conduct of regular trainings and workshops and organization and participation in various seminars, institute-industry interactive meets. The contributions made by the institute also indicate its active participation for the growth and welfare of wooden handicraft sector. Institute is making continuous efforts in building the environment focusing on infrastructure development, training and technological innovations etc. to enhance the sector's growth. The performance of handicraft industry can be improved and the greater Value addition can be done through effective

operational and technological up-gradation, cost effective production, maintains quality standards and packaging. In view of the above, the Institute is fully equipped to train and sensitize artisans working on wood with the application of latest tools and techniques of wood science and technology, so that the handicraft products made from India can stand up to International market with eco-labeling.

In order to preserve this rich heritage of India, the only constraint is the steady supply of raw material and dwindling plant population in natural habitat. This problem can be partially overcome by the seed studies and propagation studies and restocking it in natural habitat though appropriate plantation programmes involving stakeholders. These programmes can be proposed under the working plans prepared by state forest department for each forest divisions. Plantation techniques for each of the handicraft species needs to be developed so as to disseminate the package of practice to the public for cultivation. However, the artisans and craftsmen are being trained on changing trends in the industry, and to help them keep abreast of the current scenario. The problem of raw material can be partially overcome by the seed studies and propagation studies and restocking it in natural habitat though appropriate plantation programmes. The issues of raw material, wood quality and protection of species suitable for handicraft are extremely important. Main emphasis is being given on quality planting stock of *W. tinctoria, W. tomentosa, Simaruba glauca and G. arborea* as these species are good agroforestry species with multifarious uses such as dye and wood; medicine, seeds etc. With proper management of the species in terms of good silviculture, working and harvesting practices and favorable legal and policy framework, they can be taken up for large scale plantation. This is a necessary condition because of the continuous demand for huge quantity of wood suitable for handicraft as required by the industry over a long period of time. This would make this industry as self sustaining in terms of the wood requirements. The wood species required for woodcraft industry could also be raised on the farm bunds and boundary, which not only protect the crops but also help to generate more income from the unit piece of land. It isalso required to certify these private plantations and hence would not create any problem when such certified wood is exported in form of handicraft/ artifacts. Thus, the industry can remain price competitive in export market. But, the wood availability is continuing to be one major bottleneck in this industry as new issues such as sustainable harvesting of wood becomes a requirement in export.

Data and information on various wood properties is collected to generate scientific knowledge for rational utilization of wood; screening of right species for right use with right price which also helps in the inclusion of wood species in BIS list for large scale utilization. For all this, study of anatomical, physical, mechanical and working properties of wood along with processing techniques is very much required. Various physical properties of wood include colour, grain, texture, appearance, sapwood/ heartwood, moisture content, specific gravity/density, shrinkage properties. The mechanical properties such as static bending (strength, stiffness), compression parallel and perpendicular to grain, hardness, tensile strength, shear strength etc. are also evaluated in green and air-dry conditions[2]. As per Indian standards[3], various working qualities of timbers which need to be evaluated are planing, sanding, turning, shaping, mortising, boring, carving, ease of work, polishing etc. The concept of seasoning and chemical treatment of wood has been introduced to overcome these poor-quality aspects of cheap wood. The industry has responded to the changes in the availability of the wood, quality of wood and the prices of wood by shifting to lower priced wood, which is though, not mature wood and is sometimes susceptible to pest attack.

Many fast-growing plantation species have been recommended for handicraft sector; however, some of these species have not been fully studied for mass propagation, silvicultural practices, improvement in wood quality parameters and processing technologies. The Institute has state-of-art machineries and equipments housed in various laboratories, wood workshops and training centre. Major objectives are on assessment and improvement of quality of raw material, wood working and processing parameters of wood species suitable for handicraft sector. A number of plantation grown timber species such as *Acacia mangium, Acacia auriculiformis*, hybrids and clones of *Acacia auriculiformis* x *Acacia mangium, Eucalyptus tereticornis, E. camaldulensis, E. citriodora, Gyrocarpus jacquinii, Maesopsis eminii, Swietenia mahagoni, Toona ciliate, Adina cordifolia, Azadirachta indica, Grevillea robusta, Terminalia bellerica, Dalberigia sissoo, Pterocarpus marsupium, Hevea brasiliensis, Tecomella undulate, Simarouba glauca, Wrightia spp., Gmelina* spp. etc.have been tested for their utility in handicraft sector. A few promising alternate species such as *Simarouba glauca, Maesopsis eminii, Swietenia mahagony* and *Chloroxylon swietenia* for handicrafts sector have been worked out and appreciated by the wood handicraft artisans for their better working quality and processing parameters.

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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 Farmer, 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 "Atmanirbhar" 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 mets for taking forward initiatives of the industry.

WTA is a member of:

- Bureau of Indian Standards (BIS) CED-9 CED-20 Committees.
- President WTA (Shri S.C. Jolly) is a Member of Managing Committee of FIPPI.
- President WTA (Shri S.C. Jolly) is a Member of Steering Committee of IPRITI.
- President WTA (Shri S.C. Jolly) is a Member of Steering Committee of IPRITI.
- President WTA (Shri S.C. Jolly) is a Life Member of IWST, Bangalore.
- 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.
- 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.
- WTA and FRI (Dehradun) collaborated under Green India Mission to organize industry institute Farmer meets at Ludhiana (Punjab), Yamunanagar (Haryana) and Pantnagar (U.P.)
- 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 organised at forest Research Institute, Dehradun
- 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
- 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.
- WTA participated and organised multiple webinars in which leading subject experts shared views / opinion about how to tackle the problems being faced by each stakeholder
- WTA (Shri G. Rajput, V.P) participated in R & D work with Senior Scientist Shri D.P. Khali, FRI.
- WTA organized numerous hands on trainings with the industry for aspiring Technologists
- WTA assists in Industry placement of Technologists pan-India as per their skill set.

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

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Alternative plantation grown timbers for revival of wooden toys and handicrafts sector in India

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Wooden toys are strong medium for child mental and physical development. India has a strong tradition in wooden toy manufacturing through its many village skill centers working in unorganized cottage industry. This sector offers livelihood to many marginalized artisans and fetches revenue to the nation through internal and export sales. The prime need of the sector is the availability of suitable species of timbers (ideally, light and soft timbers) in required quantities which is now uncertain due to overexploitation of the resources. Traditionally used and other potential species with desirable hardness and density range are reviewed. Remedial measures suggested includes conservation of the valuable genetic resources, establishing plantations of suitable species and managing the plantations sustainably and encouraging the use of alternative plantation grown species suitable for the sector. Providing R & D inputs and training supports, establishing CFCs, Incubation/Start-Up Centres, Testing and Certification, marketing linkages, exposure to social and design trends, etc. are also suggested for the revival of the wooden toy sector.

Introduction

Toy, being the miniature replica of something with which a child can play with; wood is a preferred safe material for its manufacture. Toys helps to discover the identity of kids, help their bodies grow strong, learn cause and effect, explore relationships, and practice skills they will need as adults; and are a medium to enhance cognitive, social, and linguistic learning. Toys allow the child to imagine and create a personal interpretation of how they view the adult world.

Majority of the earliest toys discovered were all made of wood. Wooden toys continued to be a common part of childhood for years, as is revealed by archaeological studies. Even though plastic toys were much easier for mass production and were more affordable to families with children, wooden toys have still many advantages over the plastic ones. Wooden toys are environmentally sound, especially when made from sustainably sourced, certified wood. Miniature wooden play sets aid in social and emotional development. Wooden toys hold great educational value because of their simplicity. Wooden toys do not contain toxic materials. Wooden toys are also the most durable toys and can usually last through generations of play. As an organic, renewable substance, wooden toys are biodegradable and can be recycled. Wooden toys offer further eco-credentials when any paint used on them is free of toxic chemicals – or if no paint is used at all. The production of wooden toys, particularly when hand-crafted and when all materials are sustainably sourced and certified, offers a stark comparison to the creation of many mass-produced plastic toys, which can contain dubious chemicals and often offer little prospect of renewability. Wooden toys also present a direct connection to the natural world for children.

Today's wooden toys are just as innovative, if not more so, than modern, electronic toys. Cars, trucks, and wooden wind-ups make wonderful gifts and wooden pull along toys delight toddlers. Quiet games like chess and checkers, and even tic-tac-toe can be found made of wood, as well as physical games like ring toss. Wooden toys offer a range of educational qualities, especially for the children and infants who suffered from learning disabilities. Some of the classic staple wooden toys include puzzles, building blocks and miniature construction sets, all of which can help children with numeracy, literacy, motor skills and problem solving. It is undeniable that toys take quite a battering from their young owners, getting bashed up, thrown around and left out in the weather. Plastic toys can be brittle, while anything digital or audio-visual always has a risk of malfunction or obsolescence. On the other hand, wooden toys are more durable; they can endure rough treatment and last for generations, ensuring these toys can be handed down through the family tree. The relentless advance of technology has ensured that toys today are replete with bells, whistles, bleeps, screens, noises, colours and so on. But often, simplicity is best, and less is more. Wooden toys offer children a blank slate upon which they can project all the wildness and extravagance of their burgeoning/firing imaginations. Playing computer games, though increasingly dazzling and wide-ranging in their scope, can often be a solitary activity for children. Wooden toys can foster social interaction with other children and promote sharing and teamwork. Wooden toys, naturally devoid of any possibility of sound or interaction in them, allow for children to supply their own voices and sound effects in collaboration with one another. Some modern toys, with their electronic and interactive capabilities, 'do everything' for the child. Meanwhile, the simplicity of wood allows for role-playing and world-building (creating imaginary communities and towns and

so on), and can aid spatial and social awareness as a result. As far as safety is concerned, it is an unfortunate fact that plastic toys, especially the cheaply made variety, can break easily, potentially leaving sharp edges and small parts that may harm the child – particularly if they are at an age where everything they come across gets put in their mouth. Wood, strong and sturdy by comparison, offers less risk in this way. Not only are wooden toys safer than plastic toys, wood as a material can offer benefits to a child's health and well-being. A connection to nature through contact with wood can improve mental and physical wellbeing. Education spaces (where toys are often found), have increased rates of learning, improved test results, concentration and attendance when wood is prominent. Wooden toys can aid a child's physical, mental and emotional development. With an ever-expanding range of wooden toys available today, this is a world of play that children and parents can discover together.

Table 1: The major wood species are listed by Kumar et al. (1995, 1996a & 1996b) that are used traditionally for toy making:

No.	Species	No.	Species
1	*Adina cardifolia* (Haldu)	12	*Diospyrous malabaricum* (White cedar)
2	*Ailanthus excelsa* (Maharuk)	13	*Givotia rottleriformis* Syn. *Givotia moluccana* (White Catamaran Tree)
3	*Albizia lebbek* (Kokko)	14	*Gmelina arborea* (Gamarai)
4	*Artocarpus heterophyllus* (Kathal/Jackwood)	15	*Gyrocarpus jacquini* (Helicopter tree/stinkwood)
5	*Artocarpus hirsutus* (Aini)	16	*Hardwickia pinnata* Syn. *Kingiodendron pinnatum* (Piney)
6	*Alstonia scholaris* (Chatianwood)	17	*Juglans regia* (Walnut)
7	*Anogeissus pendula* (Kardahi)	18	*Lagerstroemia microcarpa* Syn. L. *lanceolata* (Benteak)
8	*Azadirachta indica* (Neem)	19	*Pterocarpus marsupium* (Bijasal)
9	*Chloroxylon swietenia* (Satinwood)	20	*Sterculia urens* (Gular/ Tapsi)
10	*Cinnamomum zeylanicum* (Cinnamon)	21	*Toona ciliata* (Toon)
11	*Dalbergia sissoo* (Shisham/Indian Rosewood)	22	*Wrlghtia tinctoria* (Dudhi/ Ivory wood)

Scenario of Indian wooden toy making sector:

Wooden toys are manufactured by traditional artisans throughout India; the main hubs are: Cochin in Kerala, Kanyakumari and Tanjavore in Tamil Nadu; Nirmal, Kondalpalli, Ettikopakka, Chittoor, Rajamundry and Tirupathi in Andhra Pradesh; Channapatana, Kinal, Mysore and Sagar in Karnataka; along with many local spots in the cities of Meerut, Moradabad, Sharanpur, Nagina, Srinagar& Rajouri, Hoshairpur, Kullu & Chamba in Himachal Pradesh, Amritsar Assam, Tripura, Nagaland, West Bangal and Rajasthan particularly Jodhpur & Udaipur, Bhopal and Jabalpur, etc. The following 22 major wood species are listed by Kumar et al. (1995, 1996a & 1996b) that are used traditionally for toymaking:

The toy making industry at present faces the acute challenge of raw material scarcity due to over-exploitation of the locally available ideal species, in the past. Due to the non-availability of the region specific species like Givotia rottleriformis in Nirmal and Kondapalli and *Wrightia tinctoria* in Channapatna and Kinal in Karnataka and Ettikoppaka in the state of Andhra Pradesh had reported to be adversely affected the livelihood of many marginalized traditional artisans and industries in those regions (Rao et al. 2001, 2011).

Aggarwal et al. (2013), in their review on the situation, suggested for extended R & D and training support including social and design trends and skills; establishing common facility, incubation, testing and certification centers; evaluate the working qualities including carving and turning qualities of alternative grown timbers that can substitute traditional species; efforts to promote the use of

- *Acacia auriculiformis* (Earpod wattle)
- *Eucalyptus camaldulensis* (River red gum)
- *Eucalyptus tereticornis* (Eucalyptus hybrid/ Mysore gum)
- *Leucaena leucocephala* (Subabul)
- *Maesopsis eminii* (Musizi/Umbrella Tree)
- *Swietenia mahogany* (Mahogany)
- *Dalbergia sissoo* (Sheesham/Sissoo/ Indian Rosewood)
- *Simarouba glauca* (Oil tree/ paradise tree)
- *Adina cordifolia* (Haldu)
- *Ailanthus excelsa* (Maharukh)
- *Albizia lebbek* (Kokko)
- *Alstonia scholaris* (Chatian)
- *Anogeissus pendula* (Kardahi)
- *Artocarpus heterophyllus* (Kathal)
- *Artocarpus hirsutus* (Aini)
- *Azadirachta indica* (Neem)
- *Bauhinia malbarica* (Kanchan)
- *Boehmeria rugulosa* (Genthi)
- *Chloroxylon swietenia* (Satinwood)
- *Cinnamomum zeylanicum* (Cinnmon)
- *Cordia macleodii* (Daigan and Dhengan)
- *Diospyrous ebonum* (Ebony)
- *Dysoxylum malabaricum* (whire cedar)
- *Euonymus crenulatus* (Spindle Tree)
- *Gardenia latifolia* (Gardenia)
- *Gmelina arborea* (Gamhar)
- *Gyrocarpus americanus* (Tanaku)
- *Hardwickia pinnata* syn. *Kingiodendron pinnatum* (Piney)
- *Holoptelea integrifolia* (Kanju)
- *Holarrhena antidysenterica* (Kurchi)
- *Hymenodictyon excelsum* (Kuthan)
- *Juglans regia* (walnut)
- *Lagerstroemia microcarpa* syn. *L. thomosonii* (Benteak)
- *Linociera malbarica*
- *Melia azedarach* (Persian lilac)
- *Mitragyna parvifolia* (Kaim)
- *Plumeria rubra* (Sonchampa and Chameli)
- *Pterocarpus marsupium* (Bijasal)
- *Sterculia urens* (Gular and Tapsi)
- *Toona ciliata* (Toon)
- *Trewia nudiflora* (Gutel)
- *Wrightia tinctoria* (Dudhi)
- *Zanthoxylum ovalifolium* Wight
- *Xanthoxylum rhetsa* (Mullilam)

Apart from the species referred above, a few species reported to be suitable for toy making (Nazma et al. 1981) are listed below:

Even though, generally, durable species are preferred for any utilization, non-durable species with suitable physical and workability features could also be utilized for toy making by providing appropriate preservative treatments, the technology for the same are available. To investigate the suitability of any species for toy making by making use of its physical properties, an exposure to the following criteria will be of use:

- *Adina cordifolia* (Roxb) Hook, f. ex Brandis (Haldu)
- *Ailanthus triphysia* Syn. *Ailanthus malabarica (Maharuk)*
- *Bombax ceiba* Syn. *Salmalia malabarica* (Semul)
- *Buchanania axlllaris* Syn. B. *Angustifolia* (Kulamavu)
- *Chukrasia tabularis* (Chickrassy)
- *Erythrina stricta* (Coral tree)
- *Holoptelia integrifolia* (Indian Elm)
- *Melia azedarach* (Persian lilac)
- *Ochroma pyramidale* Syn. O. Lagopus (Balsa)
- *Quassia indica* Syn. Samadera indica (Karingotta)
- *Tamarindus indica* Linn. (Imli)

Physical properties

Hardness* (Junka, Newton, N)

a. Very soft and soft (VS - S): Readily indented by finger nail (300-5000 N)

b. Moderately hard (MH): Not easily indented by finger nail but readily cut by a sharp knife (>5000-8000 N)

c. Hard and very hard (H - VH): Not indented by finger nail and difficult to cut by a sharp knife (>8000 – 16500 N)

Weight / Density** (kg/m^3)

a. Very light and light (VL & L): Up to 550

b. Moderately heavy (MH): 550 -750

c. Heavy and very heavy (H & VH): >750

Durability (Life span in years, as obtained in graveyard tests)

a. Perishable (P) : <2 years

b. Non-durable (ND): 2-5 years

c. Moderately durable (MD): 5-7 years

d. Durable (D): 7-10 years

e. Very durable (VD) : >10 years.

Workability

The degree of ease and smoothness of cutting wood with hand tools

*The hardness (Junka) test measures how much force is needed to drive an 11.28mm steel ball halfway through a sample of wood. The force is measured in Newton (N). One Newton is the force needed to accelerate a one-kilogram object one meter per second. The test requires a solid plank of wood that is unfinished and free of knots. The wood must also have a moisture content of approximately 12%. The steel ball is placed on the plank before accurately measured force is applied to the ball until it leaves a 200 sq.mm indentation in the wood. The test is done again on another part of the plank before the results are averaged.

** Wood density is measured as oven dry weight per unit green volume, kg/m^3.

Ideally, soft, light and reasonably strong wood with straight and close grained are preferred for toy making. It shall have good machining properties, shall not chip off during manufacturing operations. It shall also take a smooth finish and good polish. Generally, low density (300-450 kg/m3) wood with low hardness value is recommended for toy manufacture; however, moderately hard and heavy species with suitable workability are also getting acceptance in situations of reduced availability of the excellent timbers for the purpose. The hardness, wood density and natural durability categories of the prime wood species used in the toy sector are listed below for a further selection of appropriate ones for developing plantations, as this can only assure future availability of wood for this sector.

Table 2: Wood species suitable for toys sector

Sl. No.	Species	Density kg/m^3	Hardness (N) & Basic Density (kg/m^3)	Durability
1	*Acacia auriculifomis*	500-650	MH; MH	MD
2	*Adina cardifolia* Syn. *Haldina cordifolia*	700	MH; MH	ND
3	*Ailanthus excelsa*	335-480	S; L	ND
4	*Ailanthus triphysia* Syn. *Ailanthus malabarica*	400	S; L	ND
5	*Albizia lebbek*	640	MH; MH	VD
6	*Alstonia scholaris*	350-465	S; L	ND
7	*Anogeissus pendula*	946	H & H	D
8	*Artocarpus heterophyllus*	600	MH; MH	D
9	*Artocarpus hirsutus*	600	MH; MH	D
10	*Azadirachta indica*	835	H-VH; H	D
11	*Bombax ceiba* Syn. *Salmalia malabarica*	365	VS-S; VL-L	ND
12	*Buchanania axlllaris* Syn. *B. Angustifolia*	605	S-MH; L-MH	ND
13	*Chloroxylon swietenia*	960	H-VH; H-VH	ND
14	*Chukrasia tabularis*	675	MH; MH	ND
15	*Cinnamomum zeylanicum* Syn. *C. verum*	575	MH; MH	ND
18	*Diospyrous malabaricum*	800-1100	VH;VH	VD
19	*Erythrina stricta*	240-470	S; VL-L	ND
20	*Eucalyptus camaldulensis*	560	MH; MH	D
21	*Eucalyptus citriodora* Syn. *Corymbia citriodora*	780-990	H; H	MD
22	*Eucalyptus tereticornis*	980	H-VH; H-VH	MD
23	*Ficus bangalensis*	610	S-MH; MH	ND
24	*Givotia rottleriformis* Syn. *Givotia moluccana*	NA	S-MH;; L-MH	ND
25	*Gmelina arborea*	415-610	S-MH;L-MH	D
26	*Gyrocarpus jacquini* Syn. *G. americanus*	250-440	S;L	ND
27	*Hardwickia pinnata* Syn. *Kingiodendron pinnatum*	610	MH;MH	VD
28	*Holoptelia integrifolia*	595	MH;MH	ND
29	*Juglans regia*	520-670	H-VH; MH-H	VD
30	*Lagerstroemia microcarpa* Syn. *L. Lanceolata*	640	MH;MH	D
31	*Leucaena leucocephala*	640-800	H; H-VH	ND
32	*Maesopsis eminii*	640-720	S; MH	D
33	*Melia azedarach*	710	MH;MH	ND
34	*Meliosma simplicifolia*	495	S;L	ND
35	*Ochroma pyramidale* Syn. *O. Lagopus*	120-290	VS;VL	P
36	*Populus spp.*	300-550	VS-S;VL-L	ND
36	*Prunus serotina*	460-670	S-MH; L-MH	D
37	*Pterocarpus marsupium*	720-880	MH-H;MH-H	VD
39	*Quassia indica* Syn. *Samadera indica*	390	S;L	ND
40	*Salix tetrasperma*	385	S;VL	ND
42	*Simarouba glauca*	480	S;L	ND
43	*Sterculia urens*	550	S-MH;L-MH	VD
44	*Swietenia mahogany*	470-550	S;L	D
45	*Toona ciliate* Syn. *Cedrela toona*	515	S-MH;L-MH	ND
46	*Wrightia arborea*	575	MH;MH	ND
47	*Wrlghtia tinctoria*	575	MH;MH	ND

All the above wood species are equally suitable for use in the general handicrafts industry sector too. In addition to the above species, the following very durable elite species of wood which are seldom used in the toy sector, however, found prominent position in the handicrafts sector, due to its scope for fetching high prices in the product form:

Table 3: Very durable elite species of wood which are seldom used in the toy sector

Sl. No.	Species	Basic Density (kg/m^3)	Hardness (N) & Density Category
1	*Dalbergia latifolia* (Rosewood)	815	H;H
2	*Dalbergia sissoo* (Sheesham/Sissoo)	700-800	H-VH; H-VH.
3	*Tectona grandis* (Teak)	650	MH;MH
4	*Diospyrous ebonum* (Ebony)	1150	VH;VH
5	*Pterocarpus santalinus* (Red sander)	600-850	H;H
6	*Santalum album* (Sandal)	950	H;H

Working and carving qualities play a vital role in the judicious utilization of timbers which vary in anatomical features, physical and mechanical properties, durability, seasoning behaviour and other characteristics for furniture, joinery, turning, handicraft, etc. As a typical example, the Forest Research Institute (FRI), India, has evaluated the working and carving qualities of *Populus deltoides* and *P. ciliate* under six major wood working operations, viz., planning, boring, mortising, shaping, turning and sanding; carving behaviour is evaluated under punching, chiseling, fret-saw work and scooping. The results obtained are highlighted below (taking the value of 100 for teak) (Shukla et al. 1991), making Populous spp. ideal for toy sector:

Table 4: Working and carving qualities of *Populus deltoides* and *P. ciliate* under major wood working operations:

Property	*Tectona grandis*	*P. deltoids*	*P. ciliata*
Specific gravity	570	550	400
Best cutting angle in planning	25	20	15
Overall performance	100	39	42
Ease of working (ease factor)	100	119	117
Working quality index	100	94	92
Grouping based on overall performance	I	II	III
Comparative performance (turning)	100	10	52
Overall comparative performance (carving)	100	39	39
Carving quality index	100	52	52

Conclusions

Traditional Indian wooden toy manufacturing sector functioning in unorganized cottage industry scale, is under threat from sustenance/survival issues mainly due to non-availability of suitable species of wood due to the over-exploitation happened in the past and degradation of the forests in which they grow. This is affecting adversely the livelihood of the marginalized artisan community of the region. The forests used to supply the suitable species of wood raw material to the sector needs to be conserved, and needs to bring them under sustainable management practices and wherever necessary reforest. Encouraging the use of alternative plantation grown species suitable for the sector and establishing and sustainably managing the plantations are the main way of reviving the sector. Other actions required are, providing technological and training and exhibition supports, establishing CFCs, Incubation/Start-Up Centres, Testing and Certification, marketing linkages, exposure to social and design trends, etc.

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Initial exploration of the woodcraft techniques of Tamil Nadu

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Wood carving is an ancient craft of India and was practiced in this country long before the stone sculpture was taken up. Even today wood carving is in vogue, the stress nowadays being on small pieces of furniture and articles of daily use like tea-poys, chairs, screen, jewellery caskets, book-ends etc. But the carpenter of ancient India not only carved bedsteads, wooden seats and thrones, but also chariots for use in war. Ornate and beautifully carved wooden doors and panels can be seen in villages and towns testifying to the skill of Indian carpenters. The places best known for rich ornamentation and skilful execution of superior designs are Kashmir in the North, Gujarat and Rajasthan in the West and Mysore and Travancore in the South. The more impressive of them is the elaborately carved temple cars of South India. This article is a preliminary study under the techniques of woodcraft from Tamil Nadu and also includes the ethnography research on the community involvement in woodcraft.

Handicrafts not only contribute a lot to the sustained development of the country's economy, but also form a prominent element in the cultural unity of the people. They flourish in rural life, but function as connecting link between the various constituents of the society. They are also an effective medium of cultural contacts between nations. These artistic objects carry the minds of the people to distant lands, and do a sort of propaganda for the rich heritage of our culture. Finally, "crafts 52 treasures give a panoramic view of the various aspects of life of the generations that lived through centuries- a glimpse into the cultural life of the people" (Abraham, 1964). Thus, help in the preservation and promotion of traditional culture and national heritage. The Handicraft Industry, a traditional one, is the oldest industry in India. Few attempts have been made by the economists to study few aspects of this industry. Literature connected with the Handicrafts Industry can be broadly grouped in the following manner; a) Literature related with the marketing aspects of the Handicrafts products. b) Attempts related with the working of the co -operative society. c) Literature related with problems and prospectus of the Handicrafts industry. The study conducted by Pillai emphasised the uniqueness and quality of Handicrafts products, he suggested the formation of Handicrafts co-operative societies and their proper management for giving new vigor and prosperity to the industry (Pillai, 1965).

Handicrafts are mostly defined as "Items made by hand, often with the use of simple tools, and are generally artistic and/or traditional in nature. They are also objects of utility and objects of decoration." The Indian handicrafts are known the world over for their rich variety, grace, elegance and skill. Excavations conducted in different parts of India prove that India in various periods had unmemorable handicrafts. The ruins and remains unearthed from Mohan-Jo-Daro prove the high skill of craftsmanship of the inhabitants of this region. Household utensils plain and painted pottery brought about by the rhythmic turning of the wheel, terracotta, weapons and implements, ornaments, were some of the artistic and valuable things found there. Varieties of handicrafts are produced over time in all parts of the country including tribal areas. Thus handicrafts of any given time and space reflect and preserve in them the results of centuries of patient experiments of man under varying circumstances. Like art craft treasures also reflect the taste of human society through the individual and give collective mind of the community. Crafts not only satisfy economic wants but also the aesthetic yearning of man.

Importance of wood craft

Wood carving is an important traditional industry of India. It is generally done on a limited number of species of wood, suitable for the purpose. Various forms on different type of wood, elaborate carving with extra ordinary precision and accuracy are the characteristic features of Indian wood work. Images and panels, architectural elements, furniture, utensils and different types of decorative pieces in wood are produced all over India. Free, bold and deeply undercut designs and motifs of Uttar Pradesh are best represented by the Saharanpur carvings. Low stools, mirror frames table tops and elegantly designed modem furniture are specialties of Punjab while rich, intricate and variegated designs in raised, engraved or undercut on seasonal walnut articles of Kashmir. The Kashmir carvers produce wall plaques, pedestal and table lamps, articles of hollow pattern, carved furniture and other items. Bel Khudao (carving

which represents creepers) and Phul Khudao (carving which represents flowers or rosettes) designs on the utility articles of Madhya Pradesh and intricate designs of chests of drawers, tables and so far from Maharashtra are known for their freshness in traditional designs. Sankheda, the lacquered furniture from Gujarat, is fascinating and colourful. Three dimensional and relief icons, various types of panels, cups, saucers, forks etc. are specialties of Andhra Pradesh produced mainly in Bhongir and Udaigiri. Nirmal furniture is also the pride of Andhra Pradesh. Virudhunagar, Madurai and Thanjavur wood carvers in Tamil Nadu produce decorative as well as utility articles in wood. The art of wood carving as practiced by the hill tribes of Assam, Manipur, Tripura and Nagaland is entirely different in its nature from other regions. The symbolic representations of supernatural elements made in wood and bamboo are very interesting. Carved figures, furniture cabinets, jewellery boxes, chests, lamp -stands produced in West Bengal and Bihar are known for their simple yet beautiful designs. Delicate and ornamental objects are produced in sandalwood. Sandalwood carving has grown to a considerable extent in Mysore, Kerala, Madras, Rajasthan and West Bengal. The articles are invariably carved with designs of extremely involved and elaborate patterns, consisting of intricate interlacing of foliage and scrollwork.

Earliest and textual reference in India

The earliest reference to any wooden idol made in India goes to the legend of Jīvantasvāmī – a Sandalwood image of Mahāvīra or Vardhamānaiii, the last Tīrtha kara of Jain pantheon. It is said that the idol was carved in his lifetime and worshipped by his followers. This myth, though not materially substantiated, is an obvious proof in favor of an artistic practice – prevailing in the sixth century BC. However, it was only after another seven centuries that we find the oldest literary mention of wood as a suitable plastic medium for the sculpting of cult-icons. The first concrete evidence to the tradition of making wooden idols comes in the form of an epigraph, hailed from today's Andhra Pradesh. This inscription of Abhirā Vāsudeva, dated c. AD 278, describes an eight-armed wooden sculpture of Lord Vi n u – named as A ṭabhujasvāmī. This effigy, said to have medicinal and energizing properties, was installed on the Siddhalahari hill bordering Nagarjunikonda valley. The specimen, however, is not available today; yet the reference indeed ensures a living tradition in the third century AD. The next thirteen hundred odd years saw the tradition continuing with its vitality and context – and being documented in a series of indigenous literature (Gupta 2016).

Study Area

In Tamil Nadu, there are a number of places noted for wood craft. Virudunagar is famous for the traditional style. It has now started making articles for household use. Devakottai and Karaikkudi make traditional panels in different sizes. Small shrines finely carved with wood known as kavadi have exquisite designs and serve as votive offerings to the deity that devotees carry on their heads as they go singing or chanting. Panels from some of these old kavadis are detached and are now used as wall decorations. Nagerkovil and Suchindram have traditional carvers who also make figures. Madurai is famous for its rosewood carvings. The style is marked by its bold forms, the details being minutely and painstakingly worked out. Tables with the top covered with floral motifs or lovely parrots or panels with epic scenes are the most outstanding examples of this type of craft.

Google image of Virudunagar, Devakottai, Karaikkudi, Nagerkovil, Suchindram and Madurai

The wood carvings of Tamil Nadu constitute a potential topic for research in iconography. Temples in Tamil Nadu employ wood mostly for doors and vdhanas (vehicles). The doors of the Hindu temples are huge and contain figure carvings in cut out fashion on the outer surface. Especially the gigantic doors at the main entrance to temples such as the Subrahmanyasvami at Tirupparankunram (Madurai District) and Sri Sailappar temple at Sivasailam (Tirunelveli District) attract art connoisseurs. The key-hole in the main door of the Bhadrakaliyamman temple at Sivakasi (Ramana thapuram District) holds a single sculptural piece on the maithuna theme. Vdhanas are mostly used for taking the utsava beras (processional images) in ula (procession) during festivals. Popular among the vdhanas are simha (lion), vrsabha or kdlai

(bull), asva or kutirai (horse), gaja or yanai (elephant), Airavata Indra's mount, the four tusked white elephant), mayura or mayil (peacock), hamsa or annam (swan), kida (goat), peruccali (big rat), Sesa (Visnu's mount, King Cobra), Kamadhenu (wish-fulfilling cow), Garuda (kite), kalpavrksa (wish-fulfilling tree), Kailasa (Mountain peak, Siva's abode), Indra-vimana (aerial car), pallakku (palanquin), simhasana (lion-throne), bhuta (demon), Ravanesvara (the demon king of Lanka), Nandikesvara (Siva's bull vehicle in thereianthropic form), Hanuman or Anjaneya (the monkey-faced attendant of Sri Rama) and so on.

Community involved in making woodcraft in Tamil Nadu

The Asaris belong to the Kammalan groups which are made up of five occupational sections, namely Tattan (Goldsmith), Kannan (Brassmith), Tachan (Carpenter), Kaltachan (Stone Mason) and Karuman (Blacksmith). The Asaris are divided into three territorial groups, Pandya, Sozhia and Kongan. The Asaris of Madurai belong to the first group. The Kammalan caste is highly organized. They profess the Saivite form of the Brahmin religion and reverence greatly Pillaiyar, the favorite son of Siva. The Caste however has its own special Goddess Kamakshi Amma who is commonly worshipped by all the Sub-divisions. Oaths are taken in her name, and disputes affecting the caste are settled before her temple. The exact connection of the Goddess Kamakshi with the Caste is not known. There is however a vague tradition that she was one of the virgins who 'committed suicide by throwing herself into a fire and was in consequence deified.

The Kammalans claim to be descended from Visvakarma the architect of the Gods and in some places claim to be superior to Brahmins calling the latter Co-Brahmans and themselves as Visva Brahmans. According to one story of the origin of Kammalan they are the descendents of the issue of a Brahman and Beri Chetti woman. The Kammalans call themselves Achari and Paththar, which are equivalent to the Brahman titles Acharya and Bhatta, and claim knowledge of the Vedas. Their own priests officiate at marriages, funerals and on other ceremonial occasions. They wear the sacred thread which they usually do on the Upakarma day, though some observe the regular thread investiture ceremony (Nambiar P.K. 1965).

Techniques of making wood craft

Wood varies in colour, density, hardness, elasticity, strength and gravity. Some wood shows resistance to wear and tear and vibrations, others are very durable resisting decay under various conditions. Sometimes wood is defective. This is caused by defective seasoning; sometimes pieces of wood contain holes caused by insects or worms or openings in the wood, all of which seriously reduce the strength of the wood and sometimes defects become impossible to trace whether there is any opening or not. So at the time of selection of wood, only an experienced wood carver who knows all about his raw material goes to the spot to select his wood. Two different types of wood used by the wood carvers of the study area are rose wood and teak wood. But in a majority rose wood is preferred, and only to order, carved items of furniture are manufactured out of teak wood.

Rose wood: This is one of the most beautiful of native woods. It has a chocolate brown colour, sometimes tending to be reddish with a much lighter sap. The pores are rather large, but the grains are open and straight. The wood is strong, hard and moderately heavy. It is durable, splits with some difficulty, takes and holds nails well and is very easy to work upon. It polishes very well, takes glue readily and the finish will invariably be excellent and smooth.

Teak wood: It is very strong, heavy, durable and hard. The wood warps little. It shapes well, splits easily, nails with difficulty and polishes well. It is highly resistant to decay. It is fairly easy to plane, chisel and saw and splits easily. It is rather stiff and tough and the colour is of a light yellow or creamy white. The following statement would indicate the comparative characteristics of rose wood and teak wood.

Tools using from wood craft: The following are the most essential tools and equipments used for wood carving: Ruler, Handsaw, Bar clamp, Files, Drilling pit, Chisels, Wooden mallet, Screw drivers, Hammers, Cutting plier, Spanners, Jack plane, Sand paper, Brush, Dividers, T. Squares, Gauges and Putty knives.

Making Process

Earlier artisans used Burma teak or rosewood for carving. At present artisans are using a tree wood called Vengai tree which is available in local. Big logs of wood are cut into desired size and shape with the help of cutting machine. The paper sheet is first cut into the required size on which animal and floral motifs of the required length are drawn. Then the outer part of design is traced on the wood. Once the outer sketch is done then it is darkened with pencil and the details are drawn. The unwanted parts are scrapped out with the router machine, which is usually done by trained person. Then the smaller unwanted parts are removed with the help of chisel hammered by a wooden mallet. The designed part are carved slant to scrap the hard outer surface of the wood. Different types of tools like pointed, flat, blunt tools are used to engrave the pattern of design on the wood. Detail and intricate designs are carved in the end, as it involves lot of precision, which needs patience and time.

After finishing the carving work, article is rubbed using sand paper in order to obtain the smooth surface. To enhance the appearance of the woodcarvings two-three coats of polish is being applied on the carved article either by spraying or by brushing on it to enhance the look of the product and protect from termites. At the earlier time polishing was done using natural colors made up or prepared from flowers and leaves. But at the present the chemical polish is used for the polishing which is available in local markets (D'Source Digital learning environment for design).

Outer sketch is made on wood

Then the sharp pointed chisel is used for sculpturing

Artisan working in wood door

Yali sculpture

Nandi wooden sculpture

Artisan working for Mayil Vahan

Final work of woodcraft

Observation

Wood carving is an important traditional industry of India. It is generally done on a limited number of species of wood, suitable for the purpose. Various forms on different type of wood, elaborate carving with extra ordinary precision and accuracy are the characteristic features of Indian wood work. Images and panels, architectural elements, furniture, utensils and different types of decorative pieces in wood are produced all over India. The art of wood carving as practiced by Tamil Nadu is entirely different in its nature from other regions. The symbolic representations of supernatural elements made in wood are very interesting. Carved figures, furniture cabinets, jewellery boxes, chests, lamp-stands produced in South India are known for their simple yet beautiful designs.

Wood craft technology remains to be a highly labour intensive technology. The state of technology remains to be the same throughout. But in wooden furniture making there is a great trend towards technological change. Changes are highly noticeable in sketching and designing. Generally speaking Wood craft technology can be considered as an indigenous technology since it is based on locally available labour, raw-materials and other inputs. Among the four household handicrafts, the most expensive technology is that of wooden craft technology.

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Wooden handicraft sector: Status, issues and prospects

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Introduction

Wooden handicrafts sector provides livelihood to artisans concerned and revenue to the country keeping the rich cultural heritage. The Indian handicrafts are admired worldwide for its brilliant mix of colours and unique craftsmanship, which was developed since Vedic age. The melt-down of economy in 2000s was largely responsible for a partial collapse of wood handicraft market, followed by the, sectorial unemployment in India and about 54% decline in its trade. The Wooden handicraft industries has faced worst during the last three years (2018 to 2020) due to the recession related financial crisis in USA and other countries novelty in concepts, cheap and skilled labour and high quality of products due availability of suitable tree species has made the Indian wooden handicraft industries as one of the important suppliers in international market. This industry provides employment for more than 5 million artisans and offer a major opportunity of employment to rural wood working sections. Wooden handicraft sector is economically important from the point of low capital investment, high ratio of value addition and high potential for export and foreign exchange earnings for the country. The wooden handicrafts export revenue is close to 40% of the total handicraft industry (worth US$2 billion) in India. It is the second largest employment provider after agriculture (Sinha and Pasha, 2012). The export revenue value of handicrafts is 36.2%, 36.9% and 27% in USA, Europe and New Zealand. In India, the handicraft industry of Jodhpur has tremendous marketing network all over the world; major buyers Germany, France, Australia, Poland, Holland, New Zealand and Spain (Sinha and Pasha, 2012).

Status of Indian wooden handicraft industries

Traditionally, in India, wooden handicrafts are usually made from teak, sheesham, sal, mango, mahogany, etc. For idol carnation, expensive timbers like sandalwood, ebony, rosewood, walnut, oak, etc. are used traditionally. Native, imported and reclaimed wood are used. The total export revenue share of the wooden handicrafts industries is approximately 40% in 2012. There are around 90,089 carving centres, the registered artisans reported is more than 2.6 lakhs (Pradeep, 2013). The people involved indirectly to the wooden handicraft industry are higher than the directly involved (e.g., In Saharanpur District of Uttar Pradesh, it is reported that 50,000 to 87,860 persons are involved directly in the wood carving industry but about 350,000 people are indirectly dependent on it (Saigal and Bose, 2003). According to the annual wood consumption, handicrafts industries are reported to be falling in three categories, viz., <5000 cubic feet (cft) by 16% industries, 5000-1,00,000 cft by 74% industries and >1,00,000 cft by 10% industries. Agro-Forestry (AF)/Trees Outside Forests (ToFs) and Forest Departments are the major timber suppliers to the wooden handicrafts sector. The consumption of raw materials is so high; e.g., in Saharanpur alone around 25 truckloads of wood per day; roughly 3.2 million cft per annum. In Kerala, the wood consumption for handicraft sector is reported to be around 70,800 cft. The major products of wooden handicrafts includes ordinary boxes, jewellery boxes, incense boxes and stick holders, candle stands, photo frames, coaster sets, letter racks, stationary holders, pipe stands, tobacco jars, tables, figurines, idols, screens and carved furniture (Sinha and Pasha, 2012). The major handicraft items are exported to Europe, Australia, New Zealand, South America, Japan, South Africa and Gulf countries. Aproximately 35% of India's wooden handicrafts are exported to the EU and 45% are to the US. The exports of wooden handicrafts were grown up to 9% (to Rs. 4,267.37 crore) in 2017-18. In the year 2018-19, the shipments grew from 33% to Rs. 2,619 crore in the starting six months of the year. The overall provisional data of 2019-2020 says that the export of wooden handicrafts has shown decrease of Rs. 468.05 crores from Rs. 3613.51 to 3145.46 crores which implies that there is a decrease of 12.95% of the exports have shown decrease of US dollar 93.54 million (DGCI & S, 2020). Exporters play a vital role in the industry by placing bulk orders from foreign buyers and get the products manufactured in their own units. If the production is not in required volume, they outsource some portion of their production on contract basis. The exports of carved wood products amounted to around Rs. 4.3 billion in 2000-01. The major importing countries are the United States (25%) and the United Kingdom (12%) (Saigal and Bose, 2003).

Wooden handicrafts hubs of India

Major wood carving centres are spread within the different states of the country. Each State reflects uniqueness of local traditional culture and workmanship pertaining to that region. Thus, every State offers something unique to the treasure trove of Indian handicrafts. Contribution of unique

products of Indian handicrafts clusters from different states is presented below in table 1:

Table 1: Unique products of handicrafts from different states of India

No.	State	Handicraft cluster	Unique product	Major Wood used	Example Product
1.	Kerala	Kochi, Ernakulum, Thrissur and Thiruvananthapuram	Cultural dolls	Kumbil	
2 .	Punjab	Hoshiarpur and Amritsar	Old havelis had carved doors and windows; floral motifs, wooden furniture, trays, and mirror frames; artifacts of the Mughal tradition with decorative designs.	Sheesham, Teak & Rosewood	
3.	Kashmir	Srinagar and Rajouri; Anantnag, Bijbihara, Kupwara, Leh, Lalbazar, Safakada, Nowhatta, Fatehkadal, Khanayar and Rainawari	Tables, fruit trays, bowls, chairs, cabinets, candle stands, furniture, pinjara, cage work, bowls, trays, cigarette boxes, wall plaques, etc.	Walnut wood, chinar wood, & rosewsood	
4.	Uttar Pradesh	Saharanpur and Nagina; Agra, Almora, Amroha, Bijnaur, Bulandshahr, Khurja, Mainpuri, Mirzapur, Moradabad, Nainital, and Uttarkashi; Qazi Sari, Loharisaria, Lalsaria Industrial Areas and Sarai Meer, Meerut, Moradabad	Toys with ornamental, intricate patterns and traditional designs; bowls, chess boards, trays, cigarette boxes, wall plaques and table lamps to screens; bedsteads, candle stands, jewellery cases, bracelets boxes, mirror case, photo frames, incense burners, pen cases, bookcases, combs, bangles, sticks and large items of furniture- engraved, undercut and plain	Mango Sheesham, Dudhi and Sal; Teak, Mahogany and Ebony; Babul, Jamun, Haldu and Neem.	
5.	Arunachal Pradesh	Tirap,Tawang, Upper andWest Siang.	Bowls and cups; Toys, carved and painted masks, miniature figurines; statues of warriors Lord Buddha, etc.	Sal, Teak, and Oak	
6.	Rajasthan	Barmer, Bassi, Chiru, Jodhpur, Jaisalmer and Jaipur	Carved tables, cabinets, chairs, , chests, windows, racks, chessboards; Painted doors depicting scenes from epics like Ramayana and Mahabharata (unique to Rajasthan); Shape of animals,; ivory inlay works; jali or latticework in rosewood sandalwood	Sheesham, Mango, Babool and Neem	

No.	State	Handicraft cluster	Unique product	Major Wood used	Example Product
7.	Gujarat	Ahmedabad, Bhavnagar, Bhuj, Diu, Junagadh, Kutch and Surat	Wooden sculptures, toys, carved furniture, large wooden chests and ornate wooden screens	Ebony, Redwood	
8 .	Madhya Pradesh	Bastar, Budhni, Bundelkhand, Gwalior, Malwa, Rewa, and Sheopur Kalan	Wall panels, doors, window frames,; idols and furniture,of various types - painted and lacquered wood products such as masks, toys, boxes, flower vases	Sheesham, teak, dhudi, sal and kikar	
9.	West Bengal	Natungram, Bankura, Birbhum, Burdwan, Darjeeling, Hooghly, Jalpaiguri, Koochbehar, Midnapur, Murshidabad, Nadia, and Ramjibanpur	Wooden platters and bowls, wooden beams, rafters and pillars ; gods, mythological heroes, and demons; wide-eyed owls,Gour-Nitai, Krishna and Jaggannath	Neem, Mango, Teak, Sheesham, and Bel	
10.	Orissa	Bhograi,Cuttack, Khalikote, Koraput,Mayurbhanj, Phulbani, Puri,Sambalpur, Barpali, and Berhampur	Masks, ornamental panels and boxes; Puri - Lord Balabhadra, Devi Subhadra, and Lord Jagannath	White teak, Rosewood	
11.	Chhattisgarh	Bastar	Masks; doors, window frames and sculptures	Teak, Sheesham, Dhudi, Kikar and Sal	
12.	Andhra Pradesh	Bhongir, Chittoor, Hyderabad, Kondapalli, Nirmal, Tirupati, Udaygiri, and Vishakhapatnam	Carved panels, columns, framework, and traditional dolls; Mythological figurines; furniture and glazed toys; musical instruments, arches, and wooden balustrades besides combs and trinkets, rural life, nature (birds and animals).	Red sandal, Neem, Teak, Mango and TellaPoniki	
13.	Karnataka	Belgaum, Bhadravati, Channapatna, Gokak, Hounawar, Kumta, Mysore, Sagar, Siddapur, Sirsi, and Sorab.	Elephants, furniture, fabricated, designs of flowers, creepers, birds and animals, jewel boxes, lamp shades, trays, puppets, and walking sticks; Dolls/Toys	Rosewood, Sandalwood, eEony, and Soft and low density timbers like Dhudi, Butea monosperma (plash)	
14.	Tamil Nadu	Chingleput, Cuddalore, Kanyakumari, Karaikudi, Madurai, Nagercoil, Rameshwaram, Thanjavur, Vellore, and Virudhunagar.	Cooking vessels, vermilion boxes, toys, Table tops with floral motifs or parrots, wooden panels with epic scenes, etc.	Rose wood, Teak, Sandalwood, etc.	

No.	State	Handicraft cluster	Unique product	Major Wood used	
15.	Himachal Pradesh	Chamba and Kullu	Low benches, spinning wheels, smoking pipes, cradles, low settees, boxes, serving spoon, rolling pins, wooden utensils.	Pine, Deodar, Walnut, Horse Chestnut and Wild Black Mulberry	
16 .	Sikkim	Bakin (Sikkim North), Rougnek (Sikkim East)	Beautiful monasteries, heritage building and temples, Pemayangtse Monastery	Tooni, Rani chaap (Macalia) and okner (Walnut)	
17.	Nagaland	Dimapur, Dhansiripar, Diezephe, Diphupar and Zunheboto	Mithun heads, hornbills, human figures, elephants, tigers and the log-drums or xylophones.	Bhurkul/Gular wood, Mango, Green Bamboo, Sheesham	

Source: http://www.wooden-handicrafts.com/statewise-wooden-handi.html)

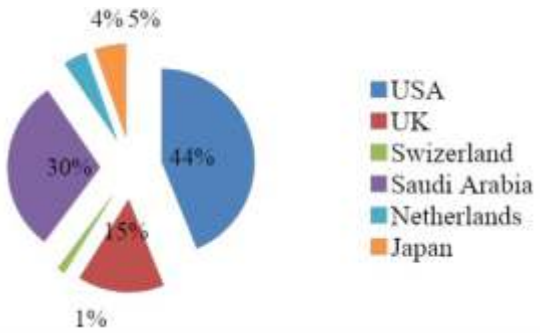
GI Tagging of Wooden Handicrafts

Geographical indication (GI) is a sign used on products that have a specific geographical origin and possess qualities or a reputation that are due to that origin. Protection for a geographical indication is usually obtained by acquiring a right over the sign that constitutes the indication.The wooden toy making art of Channapatna, Karnataka is a world famous GI tagged wood craft; of great demand in UK and USA. Products like rocking horses, jumping clowns and the clapping monkeys have recently become one of the favorites amongst the children in India and abroad. These products are eco-friendly, i.e., they are made up of soft wood and vegetable dyes e.g., the resin from the tree *Rhus verniciflua* which is resistant to water, acid, and alkali; shellac, an animal product similar to cocoons; natural colors extracted from indigo for blue, turmeric for yellow, katakata for brown and annatto seeds for red. Similarily, there are some other states which has been GI tagged for their unique wooden handicrafts products, viz., Kondapalli Toys, Mysore Rosewood Inlay, Bastar Wooden Craft, Ravanahatha, Rajasthan, and Saharanpur wood crafts from Uttar Pradesh; Kinnal Crafts of Karnataka and Thammampatti wood carving of Tamil Nadu.

Processing of wood for handicrafts manufacture

Wood processing for handicrafts manufacture involved two major steps viz., preservative treatment and seasoning (drying).

- Preservative Treatment: In treatment process, Bureau of Indian Standards approved wood preservative chemicals (boric acid, borax, or other suitable eco-friendly wood preservative chemicals) are applied with or without pressure in the wood to protect it from bio-deterioration from the attacks of fungi, insect borers and termites. Details of the process are available in the concerned Indian Standards (BIS, 2001).
- Seasoning: After preservative treatment, the wood becomes wet and it needs to be dried/seasoned before making any article to ensure dimensional stability for the wooden product. Wood can be air-seasoned under shade or can be dried in technically designed seasoning/drying kilns for the quick handling of mass quantity of timber. Details on seasoning techniques are available from the concerned Indian Standard (BIS, 1993). Only 21% of the industries have their own



(Source: http://www.india-exports.com/handicraft.html)

Fig. 1: Major destination of Indian wooden handicrafts

treatment and seasoning plants. Remaining 79% industries depend on other industries for treatment and seasoning of their timer (Sinha and Pasha, 2012).

Dominant species of woods that are commonly used in Indian handicrafts sectors and their share are given in Fig. 2; popular ones are walnut, sandalwood, teak, sheesham, mango, deodar, ebony, redwood, red cedar and sal. A checklist of the different wood species used in Indian Handicrafts sector is given in Table. 2.

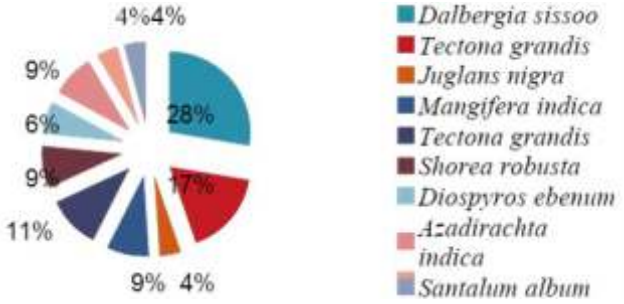


Fig. 2. Dominant wood species used in Indian handicrafts sector

Technological issues/constraints in the Indian wooden handicrafts sector

Indian wooden handicrafts sector is facing severe scarcity of suitable raw material. Shortage of skilled labour, poor technical infrastructure and inadequate training opportunities are found to be the major issues in the sector.

Table. 2. Checklist of different wood species used in Indian handicrafts

No.	Species	No.	Species
1.	*Adina cordifolia* (Haldu)	13.	*Platanus orientalis* (Chinar)
2.	*Aegle marmelos* (Golden Apple)	14.	*Pterocarpus santalinus* (Red sandalwood)
3.	*Azadirachta indica* (Neem)	15.	*Quercus robur* (Common oak)
4.	*Berchemia zeyheri* (Pink ivory)	16.	*Santalum album* (Indian sandalwood)
5.	*Cedrus deodara* (Devdar)	17.	*Sequoia sempervirens* (Coast sandalwood)
6.	*Dalbergia sissoo* (N. Indian rosewood)	18.	*Shorea robusta* (Sal)
7.	*Diospyros ebenum* (Indian Ebony)	19.	*Swietenia mahagoni* (Mahogany)
8.	*Gmelina arborea* (Gamhar)	20.	*Syzygium cumini* (Malabar plum)
9.	*Juglans nigra* (Black walnut)	21.	*Tectona grandis* (Teak)
10.	*Mangifera indica* (Mango)	22.	*Terminalia tomentosa* (Asan, Indian laurel)
11.	*Pinus roxburghii* (Chir pine)	23.	*Vachelia nilotica* (Gum Arabic tree)
12.	*P. wallichiana* (Himalayan white pine)	23.	*Wrightia tinctoria* (Dantapala, Dudhi)

Conclusion

Indian wooden handicraft industries are functioning in the unorganized, cottage industries sector, and is under threat on sustainability due to non-availability of suitable wood species.. Remedial actions for conservation of suitable tree species and large scale planting needs to be promoted. Plantation timbers needs to be introduced in the handicrafts sector. Potential of the various plantation timbers available for their use in the production of various kinds of handicrafts needs to be assessed. Awareness making and training on the applicability of modern wood working machines and tools needs to be ensured. Issues connected with the use of illegal wood for the production of handicrafts for export needs to be faced by creating more opportunities for chain of custody (CoC) type of certification from authorized agencies like the Export Promotion Council for handicrafts (EPCH). Developing more Geographic Indicator Tagging for this sector also needs to be investigated.

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AGRO FORESTRY

RURAL EMPLOYMENT

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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.

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Preservation of wooden handicraft articles with water borne preservatives

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Handicrafts are considered as one of the oldest traditions of the world. Handicrafts made out of wood are made by decorating or carving the wood to create unique articles by craftsman. India is considered as the land of tradition and culture. The Indian handicraft items are a perfect mix of traditional designs with modern techniques. Thanks to the worldwide move towards more sustainable and environment friendly products, demand for the wooden handicraft items in the global market is in increasing.

Manufacturing process of wooden handicraft involves selection of wood species, procurement of wood, cutting the wood to proper desired shape, seasoning of wood, preservative treatment, carving of the articles and application of coatings and colours. Products made from wet wood often shrink substantially as wood dries. Therefore, seasoning is very essential process for wood for proper finishing and to avoid defects like checks, swelling, shrinkage, cracks, twisting, cupping, warping, etc.

India being a tropical country large quantity of timber in service is damaged by bio-organisms including fungus, termites and borers (Fig. 1). Such degradation also results in loss of strength in wooden article. With the rapid industrial and agricultural development, the demand for timber for various purposes has increased considerably. In view of the limited availability of naturally durable species, such as teak (*Tectona grandis*) and Sal (*Shorea robusta*), demand for fast growing plantation timbers have increased. Unfortunately, most of these fast-grown wood species are associated with large variability and low durability. These low durability timber species need proper seasoning and preservative treatment to enhance their service life. Service life of wood can be significantly enhanced by preservative treatment and hence this also helps in conservation of material resources of the country.

Fig. 1 Wood decay by fungus and insect

Natural durability of wood

Heartwood of many tree species exhibits varying extent of resistance against deteriorating organisms due to presence of extractives that inhibit degradation. This inherent ability of wood to resist degradation by biological organisms is known as natural durability. In general, sapwood of all timber species is non-durable and therefore needs protection. To test the natural durability of wood, field tests also known as graveyard trials are used wherein a piece of wood is half buried under ground and is regularly assessed for degradation (Fig. 2).

a *b*

Fig. 2 (a) Samples exposed to open field conditions for assessing durability class, (b) Samples attacked by insects

Generally, timbers are classified under different durability class based on their heartwood durability in ground contact (Table 1) as per IS:401.

Table 1 Durability class of heartwood (IS:401)

Class	Average Life (Months)
I	120 and over
II	60 and over but less than 120
III	Less than 60

Many tropical timber species like teak, rosewood, deodar, Sal were observed to be highly naturally durable whereas species like rubber wood, mango wood, pines, are non-durable timbers. Limited availability of durable timber and the urge to increase the service life of wood products necessitated the need for wood preservation.

Wood seasoning

To protect wood from cracking, splitting and damage by insects and fungi, proper processing of wood is necessary. It is the first step towards value addition and wood protection. Seasoning is one of the most important

processing steps wherein wood is dried to specific moisture content depending on the surrounding atmospheric conditions in a controlled manner. The primary objective of wood seasoning is to enhance the wood properties, minimizing any quality losses and thereby make timber more valuable. Timber with less than 20% moisture content has no risk of developing stain and mould as a result of fungal activity. Dried timber is stronger than wet timber. Drying improves dimensional stability, woodworking quality and nail and screw holding properties of wood and easy for application of coating. Dried wood improves electrical and thermal insulation and easy to transport. The timber, with proper staking, can be air dried (Fig. 3). The rate at which wood dries in the air drying depends upon variables that involve the wood itself, the yard, and climatic conditions other than wind to allow faster drying. Drying time for air drying is 2-3 months or more depending upon weather conditions. Timber can be dried faster in seasoning kilns (Fig. 4). Kiln seasoning is drying of timber by keeping it in closed chamber in controlled temperature, RH and air circulation environment. Various types of kilns include steam heated kiln, electrical heated kiln, de humidification kilns, solar dryers, vacuum drying, and RF and microwave drying.

Wood Preservation

Wood preservation is the art of preserving timbers against the agencies of deterioration. The objective of wood preservation is to prolong the life of non-durable wood. Wood preservatives are chemical substances, which are applied to wood to make it resistant to attack against decaying agents. The importance of protecting wood from bio-deterioration was well recognized and methods like soaking or coating with essential oil of cedar and linseed oil, tarring, charring were practiced to protect timber from insects and fungal decay. It was not until the early part of the nineteenth century that the preservation of wood by impregnating the cellular structure of wood with different chemical substances, which were capable of inhibiting decay, became scientific in principle and developed rapidly. Since then several chemical systems have been tried and innovative treatment methods have been developed to treat wood. Wood preservation is one of the most important processing steps. The choice of chemicals and treatment procedures mainly depend on end use.

Prophylactic treatment

Freshly felled timber is liable to be immediately attacked by fungi and insects and may also develop splits and cracks. The splitting and cracking may be controlled by end coats and also by ponding the logs in fresh water. If the ponding facilities do not exist, then continuous spray with water containing insecticide and fungicide on

Fig. 3 Air drying of wood

Steam heated kiln *Vacuum kiln*

Fig. 4 Kiln drying of wood

properly stacked logs can protect logs from degrading for a long period. For short-term protection, spray with a combination of borax: boric acid (1:1)1% concentration is needed. If attack is already taken place to arrest the biological activities, the logs can be sterilized by steam treatment to kill infection and thereafter prophylactic treatments can be given to prevent fresh infection.

Preferred water-soluble wood preservatives for handicrafts articles

- Copper sulphate, boric acid and borax (2:1:1) 4 to 6% - It is toxic to fungi and insect borers and termites.
- Copper sulphate and boric acid (2:1) 4 to 6% - It is toxic to fungi and insect borers and termites.
- Boric acid and Borax (1:1) 4 to 6% in water-These have been used successfully against lyctus borers, sap-stain and some species of termites.

All water-soluble preservatives are inorganic salts which are not fixed or chemically bond with wood substances. When exposed to water, these chemicals undergo dissolution in water and hence leach out gradually. This leaching of the preservative can be, to some extent, reduced if a water-proof paint coating is applied on the treated material and is maintained properly. Waterborne preservatives are effective against both fungi and insects. Borax and boric acid treatment does not impart any colour to wood after treatment process. They leave the wood in a clean condition which is not unpleasant to handle.

Process of wood preservation for wood used in handicraft

One of the issues in impregnation of chemicals in wood is the permeability and ease of treatability. Sapwood of

most of the species can easily be impregnated with chemicals but it is not the same with heartwood. The treatability of heartwood of different species is different due to their anatomical structure. In many cases the natural durability of heartwood of the same species exhibits a large variation. Accordingly, the treatability of heartwood is classified in 5 grades as per IS:401 easily treatable, treatable but complete penetration not always obtained, only partially treatable, refractory to treatment, and very refractory to treatment.

Methods of preservative treatment

After considering the treatability parameters choice of right method of treatment is very important. The different treatment processes are discussed below:

Pressure treatment process

Wood is placed into an airtight steel cylinder (called preservative treatment plant) and immersed in a preservative (Fig. 5). Increasing pressure drives the chemical into the wood. Deep, uniform penetration of

Fig. 5 Photograph of pressure treatment plant

preservatives is achieved and is faster, reliable process and can be easily controlled and regulated. There are also some other methods like oscillating and alternating pressure method, double vacuum treating methods etc, which are used for the treatment. Pressure treatment usually gives better protection than non-pressure treatment whenever pressure treatment is impractical or non-availability of vacuum pressure impregnation plant near the working place other methods can be chosen.

Non-Pressure Processes

(a) Treatment of dried wood

Surface application: In this process, material is debarked completely and then brush coating or spraying can be done. Surface coating has a limited scope and is used mostly for treating material at the site. Penetration and retention is less in surface application.

Soaking or dipping treatment: In this process, material is debarked completely and submerged in the preservative solution for 24 hrs to 96 hrs until the required absorption is obtained. This application is better compared to surface application.

(b) Treatment of poles / bamboo in green condition

Sap displacement method:

Fig. 6 Sap displacement method of treating green bamboo

This method is very effective for treatment of freshly-cut debarked poles (Rao 2001). The freshly cut debarked wood pole / bamboo is placed into the preservative solution (Fig. 6). The preservative passed through and replaces sap of the poles/bamboo by wick action. Poles have to be reversed for the uniform absorption of preservative. Treatment completes in 2-4 Days. This method is preferred for its simplicity and low cost and can be carried out without technical know-how at the place of timber extraction.

Boucherie Process:

In this method carried out with the help of Boucherie equipment (Fig. 7). In this process, freshly cut poles with branches, bark and leaves intact are attached to a rubber outlet by their butt ends connected to a reservoir containing preservative solution (Venmalar et al. 2012). An air pressure of 0.5 to 2 kg/m^2 is applied on the surface of the preservative in the reservoir. The preservative displaces the sap which is then forced out at the other end and can be carried out within 45 minutes to 1.5 hours depending on the length of the pole.

Fig. 7 (a) Boucherie equipment, and (b) Boucherie process for treatment of green bamboo

Note. Whatever the process of treatment adopted, material for treatment shall be sound and needs to be dried to appropriate moisture content, except in the case sap displacement and Boucherie treatment process (both are for green condition).

Conditioning of treated samples after treatment

Freshly treated samples should be stored under shade for drying to avoid water leaching. Proper conditioning of the samples for 2 weeks to 4 weeks is required depending on the size is a must for fixation of preservatives.

Safety Measures while handling preservatives

- Wood preservative chemicals should be well understood about the toxicity of preservative chemicals to be used.
- Display precautionary notice and the correct procedures.
- Wear suitable protective clothing gloves, aprons, masks and safety glasses while handling preservative solutions and freshly treated samples.
- Follow instructions given by the manufacturers.
- Any spillage of chemicals should be immediately attended (wash with plenty of water).
- First aid help should always be available.

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Natural colours for finishing and colouring of wooden handicrafts and toys

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Handicrafts are the items mostly made by hand and/or with the use of simple tools. Handicraft is used for showcasing the culture, traditional arts and crafts and encompasses a wide range of artefacts. The informal sector, which includes handicrafts, has been described by the International Labour Organization (ILO) as a part of economic activity characterised by certain features like reliance on local available resources and skills, family ownership, small scale operations, labour intensity, traditional technology, skills generally acquired outside the formal school system, unregulated and competitive markets (Anon. 2019). Most of the wooden toys and handicraft's items are aesthetically appealing, creative, artistic, and decorative. Handicrafts and toys of India reflect the tradition, religious, social and cultural aspects of Indian society. The range of Indian handicraft is as diverse as the culture diversity of the country. As a highly decentralized activity, the handicraft industry is a shining example of using local resources and local initiatives that provide economic empowerment to people.

Manufacturing of wooden toys and handicrafts is predominantly carried out in the unorganized household sector. In many regions of the world, handicrafts sector has been identified as the second largest sector of rural employment after agriculture. The handicrafts industry has over the years contributed significantly to the employment and foreign exchange of the country. It is omnipresent with each state contributing through one or more crafts and has made tremendous progress during the last decade. However, despite the large production base the market at international level is still limited. India's share in the world handicraft exports is less than 2% (Source: Working group report on Handicrafts for the 12th Five Year Plan).

Finishing of wooden toys and handicrafts are important to attract better price and marketability of the product. Finishing includes consistency in design, dimension and accuracy of surface and colour, and polish or paint used. Appearance of wooden toys and handicrafts is considered as most important factor.

Finishing of wooden toys and handicrafts

Wood finishes are generally clear, protective coatings applied on the wood surface. The basic purpose of finish is to make handicraft beautiful and protect it from water, dirt, and changing weather conditions. Unfinished wood is highly susceptible to moisture changes, resulting in constant swelling and shrinkage. It is also susceptible to various biological agents including fungi and borers. Wood finishes are also used to preserve wood products. Depending upon the nature and method of treatment, wood finishes are classified in different categories e.g., penetrating types or film forming and water-based wood finishes or oil-based finishes.

Various wooden handicrafts items

Penetrating oil finishing

Penetrating oil finishes are absorbed into the wood and act as a wood sealant. Commonly used three types of oil used are Linseed oil finish, Tung oil finishes and Danish oil finishes. Since handicrafts items are generally not subjected to water and high humidity, the drying oils such as linseed and tung oil are appropriate as natural finishes. This enhances the appearance and looks of the handicraft's items.

Clear varnish

Varnish is one of the most commonly used finishes. Traditionally, clear varnish was a transparent film-forming finish that was used to enhance the natural beauty and figure of wood products (Pic. 2). These varnishes were made from a solution of natural resins, linseed or tung oil, or both, and turpentine. Varnish is also combined with polyurethane for enhancing its durability. Urethane-based varnishes have good abrasion resistance and perform well on interior woodwork, furniture and floors as it degrades in direct sunlight.

Pigmented varnish

Clear varnishes are modified to improve its

performance by adding finely ground inorganic pigments (Nano pigments). These pigments partially block UV radiation yet allow much of the visible light to pass through the finish and appear transparent. The performance of these pigmented varnishes is better than traditional clear varnishes.

Waterborne latex semi-transparent stains:

Waterborne latex semi-transparent stains are usually an acrylic or modified acrylic and have high molecular weight and therefore the polymers are too large to penetrate the cell wall. It gives the look of an oil-based semi-transparent stain by forming a thin film.

Solid-colour stains

These are opaque finishes that come in many colours and are made with a higher concentration of resin and pigment than semi-transparent penetrating stains. These are available in latex-based (usually acrylic or modified acrylic polymers) and oil-based formulations. Oil and latex solid-colour stains are similar to paints and they form a film.

Paint

Paints are highly pigmented coatings with film-forming properties and protect the wood surfaces from weathering, obscure some surface defects, provide a cleanable surface, offer many colours, and give high gloss. Paint retards penetration of moisture, decreases discoloration by wood extractives, and retards checking and warping of wood. Paint is available in two general types: solvent-borne oil-alkyds and waterborne latexes (usually acrylic or vinyl acrylic polymers).

Generally, oil-based paints are mixture of finely ground inorganic pigment in a resin (binder) with additives to speed curing, improve application, and give mildew resistance. The simplest resin is a drying oil, such as linseed oil. Modern oil-based paints have the drying oil combined with a poly functional alcohol to form an oil-alkyd. Oil-alkyds form a film by reacting with oxygen in the air to give a cross-linked polymeric network. Modern oil-alkyds have complex solvent systems to meet VOC requirements.

The latex-based paints are also a mixture of finely ground pigment in a resin, but here the resin is a synthetic polymer, and it merges to form a film and also these polymers do not react with oxygen. The main solvent is water, with other solvents to keep the polymer flexible. Acrylics and vinyl acrylics are typical resins in wood finishes.

The oil-alkyd or latex primers link wood to top-coats and provide a good base for all succeeding top-coats (initial top-coats and refinishing). Primers seal the surface

Wooden handicraft using clear varnish

Finishing of wooden handicraft using pigmented varnish

to prevent extractives bleed, provide adhesion between the wood and top-coats, and give colour base to even out differences in wood colour and top-coat colour (Williams, 2010).

Colourants used for colouring toys and handicrafts

Most of the colour material being used for traditional toys in India is reported to be derived from natural sources particularly from plants and minerals. But there is limitation of varieties of shades in natural colours. Therefore, synthetic colours are also used for colouring handicrafts and toys across the globe. However, these synthetic dyes have environmental and health issues. Hence, most of the standards for the manufacture of toys restrict use of many synthetic colourants having hazardous effect. For example, ISO 8124.7:2015, ISO 8124.7:2015/Amd.1:2020, IDT) restricts the use of azo colourants. Similarly, Indian Standards IS: 9873(Part 7)-Safety of Toys: Part-7: Requirements and test methods for finger paints, restricts the use of such toxic chemicals for colouring the toys. During manufacturing and dyeing process and usage, cleavage of one or more azo groups can produce the primary aromatic amines which are considered to be dangerous and carcinogenic. Specifically, they have been seen to cause bladder and liver cancers. These azo dyes can come into contact with human bodies through inhalation, ingestion and/or dermal absorption. Owing to their harmful health effects and environmental consequence, this type of colourants has been prohibited in many countries.

Natural colours for handicrafts and toys

Chemical pollution has been a cause of major concern across the world owing to its severe detrimental impacts on air and water quality. Effluents and emissions from industries and use of synthetic and toxic chemicals contaminate the ground water resources, surface water bodies and productive crop lands. Synthetic dye

production units and user of such colourants are one of the major sources of such pollution. Despite obvious adverse environmental consequences of synthetic dyes, their extensive production and use by industries is still continued unabated.

With the environmentally benign products becoming a top priority in recent years, natural dyes provide a safest alternative to the synthetic dye chemicals which are not only eco-friendly but also prevent environmental pollution. Natural dyes can be defined as those colorants (dyes and pigments) obtained from animal, minerals or vegetable matter without processing. These vegetable dyes are renewable and a range of shades can be obtained using variety of plants.

There is lack of scientifically validated information on dye-yielding sources, sustained supply of raw material, yield and colour quality. As a result, natural dyes are still mostly used by small-scale professional dyers and hobbyists. Also, most of available traditional wisdom in this context has not been properly documented and scientifically validated. A number of plant species have been reported to be used by diverse ethnic communities for dyeing purpose of various articles.

Finishing of wooden handicraft using natural colours

Dyes from plants

The vegetable dye can be obtained from bark, flowers, fruits, leaves, root, seed and wood of the different plant species. Dyes extracted from plants (herbs/shrubs/trees) are known as vegetable dyes. Some of the dye-yielding plants are given in Table 1.

Table 1: Indian dye yielding plants (Kumar and Tripathi 2011; Tiwari 1994)

Plant	Common/Trade Names	Part employed	Colour produced
Acacia nilotica	Kikar	Leaves, bark & pods	Black to dark brown
Acacia catechu	Khair	Heartwood	Red & brown
Acacia sinuata	Ritha	Bark	Brown
Acacia farnesiana	Cassic flower, Gand Babul	Bark	Black
Acacia leucocephala	Safed Kikar	Bark & leaves	Red
Aegle marmelos	Bel	Fruit rind	Yellow
Albizia odoratissima	Kala siris	Bark	Brown
Aleurites moluccana	Indian walnut, Jangli Akhrot	Root	Brown
Alnus nepalensis	Nepal alder, Udis	Bark	Brown
Andropogon sorghum	Chinese sugarcane	Seeds	Red
Annona reticulata	Custard apple; Ramphal	Fruit	Red
Anogeissus latifolia	Bakla, Dhaure	Leaves	Black
Areca catechu	Betel-nut pan, Supari	Nut	Black
Artocarpus lacucha	Dahua	Roots	Yellow
A. heterophyllus	Jack fruit tree, Kathal	Wood	Yellow
Madhuca longifolia	Butter tree, Mahua	Bark	Yellow
Bauhinia variegata	Kachnar	Bark	Yellow
Berberis nepalensis	Nepal berberry spreng.	Root	Yellow
Bixa orellana	Annatto, Latkan	Seed	Orange & Red
Butea monosperma	Bengal kino; Dhak; Palas	Flowers	Yellow
Butea superba	Palas lata	Root	Red
Caesalpinia sappan	Sappan wood, Bakam, Patang	Wood	Red
Careya arborea	Kumbhi	Bark	Red
Carthamus tinctorius	Safflower, Kusum	Flowers	Red
Cassia auriculata	Tenneres cassia, Tarwar	Flowers	Yellow
Cassia tora	Foetid cassia, Chakunda	Seeds	Blue & Red
Cassia fistula	Amaltas	Bark	Red

Casuarina equistifolia	Janglisaru	Bark	Brown
Toona ciliata	Indian mahogany; Tun	Leaves, Flowers	Red & Yellow
Ceriops candolleana	Mangrove, Goran	Bark	Red & Brown
Chloroylon swietenia	Indian satin wood; Bhirra	Bark	Yellow
Cordia dichotoma	Sebesten tree, Lasora, Chota Lasora	Leaves	Yellow
Cordiaria nepalensis	Makola, Masuri	Bark	Yellow
Crocus sativus	Saffron, Kesar	Flowers	Yellow
Curcuma longa	Turmeric, Haldi	Root	Yellow
Datisca cannabina	Akalbir	Root	Yellow
Delphinium zalil	Asbarg, Asbar	Flowers	Yellow
Diospyros malabarica	Gab	Fruit	Brown
Syzygium cumini	Black plum, Jammun	Bark	Red
Ficus religiosa	Pipal	Bark & Leaves	Red & Brown Yellow
Flemingia macrophylla	Waras, Barasal pan	-	Yellow
Garcinia xanthochymus	Dampel, Tamal	Bark	Yellow
Garuga pinnata	Chogar	Leaves	Red
Geranium nepalense	Bhand, Bhanda	Roots	Red
Gossypium herbaceum	Cotton;Kapas	Flowers	Yellow
Indigofera tinctoria	Indigo, Nil.	Leaves	Blue
Jasminum humile	Jasmine;Pitmalti	Root	Yellow
Lawsonia inermis	Henna; Mehendi	Leaves & root	Red
Mallotus philippensis	Kamala	Fruit	Orange
Mangifera indica	Mango; Aam	Bark	Yellow
Melastoma Melabathricum	Indian rhododendron	Fruit	Purple
Memecylon umbellatum	Iron wood	Leaves and flowers	Yellow
Mesua naga	Nagkesar	Flowers & Bark	Orange, Brown
Mimusops elengi	Bakul	Barck	Brown
Morinda citrifolia	Indian mulberry	Root & Bark	Red
Morinda tinctoria	Ach	Bark	Red
Moringa olifera	Horse-radish tree, Soanjna	Wood	Blue
Nyctanthes arbortristis	Harsinghor	Flowers	Yellow
Lannea coromandelica	Jingan	Bark	Golden & Pale Brown
Hydyotis puberula	Chay root; Chirval	Root	Red
Emblica officinalis	Emblic myrobalan; Amla; Aonla	Bark & Fruit	Black, Grey and Brown
Pinus wallichiana	Indian pine;		
Kail	Bark		
	Yellow to deep Orange		
Pinus roxburghii	Long-leaved pine; chir	Bark	Yellow, Brown
Pterocarpus marsupium	Indian Kinetree; Bijasal	Bark	Red - fawn
Pterocarpus santalinus	Sandal wood; Lalchandan	Wood	Red
Rhizophora mucronata	Mangrove	Bark	Chocolate
Rubia cordifolia	Indian madder; munjittee	Root	Scarlet to Red
Sarcochlamys pulcherrima	-	Leaves & twigs	Brown
Semecarpus anacardium	Marking nut	Fruit & Bark	Black
Shorea robusta	Sal	Bark	Red & black
Symplocos racemosa	Lodh	Twigs, wood & Leaves	Yellow
Tectona grandis	Teak tree; sagwan	Leaves	Yellow
Terminalia bellirica	Bahera	Fruit	Yellow & Brown
Terminalia chebula	Harar	Fruit	Yellow & Brown
Terminalia tomentosa	Asan	Bark & fruit	Brown
Ventilago denticulata	Pitti	Bark & Roots	Red, Purple andChocolate
Woodfordia fruticosa	Dhai	Flowers	Pink to Red
Zizyphus mauritiana	Indian jujube, Ber	Leaves	Red-pink

A large variety of colours can be obtained from vegetable sources. The class of compounds responsible for colours may consists of flavonoids, quinones, indigoids, polyphenols etc. A number of colouring compounds belonging to different classes have so far been isolated from various plants and their structures have been established. The plant derived colourants have also been tested for dyeing properties on various kinds of materials including wood.

The advantages of using natural colourants are manifold as they are eco-friendly, safe for body contacts, unsophisticated and harmonized with nature while most of the synthetic dyes cause environmental pollution during their production and use. Moreover, the articles dyed with synthetic azo dyes may cause different kind of skin turmoil. Environmental awareness as well as presence of toxicity in the synthetic dyes has generated lot of interest

Mallotus philippensis tree with fruits

in the renewable, biodegradable and eco-friendly natural dyes. The advantages of natural dyes are as following:

- They are biodegradable and environment friendly, thus no disposal problem.
- They are nontoxic and thus no health hazard.
- Similar to synthetic dyes, a range of shades can be developed from a natural dye.
- Practically no or very mild chemical reactions are involved in their preparations.

Preparation of vegetable dye

The basic raw materials required for manufacturing of vegetable dyes are natural produce. The process of manufacturing of vegetable dyes involves following steps:

- Collecting the parts of the plants (leaves, barks, stems, flowers, fruits, seeds)
- Testing of raw material for assessment of colour contents
- Drying and size reduction by pulverizing raw material
- Separation of different size by vibrating screen
- Extraction of colouring component
- Phase separation
- Fine filtering
- Drying of colouring matter (dyes) in spray dryer or vacuum tray dryer
- Packing

Animal dyes

Animal dyes are extracted from the dried bodies or exudates of certain insects. The examples of animal dyes are cochineal, kermes, and lac. These dyes are available in the market in the form of dark grains and are used by dissolving in hot water. Some of the potential dye producing insects and insect groups are listed below:

- Cochineal scales (Dactylopius spp) found on opuntia.
- Lac insect (Laccifer lacca) found on lac hosts.
- Gall-like coccids (Kermes spp) found on Oak.
- Mealy bugs, especially the red bodies. Many garden plants are host to mealybugs.

Dyes from fungi

Pigment and dye can be produced from microorganism. Due to the abundance, quicker growth and eco-friendly biological origin, the use of certain non-toxigenic filamentous fungi to produce pigments and that can be used as colorants for various applications. The use of fungi permits the production of pigments under controlled laboratory conditions that enables to produce in large quantity with consistence colour (Pic. 6 and Pic. 7). Production of pigments from microorganisms particularly from fungi is advantageous because it can grow rapidly which may lead to a high productivity of the product. Some fungi are very colourful and attractive. On the one hand interfering chemicals in dyeing, such as chlorophylls is not present in fungi at all on the other hand colour imparting compounds such as betalains, carotenoids and other terpenoids are widespread in some species of higher

Fruiting body of Pycnoporus sanguineus

Liquid broth of Fusarium solani

fungi. Many of the pigments of higher fungi are quinones or similar conjugated structures. Many fungal species such as *Thelephora ganbajun*, *Boletopsis griseai*, *Fusarium spp.*, *Penicilium spp.*, *Pycnoporous sanguinius*, *Xylaria sp*, *Boletus calopus*, *Phellinus pini*, *Phellinus linteus* etc. produce pigments.

Mineral colouring matters

The colours/pigments obtained directly from earth or minerals come under mineral colouring matter such as oxides and hydrated oxides of iron and manganese, umbers, ochre, titanium dioxide etc. The wood can be dyed in various colour using mixture of iron and chromium salts. Some of these pigments provide excellent protection of wood from environmental and biological degradation.

Conclusions

Natural colours produce very uncommo n, soothing and soft shades as compared to synthetic colours. Natural colourants can be used for colouring and finishing to wooden handicrafts and toys. Natural colours not only improve the aesthetics, they are safe to handle and have wide range of antimicrobial properties. On the other hand, synthetic dyes and colourants produce toxic wastes and have harmful effect on environment and human being.

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Accelerate the growth of toys cluster in Kinnala, Karnataka

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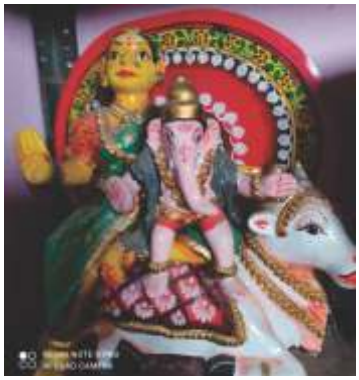
Manjula is busy carving out Rati, the Hindu goddess of love, from poniki white sander wood at her home in Kinnala village of Koppal district, Karnataka. She first carved the idol's head and then moved on to sculpting the other body parts, each of which was drawn on the softwood before being shaped. The parts will be later joined to create the consort of Lord Kamadeva.

Manjula grew up watching her grandmothers and mother lend a helping hand in the hand-painted wooden craft of Kinhala, Kinnala or Kinnal, which derives its name from the Kinnala village and received the Geographical Indication tag in 2012. Unlike Manjula, women earlier mostly helped in preparing colours and painting the artefacts. But they are now actively involved in carving and shaping the dolls. Among the 67 chitragar (artisan or painter) families in Kinhala, 25 are actively engaged in the craft. "It takes 15 days to make a 2-feet doll. Women of all age groups are now much more actively involved in the process than before," says Manjula, whose family earns about Rs. 20,000 to Rs. 25,000 per month from the craft. After the decline of the Vijayanagar

Empire, the chitragars migrated to various places and received the patronage of the Nawabs of Koppal, Desais of Kinnala and Nawab Salar Ali Jung, an art patron of Hyderabad.



Kinnal Craft or Kinhal Craft (Kannada: ಕಿನ್ನಾಳ ಕಲೆ), is a traditional wooden craft local to the town of Kinhal, or Kinnala, in Koppal District, North Karnataka, India. The town is famous for Kinhal toys and religious idols. Recently this Craft has been granted Geographical Indication and its GI Application number is 213. Kinnala was once a flourishing centre for crafts, the most well-known being carvings in wood. The famous mural paintings in the Pampateshwara Temple, and the intricate work on the wooden chariot at Hampi, are said to be the work of the ancestors of the Kinhal artisans of today. Old paper tracings found in the ancestral house of one of the artisans further substantiates this belief.

Method:

The artisans are called Chitragar. Lightweight wood is used for the toys. The paste used for joining the various parts is made of tamarind seeds and pebbles. Jute rags, soaked, slivered into pieces, dried, powdered, and mixed with saw dust and tamarind seed paste is made into kitta. A mixture of pebble powder paste with liquid gum is used for embossing the ornamentation and jewellery on the body of the figure. Once the components of the figure are assembled, kitta is applied by hand all over, and small

pieces of cotton are stuck on it with the tamarind paste. Over this is applied the pebble paste which forms the base for the application of paint. Previously, toys depicting people involved in various occupations were popular; now the preference is for figures, animals, and birds. Garuda, the epic bird, has 12 components while Lord Ganesha on a throne has 22 components. The styling is realistic and the designing and chiselling has a master touch. In the festival season, clay toys and images are made, often out of cowdung and sawdust.

Light wood of neem, nugge (drumstick tree) and kitta (liquid and paste of tamarind seeds) are the basic materials used here. The artisans do multifarious job of cutting, polishing, painting and ornamenting the furniture. Brushes made of hair of squirrel's tail are used to do delicate painting. Small and big ornamental boxes, stools, low planks (chowkis), god-stands (peetha) and cradles are the specialization of these artisans. The subjects of the art could be mythological characters, birds, animals, creepers, flowers and fruits.

Today the artists of this craft not only make toys but also other objects made of wood. They then decorate these articles. The artists were titled as 'Chitragars' or makers of pictures. The wood used in this craft is from Polki, Hale and Hirelevu. These woods are light in weight.

The ornamentation and jewellery on the body of the figure are pressed with the mixture of pebble powder paste with liquid gum. Once the various parts are organized together the artist smears kitta all over the craft with his hands. Then, small cotton pieces are stuck on the craft with tamarind paste on them. Next the pebble paste is applied again and this coat is the base for application of paint.

The craft piece is coloured with the most vibrant colours of green, blue, yellow etc. Also, the paint brush used in this craft is made out of squirrel's tail. But today they look out for toys of figures, animals and flowers.

Challenges:

Presently, the changing trends in toy world the popularity and preference for Kinnala has been declining rapidly. The Government has taken initiatives for the revival of the traditional craftworks. Like other industries, this toy hub has been struggling since March due to the Covid-19 pandemic, which dealt a crippling blow bringing business to a grinding halt amid the lockdown. "A Fruit Basket would sell for Rs 500 apiece. Now we are forced to sell it at Rs 300. We oblige as we need money to survive. We don't have any other skill," said Sheshappa, who proudly displays the colourful Fruits his family produces. Of the 67-plus toy making families, only 25 to 30 per cent are functional after the lockdown, according to the toy makers. Many local artisans have shut their units and are working as taxi drivers, masons and construction workers for their survival.

Way Forward:

They also have problems in getting good quality treated seasoned wood which will enhance the quality of Toys, time to process and reduce wastage. The cluster needs design and ideation intervention to make for today's market. The youth need to be provided with skill training and innovative mindset to be globally competitive and thrive. The government should provide online portal for certification for promoting exports, also bring the raw materials wood out of Sec 5 to Agro forestry products so that the artisans and craftsmen are not harassed about the source of wood. Government should plan to set up a Common Facility Centre for Treatment, Preservation and Seasoning of wood and a Common Marketing Centre on Koppal – Goa Highway to help the members sell their wares.

The wide range of products now being made by Kinnala artisans includes palkis (palanquins), cradles, decorative umbrellas, stools, birds and animals, picture frames, mirror frames, decorative plaques, fruit and vegetable trays, crowns, armour and weapons for village dramas, stage performances of the epics, and more. Santhosh Kumar Chitragar, whose artworks won him the Karnataka Shilpakala Academy award, is one of the artisans making more contemporary dolls. "I began learning the craft from my father when I was 10," says the 28-year-old who has

done Masters in Fine Arts.

The artisans now make dolls as per the requirements of the customers. "We take advance orders because creating the dolls is a time-consuming process," says Santhosh, who has not limited himself to making religious idols. "Women, who are more actively involved in the craft now, also make six-inch figurines mostly," he says.

The process of Kinnala craft

The materials used for the Kinnala craft are locally available softwoods from neem, drumstick and poniki. Being lightweight, these woods require a metallic finish for a smooth texture. A cloth collage is put on the wood for structural support. All the parts of the doll are first joined together with a paste of tamarind seeds and pebbles. Then, on the body of the doll, a paste called kitta is applied using hands. The basic process is completed with a final layer of pebble powder paste. While many artisans continue to use natural colours, others have shifted to market-made bright paints not all of which are eco-friendly. Santhosh Chitragar, Karnataka Shilpakala Academy award winner, at his workshop. (Pic: courtesy Santosh Chitragar)

Traditionally, artisans used limestone, red soil and carbon black besides other natural materials to make dyes. The most prominently used colours are ochre, brick red, deep green, white, black, and lapis. The craftspeople use a brush made from the hair of squirrel's tail for painting. A thin layer of varnish is applied after the paint fully dries up.

Workshop observations:

The workshop saw attendance of about 100 members of artisans, craftsmen for the design sensitization workshop. Sri. S.M. Jhamkhandi Director MSME Centre of Excellence, Indian Institute of Science Bangalore in his address spoke of the threat perception of the market and sensitized the artisan of the change in market demands, hidden expectations of the customer, ideation to integrate sensors and electronics to make Toys with IoT to educate children on Hindu Mythology, Ramayana, Mahabharata, Bhagawad Geeta etc. He also explained the schemes

wherein Government of India DC MSME can give grants for Ideation design new Toys and do product visualization as a pre-production tool.

Mr. B.L. Dhananjay, Technical Officer, Institute of Wood Science & Technology, Bengaluru explained the simplest process of Treatment & Preservation of wood to prevent attacks from Fungus, Borers & Termites by dipping the seasoned wood pieces in a solution of Boric Acid & Boric Powder in the ratio of 4:4:100ml of Water. The wood pieces should be submerged for a period of 48hours and then dried before using it for making toys.

Workshop outcomes:

Laghu Udyog Bharati Karnataka members will assist the Toys cluster in Ideation, prototype making, and production of IoT based Toys. The lead will be taken up by MSME CoE and the Ideation will be from students of 3rd year of Engg/BCA, LUB K members will be involved in developing the prototype under Design clinic scheme to help the artisans develop new Toys.

To help the Toy cluster in marketing their Toys LUB K under Gram Shilpi Prakosta organized an exhibition on 9th to 11th April 2021 at Hubballi. The main objective of the Mela was to familiarize rural entrepreneurs and artisans on how to revamp their business strategies and scout for business opportunities. The basic intention of the three-day event was to encourage and promote rural business which is the theme for Atmanirbar Bharat promoted by Prime Minister Shri Narendra Modi ji. The Mela was an excellent platform for all rural based artisans who showcased and marketed their products to not only the general masses but also the B2B community. This Mela was exclusively hosted for rural Artisans alone and trading community was not allowed. The exposition specifically focussed on artisans from 12 districts of Karnataka. Ten sectors were identified to be showcased like Wood carving, Stone, metal products, leather, handicrafts, hand-made textiles, Handloom, traditional medicines, speciality foods and propriety products. Karnataka is traditionally renowned for its art and artefacts, woven handloom and handicraft and eco-friendly products. Each district of

Karnataka manufactures an exclusive hand-crafted article using locally available and natural resources not only to cater to the local needs but also to decorate interiors and exteriors for the masses.

Today it is estimated that several families across Karnataka are directly engaged in promoting this traditional heritage. The traditional businesses passed on for generations are still keeping it alive despite severe hardships due to rapid industrialisation and modernisation. These heritage value products are slowly losing it is charm and the skilled/technical art is slowly on the vane. The need of the hour was to establish a platform to preserve and upscale these dying arts and develop sustainable models to revive our technical and scientific based eco-friendly products produced by our rural masses. The craftsmen willing to train the younger generation if the government comes forward to set up centres and encourage them with necessary wherewithal and support mechanisms. In order to sustain the traditional heritage Laghu Udyog Bharati has now proposed to develop sustainable models like a museum-cum-sale unit and seasonal exhibitions to showcase district-based respective art and provide better livelihood to rural artisans. This Rural Artisans Mela in Hubballi was the first in the series of programmes to promote Gramashilpi Udyami Prakoshta that Laghu Udyog Bharati-Karnataka will be organising to promote Rural Artisans. Similar such events will be organised in other districts of Karnataka in a phased manner.

About LUB-K

Laghu Udyog Bharati - Karnataka (LUB-K) is the State Chapter of LUB catering to the 24 districts of Karnataka and works towards the empowerment of entrepreneurs in Micro and Small sector. We plan to cover to all the 30 districts of Karnataka in a few months from now. It plays an active and important role in promoting trade and investments in the State. Being the apex organisation in Karnataka for MSMEs, it regularly interacts with Senior Government Officials both from the Centre and State on critical issues concerning MSME sector.

LUB-K is involved in activities vis-à-vis:

- Capacity building programmes for Entrepreneurs
- Industrial Visits – To showcase best practices & encourage MSMEs to adopt and replicate the same
- Interactive Meetings with Government Departments
- Participation in National and International Exhibitions and Trade Fairs
- Hosting of National and International Exhibitions
- Hosting and Organizing International Business Delegations for Technology transfers, B2B & Joint Ventures and Collaborations
- Standalone Women Entrepreneurs Cell

Gudigars, the handicraft community and Indian Sandalwood – an inseparable association

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Introduction

Handicrafts is a generic term and is defined in a simple way of efficiently using own hands to make objects. It can be known as crafts or craftwork. By using ordinary hand tools items having ethnic and traditional value are designed and is an age-old process. It exemplifies a tradition of many centuries and the items so made are used extensively in sacred and ritualistic events encompassing the cultural significance. Various forms of handicrafts include wooden items, pottery, jewellery, sculpture, metalware and many others. In its true form, any items produced using machines or created in factories do not fall under the ambit of handicrafts. India is known for handicrafts since time immemorial and the ethnically embodied handicraft items used domestically formed an integral part of Indian society. India's handicrafts are well accepted in the global market considering the uniqueness of each handmade item.

According to Indian mythology, Vishwakarma considered as the divine sculptor and architect of the universe is the deity of arts and handicrafts. It is believed that he had five sons and each of them specialising in a specific domain – *Manu* worked in iron; *Maya* in wood, *Tvasta* in brass, copper and iron, *Silpi* in stone, and *Visvajna* in gold and silver jewellery. Even today his blessings and divine support are sought by artisans or craftsmen on the holy day of Vishwakarma Jayanthi generally celebrated on 16 or 17th September of Gregory calendar.

India is a richly diversified country in terms of culture and heritage and harbours diversified tree species providing the basic material for wooden handicrafts. Wooden articles in India range from toys to exquisitely carved decorative articles which also signifies the art, individuality of the craftsman and the wood which the craftsman works to reveal his gifted talent. One such wood is Indian sandalwood *(Santalum album* Linn.) known globally for its aromatic heartwood and the heavily scented essential oil obtained after steam distillation of heartwood. The erstwhile Mysore state presently Karnataka has been traditionally known for wood carving which is an ancient craft supported by the royal families. Karnataka is known for various handicrafts Rosewood inlay, traditional paintings of Mysore, Channapatna lacquerware and toys, Kinhal toys, Bidri ware, Navalugund durries, stone sculpture, shimmering silk, beautiful bronze and copper crafts, and many more. However, it is claimed that sandalwood carving is the most popular, interesting and highly valued. Indian Sandalwood (*Santalum album* Linn.) popularly known as 'Srigandha' in Kannada, was extensively distributed in the southern part of Karnataka and the Northern part of Tamil Nadu. The highly scented heartwood is sought after by the artisans for crafting because the wood is close-grained, smooth, and having evenness and fineness structure. All these attributes are amenable to delicate and intricate carvings. The craftsman community involved is known as *Gudigar*. Both the wood and the craftsman come from Karnataka one of the important southern states in India.

The craftsmen *Gudigars*

Gudigars or Gudikars is a small community recognised as master craftsmen and known for their fine arts. The word 'Gudi' means temple in Kannada and *Gudigars* are temple artisan or craftsman who has painted and carved the brilliantly decorated Hindu temples. They were associated with temples specially decorating them through carving and painting. There is another derivation attributed to the Sanskrit word *Kuttaka* meaning a carver. They associate themselves with fellow caste known as *Chitrakaras* in Goa who are ornamenters or decorative artists. It is believed that they have migrated from Goa to escape from the torments of the Portuguese and settled in South Kanara and Shimoga districts of Karnataka. They gradually settled in prominent towns of the two districts (Shimoga and South Kanara) namely Sagar, Sorab, Honnavar, Kumta, Sirsi, and Siddapur. In Sorab taluk they are found in Jade, Bilegodu, Jamballi, Tavanande, and Janginakoppa villages. In Sagar taluk, they have settled in Talaguppa and Honnakeri villages. In Sirsi, they are settled in Banavasi, Koppa, Koorli, Islur, and Hebballi villages, Bilgi and Herur villages of Siddapur taluk, Nathakeri hamlet in Karva village of Honnavar. The fact that Konkani being their original language supports their claim to have been migrated from Goa, over some time those shifted to Shimoga district speak Kannada while those in coastal town still speak Konkani. Intrinsically they are highly skillful artisans. They are familiar with carving, painting, sculpting, and moulding earth for preparing idols. Their talent is exhibited in the form of pith

garlands, coronets, and preparing trinkets. Those *Gudigars* settled in Shimoga and adjoining areas came under the patronage of Mysore Maharajah, while rulers of Bombay Province patronised those settled in North Kanara.

Mr. Benjamin Lewis Rice (1837-1927), a British historian, archaeologist, and educationist wrote the Mysore Gazetteer is highly appreciated even to this day. In the Gazetteer, there is mentioning about *Gudigar*s as follows *"The details, though in themselves often highly incongruous, are grouped and blended with a skill that seems to be instinctive in the East, and form exceedingly rich and appropriate ornamentation, decidedly oriental in style, which leaves not the smallest portion of the surface of the wood untouched. The material is hard, and the minuteness of the work demands the utmost care and patience. Hence the carving of a desk or cabinet involves the labour of many months, and the artists are said to lose their eyesight at a comparatively early age"*. Therefore, *Gudigars* were true artisans richly endowed with all the artistic techniques as they could provide detail and delicate finishing be it in surface carving, incised working, high relief or deep under cutting, pattern working, scroll and foliage. Their uniqueness in carving was imprinted in every product that used to be made by them.

Gudigar(s) at work
(Source: https://demowe.xyz; Shri Bikku Gudigar Kala Kendra)

Considering their creative skills, woodcrafts carved by *Gudigars* reflect their artisanship as seen in the images of Hindu Gods such as Venugopala, Nataraja, Radha-Krishna, Rama-Sita, Vishnu, Ganesha, Lakshmi, Saraswathi, etc. Decorative designs depicting mythological messages such as Geetopadesha, Lord Krishna and Arjuna, Menaka-Vishwamitra, Shakunthala-Dushyantha, etc., and motifs from Ramayana and Mahabaratha. Most of these designs are similar to those found in stone sculptures in different temples of Karnataka. Some of the crafts that are popular both within and outside the country include, photo frames having rectangular or oval-shaped niche at the bottom with a pierced carving of swan or peacock, calendar stands, caskets, paint, jewel boxes, utility articles like shirt buttons, combs, pen holders, paper knives, cuff links, semi-circular or circular shaped fans, toys of animals like lions, horses, camels, elephants, etc., walking sticks with exquisitely carved handles, sewing boxes, book racks, playing card covers, inkstands, paper cutters, pen racks, envelope boxes, paper weights, flower pots, garlands (which are generally made by the women using the thin shavings of sandalwood obtained during planing), rosaries, and many such other items. The Holy Cross and the Crucifixion of Jesus Christ's idols are sought after by the Christian devotees of the Kanara coast. It is a common practice to present these popular items as gifts on different occasions.

Tools and carving techniques

The common carpenter tools used by the carvers which are available from the local merchants are – handsaw, plane, ruler, try square, hammer, and screwdriver and these are available from the local merchants. The *Gudigars* also use some specific carving tools made by local blacksmiths. These tools are modified chisels and gouges of different size and shape useful for carving. They are known as *Kadiyuva Chana* – a firmer chisel with a bevelled cutting edge for severing the sandalwood; *Bagina Chana* – a curved edge chisel having an arc shape which is used for short cuts and internal curves and also to scoop out curved recesses; *Nunupu Chana* – a firmer chisel with bevelled cutting edges suited for hand manipulation. Some of the fine chisels have a width of half an inch to the point of steel nib. Typically, the *Gudigar* uses tools of different fine edges for bringing out the subtle shapes and curves with exquisite details. It is mentioned that these carvers avoid using a file but use chisels for obtaining smooth finishing which has deleterious impact on their eyesight. It is often mentioned that *Gudigars* from the Shimoga area are dexterous compared to those from coastal areas and the main reason attributed to this is the copious availability of sandalwood in Soraba and Sagar which facilitated them to understand the texture of the wood and thereby better carving intricacies.

Sandalwood casket carved by Puttappa Gudigar in 1875
(Source: www.gudigars.com)

Photoframe carved from sandalwood
(source: https://demowe.xyz/sandalwood-crafts-complex-soraba)

A sandalwood model of temple gate (Gopuram)
(Source: https://www.christies.com/en/lot/lot-5901031)

The *Gudigars* follow varied types of carving like carving in the round and carving in the relief. Carving in the round needs extra care and skill because it is carried out when the object is not attached to the rest of the wood. While carving this, they follow four stages – 1) reducing the woodblock to shape 2) boasting in 3) finishing, and 4) polishing. If the wood is attached to the rest of the wood it is known as relief carving. In the relief carving if the figure is bold, flat, and low, then it is known as high, middle, or low relief carving, respectively. Some of the other carvings are incised chip and pierced type of carving.

As a specialised handicraft community, there are many talented craftsmen like Vitthal Shetty, Samba Shetty and Ashok Gudigar have received master craftsman awards at the national level. It is mentioned that Dwight D. Eisenhower was the first president of United States of America who visited India in December 1959 to symbolise a common quest for peace. On behalf of the then President of India Dr. Rajendra Prasad, the US president was provided with an array of gifts. Among them that stood out was the intricately carved Sandalwood depicting an episode from Mahabharata signifying the symbolic representation of the victory of good over evil. This was singlehandedly carved by a Gudigar Samba Shetty from Honnavar who took eighteen months to complete this wonderful craft. No wonder why art enthusiasts respect this community saying that machines can never replace the unique carving skills of these craftsmen.

However, this intrinsic association of Indian sandalwood and *Gudigars* have been severely impacted by the non-availability of sandalwood in its natural habitat due to various obvious reasons. To foster this harmonious relationship availability of sandalwood is very important. The only ideal solution for this is encouraging extensive cultivation of sandalwood. Institute of Wood Science and Technology, Bengaluru a premier institute has taken the onerous task of reviving the past glory of Indian sandalwood by conducting extensive research on various aspects related to sandalwood cultivation and providing training for those interested in successful cultivation. This would pave the way in strengthening and reviving the strong intrinsic bonding of sandalwood and *Gudigars* in Karnataka.

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Handicraft: From boom to brink

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Handicrafts and toys have been in an integral part of any civilization. Toys and handicrafts excavated from ancient civilization gives us an idea about the infrastructure, transportation and ways of life of the civilization. Toys have been an integral paraphernalia in depicting and linking traditions, religion, and history in the form of amusement and entertainment. The pattern of handicrafts reflects the culture of the area and often a specific community produces indigenous crafts. Wood and clay had been used since ancient time for making toys until the current century when the burst of plastic made cheaper toys prevailing. However, the market faces threat from other issues like raw material supply, decentralized system and patriarchal attitude of the market. A large number of women and people belonging to the lower strata of the society contribute to the industry. This paper aims to look into the problems faced by the handicraft industry and wooden toy industries.

Diversity in Indian handicrafts

Handicrafts can be in general defined as objects made by skillful artisans using hand and age old ethnic tools. Each and every craft created is a mirror reflecting the identity of the tribe. The use of wood to make handicraft is prevalent in India since ancient times. Each part of India has its own endemic woodwork. This is due to the vast geography and biodiversity of India since final product is mostly influenced by the raw materials and wood locally available. For example, most of the handicrafts found in north eastern part of India and in Kerala are mostly made up of bamboo, while in North India, it is walnut (Juglans regia) and sheesham (Dalbergia sisoo). As we move towards the southern states, the raw material base changes to rosewood (*Dalbergia latifolia*) and sandalwood (*Santalum album*).

Karnataka is famous for its sandalwood carvings and ivory wood carvings. A small community of Gudigars inhabiting in Shimoga district of Karnataka makes idols, statues and fancy souvenir and memento out of Sandalwood. In the west, Rajasthan and Gujarat produces one of the finest textiles and tie-dye textiles commonly known as "bandhani". Artisans from Rajasthan specializes in items made out of lac, a resinous secretion from Kerria lacca that is processed by heat treatment. West Bengal has its own form clay handicrafts commonly

known as "terracotta" or burnt clay. The most common form of terracotta handicrafts are vessels, earthenware, roofing tiles and bricks. Idols depicting gods and goddesses are also made out of terracotta.

India has long coastline and the handicrafts found along the shores are mostly made out of shell and conches and the items varies from forks, bangles, bowls, and other household items. India has wide variety and diversity of bamboos and canes. The artisans of north eastern states, mainly Tripura and West Bengal has mastered the craft and creates almost every objects of daily uses from baskets to mats, from trays to hats. Bamboo handicrafts involve manual skills, unique carving equipment and traditional knowledge of the craftsman.

Major centres of woodcrafts

The wood carving industry is one of the finest cottage industries in India. The major wood carving centers are in North India mainly Saharanpur, Moradabad, Nagina, Meerut and Srinagar (Aggarwal et al., 2013). The distinct feature of Saharanpur is the reputation and benevolence for its excellent craftsmanship. The raw material varies from shisham (*Dalbergia sissoo*), mango (*Mangifera indica*), Babool (*Acacia nilotica*), Haldu (*Adina cordifolia*), Toon (*Toona ciliata*), Teak (*Tectona grandis*), Pine (*Pinus roxburghii*), Silver Oak (*Grevillea robusta*),

and Papdi (*Holoptelea integrifolia*) (Dubey et al., 2020). The intricate process involves slicing, cutting, carving, sanding, polishing and finally assembling.

In the north east, Tripura and Assam has been the leading example in terms of utilization of natural resources to produce export quality crafts. Madhya Pradesh excels in wood carving with some of the most popular products being carved boxes, wooden spears, funerary pillars, artifacts inscribed with animal motifs and furniture. Panchgani, a hill station in Satara district of Maharashtra encourages rural traditional handicrafts among the villagers. The interesting fact about the handicrafts is that the objects are made out of combination of wood, bamboo, stone, brass, fabric and iron.

Karnataka is well known for its small scale toy industries concentrated in Channapatna, in Ramanagara district. This picturesque town is famous for its wooden toys with its craft so developed that it is also known as "gombegala nagara" which translates to town of toys. Tipu Sultan, the erstwhile ruler of Mysore introduced the wood carving and encouraged the Persian artisans to expound the skills further. The legacy is continued till date with toys made from Ivory wood (*Wrightia tinctoria*) for the additional shine and then colored using vegetable dyes

Complications

The major constraints that the Micro, Small and Medium Enterprises (MSMEs) faces are (Jadhav, 2013)

- Lack of financial support
- Outdated techniques of manufacturing
- Poor marketing schemes
- Constraints in availability of raw material
- Competition from mechanized goods

With the advent of technology, there is burst of electronics and cheap plastic products. The production rate has increased, the production cost went down substantially thereby changing the needs of the market. The Indian handicrafts failed to diversify and mass produce on similar scales thereby weakening the sector automatically. This problem aggravated in absence of proper administration from the government and financial and technological support. Local youths shifted from age old tradition to sustain their livelihood and thereby handicraft industry faces slow oblivion's curse.

The next major issue faced by the handicraft industry is the availability of raw materials. The major species used traditionally in the handicraft sector are *Adina cardifolia* (haldu), *Ailanthus excels* (maharukh), *Albizia lebbek* (kokko), *Artocarpus heterophyllus* (kathal), *Artocarpaus hirsutus* (aini), *Alstonia scholaris* (chatian), *Anogeissus pendula* (kardahi), *Azadirachta indica* (neem), *Chloroxylon swietenia* (satinwood), *Cinnamomum zeylanicum* (cinnamon), *Diospyrous ebonum* (ebony), *Dysoxylum malabaricum* (white cedar), *Gmelina arborea* (gamarai), *Hardwickia pinnata* (piney), *Juglans regia* (walnut), *Lagerstromia mic*rocarpa (benteak), *Pterocarpus marsupium* (bijasal), *Sterculia urens* (gular and tapsi), *Toona ciliate* (toon), *Wrightia tinctoria* (ankudu, jeddapaala, tedlapaala), *Pterocarpus santalinus* (red sanders), *Givotia rottleriformis* (puniki) and *Gyrocarpus jacquini* (helicopter tree, propeller tree, stinkwood) (Kumar et al., 1995, 1996a, 1996b; Aggarwal et al., 2013). The overexploitation of these woods made the species scarce and The Forest Conservation Act 1980 made procurement of timbers difficult. This dwindling supply accompanied with high cost forces the artisans to renounce their professions.

A faulty marketing scenario exists in our society. The presence of "middleman" (intermediaries) between artisans and retailers hampers the economic condition of these people. Even though the price of raw materials increased few folds, the price of the product remained static (Aggarwal et al., 2013). Synthetic and plastic products haunts the market since it's cheap, easily available, has wide varieties and has improved designs. Thus, these outrun our traditional items in the long run. Moreover, there is almost no significant development in the technologies to mass produce and speed up the production of these handicrafts. The tools used to manufacture these craft items are centuries old, often passed down the family through generations. These delicate tools are necessary of intricate carvings but not suitable for surviving the race of production.

Aggarwal et al in 2013 discussed another discrimination that the industry faces. The export traders often overlooks female artisans during procurement processes, even though many women make export-quality products. This bias may be partly because women mostly use hand lathes and exporters prefer articles made on

power lathes. It may also reflect the continuing low profile in the industry of women, who have traditionally catered to local clients and markets.

Lastly, there is an urgent need to find few alternative plantation timber and genetically improve the species so that the issues of raw material can be curbed. In absence of alternative source of wood, the traditional workers will find it difficult to sustain themselves with conventional wood. There is a serious lack of training centres to improve the skill base and to train the youths in designing and marketing. On similar lines, performance tests and quality assessments at regular intervals to maintain the standards of the product.

Conclusion

Handicraft sector is an unorganized and unstructured sector yet one of the most important productive sector and export commodity for a developing countries (Ghouse, 2012). Even with over six million artisans concerned with production being employed in the sector, no proper marketing schemes exist in this traditional field. Thus, a mutual association between the Indian government and the handicraft exporters is needed in order to promote the artisans, and boost the traditional sector. Women form a major fragment in the craftwork field. The entrepreneurial development of these women will in turn accelerate the growth of the economic status in the society. Entrepreneurial skills in a way promotes uniqueness and hence gives a competitive advantage in the market. A basic principle to market handicrafts is through tourism. Handicrafts industry of West Bengal contributes to the development of economy in the rural tourism development (Gupta and Mukherjee, 2006). Geographical Indication (GI) tags provides value addition to a product and conserves the cultural integrity of the object. Hence the handicraft items can be provided such tags to preserve the nativity of the item. This will not only reduce the socio-economic condition (Naidu et al., 2014) of the place but also promote the local youths and communities to conserve their ethnicity and culture while producing handicrafts for livelihood.

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Company Background:

KumarEngineeringCo. is a pioneer in India for making indigenous global standard machines being used in the wood working industries as Plywood, Laminate & Furniture, Founded in 1990 by Mr. Sunil Srivastava (M.D.) on Engineering graduate with breakthrough experience in advance automation with strong focus on research and development, our organization is recognized worldwide for technical excellence and development of innovative products. The numerous industry milestones, new products, technical upgradations and patents that have resulted from our work continue to provide long-term benefits to our clients.
We are ISO: 9001 2015 certified company located in NCR District Rohtak, Haryana, approximately 40 miles from the capital city of New Delhi and easily accessible from the airports.

Core Competencies:

- Double Head Wide Belt Top Sanding Machine
- Double Head Wide Belt Bottom Sanding Machine
- Heavy Duty Both Side Sanding Machine
- Triple Head Calibrating and Sanding Machine
- Heavy Duty Laminate Sanding Machine
- Heavy Duty Both Side Calibrating Machine
- Super Heavy Duty Both Side Calibrating Machine
- Single Combi Head Sanding Machine
- Single Head Calibrating Machine
- Double Head Both Side Brushing Machine
- Triple Head Both Side Brushing Machine
- Automatic Edge Cutting Machine (ServoControlled)
- Hardwood Calibrating & Sanding Machine.
- Sanding Machine with Cross Belt for UV/Lacquer.

Our Clients:

We have a diversified client base & enjoy strong patronage of 500+ national & international clients including leading Plywood, MDF, Laminate and other wood-based product manufacturers, research organizations and government agencies. Apart from pan-India presence our machines are being increasingly exported to Nepal and preparing for other neighboring countries.
We look forward to receiving your esteemed order and forging a strong relationship with you. Please feel free to contact us for more information

Multi coloured laminated compregs using dyed veneers of plantation species (Densified Laminated Lumber) for high end applications

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There is a severe shortage of conventional timbers for manufacture of compregs wherein high density is the requirement. Under such circumstance, it is the need of the hour that plantation species that are enormously available in the country are efficiently utilized for the manufacture of compregs. The multicoloured laminated lumber has been widely used in European and American market for making speciality ornamental and utility products. Currently, the lumber products are being imported and the final transformation to utility products are being manufactured in India for export purpose. To minimize the import of such products, the technology for dyeing of veneers that are very essential to add up the aesthetic appearance of the product and the process of manufacturing multi coloured laminated compregs technology has been developed at IPIRTI under a sponsored project for M/s. Indeutsch International, Noida. This development on national level will bring in economy. The main objective of the present invention is to provide a process of manufacturing of Multi coloured laminated compreg and transforming the compreg thus obtained to various ornamental and utility products.

In this study, the process of dyeing the poplar wood veneers and birch wood veneers of 1.6 mm with different colours to achieve through and through penetrations were optimized. The resulting veneers had uniform colours in all spots of the veneer with through and through penetration and was not leachable after 2-3 washings. The coloured veneers were dried to a moisture content of 6% - 8% for further processing to compregs. A specially formulated phenol formaldehyde resin with a plasticizing agent was used for spreading onto veneers. The addition of plasticizing agent in the resin formulations helps to minimize the brittleness of the veneers which otherwise may result in the cracks of the product during pressing. Adhesive formulation and process parameters have been optimized to manufacture compregs of 50 mm thickness using the dyed veneers of poplar and birch wood species. Lumber constructions were adopted and the machining properties of the compregs were studied. The machining properties of compregs made by lumber construction possess the properties desired for turning speciality products like knitting needles, shawl clips, crochets, knitting dolley, Nostepinne Ball winder etc. It has been observed that the production cost of the compregs made using poplar veneers is 75% cheaper than the imported cost of the same product while the compregs made using the imported birch veneers is found to be 55% cheaper.

Introduction

Wood can be densified and its properties modified not only by filling its void volume with polymers, molten sulfur, or molten metals but also by compressing it under conditions such that the structure is not damaged. Compressed solid wood has been made in Germany since the early nineteen thirties and marketed under the trade name of Lignostone. Laminated compressed wood is marketed under the trade name Lignofol. A resin treated laminated compressed wood known as Kunstharz schichtholz has also been in commercial production. These densified materials are used for textile shuttles, bobbins and picker sticks, for mallet heads, for forming jigs and for various tool handles.

Methods for improving the physical and mechanical properties of wood or wood based materials, such as polymer impregnation, synthetic resin treatment, and wood compression under specially controlled conditions often combined with chemical treatments, are increasingly being investigated by scientists in Thailand. Conventionally, wood and wood based materials were treated to meet desired requirements for specific mechanical properties, in particular high bending strength. Commonly, a synthetic resin treatment, phenol formaldehyde resin has been used with a high compression in order to improve the physical and mechanical properties of wood or wood-based materials.

The plasticizing effect of phenol formaldehyde resin forming mixes on wood has been taken advantage of in making a resin treated compressed wood with specific gravities ranging from 1.2 to 1.35 at pressure of 1,000 psi or less at 125 to 150^{0}C. Fortunately when heat and pressure are simultaneously applied, the wood responds to compression more rapidly before the curing of the resin.

Phenol formaldehyde resin treated compressed wood, frequently called Compreg, is normally made from treated veneer rather than solid treated wood. Compreg is much more dimensionally stable than the best untreated compressed wood. It approaches the dimensional stability of impreg in the sheet directions but it swells appreciably more in the thickness direction because of the reduced thickness on which dimension changes are based.

Various methods are known for the production of artificial wood veneer whereby sheets of natural wood, obtained by rotary cutting from a log are dyed or coloured, superimposed and glued together by compressing them in a mould to form a block of sheets in a press provided with moulds having surfaces of a suitable configuration for shaping the sheets of the block according to a predefined pattern.

Dyes can be natural or synthesized from benzenoid hydrocarbons obtained from coal tar or petroleum. There are over 7000 different synthetic dyes currently in use in the textile, leather, paper food and cosmetics industries. Dyes are distinguished from pigments in that they are soluble in the application medium, usually water whereas pigments are insoluble. In the present invention a water/alcohol solution has been found preferably as a solvent over water. Other solvents that are finding acceptance in the dyeing industry may also be utilized. Pigments are used in manufacturing printing inks, paints, automobile finishes and incorporated into plastics and rubbers.

Veneers such as maple, chestnut, alder, birch, hickory, beech, ash, walnut, poplar, cherry, oak and elm, require a higher pressure to obtain effective penetration of the dye through the veneer. The chamber is pressurized until the wood absorbs the amount of colour that is desired. At pressures of 100 to 200 psi the time required for penetration is about 4 to 6 hours. When the colour is absorbed the pressure is released and the veneer is removed. The veneer is then washed with warm water until there is no bleeding and then air dried.

The resulting veneer is consistent in colour such as yellow, green, blue, red and the dye penetrates completely through the veneer. The veneer can be sanded, cut etc without damaging or changing the colour avoiding the need to touch up these areas as in conventional methods which are difficult to get colour matches. Through and through penetration of the dye into the wood enables to obtain a wide variety of colours without masking the grain of the wood.

The method of processing wood to obtain attractive products used in decoration and utility has a long history. Thousand years ago, Chinese shaved wood and glued it together for use. Later on, English and French are reported to have worked on the principles of plywood. The processed wood comprises of a range of derivative wood products that are manufactured by binding or fixing the strands, particles, veneers, fibers or boards of wood along with adhesives such as liquid animal glue, resin from tree sap, bee wax etc., to form composite materials. For similar utility products the multicoloured laminated compreg would find the best place for transforming into various utility products that can compete with the similar kind of conventional metal products

Literature review

Compressed solid wood has been made in Germany since the early nineteen thirties and marketed under the trade name of Lignostone. These densified materials are used for textile shuttles, bobbins and picker sticks, for mallet heads, for forming jigs and for various tool handles.

Early United States patents for compressed wood are as follows: Sears, 1923: Olesheimer, 1929, Brossman, 1931 and Esselen, 1934. The latter differs from the others in that the wood is compressed circumferentially by driving cylindrical pieces of wood through tapering dies. These patents are concerned almost entirely with the mechanics of compression and did not adequately consider plasticization of the wood or stabilization of their product. Because of this none of the patents were put into continuous use. It has been found that impregnation of wood with liquid ammonia causes a high degree of swelling and a high degree of plasticity of wood.

Methods for improving the physical and mechanical properties of wood or wood based materials, such as polymer impregnation, synthetic resin treatment, and wood compression under specially controlled conditions often combined with chemical treatments, are increasingly being investigated by scientists in Thailand. Conventionally, wood and wood based materials were treated to meet desired requirements for specific mechanical properties, in particular high bending strength.

Compreg is a phenol formaldehyde resin impregnated wood-veneer laminate; compressed under high heat and pressure to a high specific gravity, thus the properties of wood and a synthetic resin polymer network are combined. These products normally have mechanical properties [modulus of rupture (MOR), modulus of elasticity (MOE), and modulus of hardness] higher than untreated wood due to their higher specific gravity. Generally, compreg has been used for special purposes, such as concrete shuttering, deck, electrical insulation, fan blades, silent gears and aircraft parts. The final products are more

expensive than normal wood or wood-based panels because of high production costs of the chemicals and the special processing. Dye diffusion exerts a significant influence on dye fixation, ultimate color yield and colorfastness of a dyed fiber. Therefore, dye diffusion should be considered for dye selection and color matching as one of the primary parameters in addition to the nature and chemistry of veneer, chemical structures/functional groups present in wood as well as various bonding types.

Materials & Methodology

A high tonnage hydraulic hot press fitted with platens or specially designed moulding dies with heating and cooling arrangements which exerts a pressure of 100 kg/cm^2 of size 4'x 4', auto clave and pressure impregnation plant was used in this study for the manufacture of compregs.

Dyeing of veneers

Veneers of *poplar* and *birch* of 1.6 mm thick were used in this study. Dyeing of veneers were carried using *poplar/birch* veneers of 1.6 mm thick and water soluble dyes. Veneers were dyed by pressure impregnation method with the facilities available at the institute. Further the dyeing was conducted by 2 methods

i.e., (1) by using 0.3% -0.5% alcohols and

(2) by maintaining pH 4-5

Both the process of dyeing have yielded satisfactory results.

The dyeing process using alcohol upto 0.3 % (v/v) was sufficient to achieve the desired penetration. It has been observed that the dyeing process by maintaining pH requires less percentage of dye than the other process which requires by about 2-3%. The percentage of the dye varies from 0.3-0.5 %. The time given for the penetration depends on the pressure employed. The chamber is pressurized until the veneer absorbs the amount of colour that is desired. At pressures of 1- 1.4 kg/cm^2, the time required for penetration is about 2-3 hours. Lower pressures will result in slower penetration times. When the colour is absorbed, the pressure is released and the veneer is removed. The veneer is then washed with warm water until there is no bleeding/leaching and then air dried. Care should be exercised at pressures in excess to avoid the integrity of the veneers.

Method of Dyeing

The *poplar / birch* veneers to be colored is immersed in a dye bath in a container. Hardwoods have pores which vary in size from about 50 to 300 micrometers and the dye should be selected based on the pore size. The container containing the veneer and dye is then put into steam pressurized chamber. The chamber can be any configuration but for dyeing long strips of veneer a cylindrical or rectangular shape is most practical and is pressurized to 1- 1.4 kg/cm^2. On the lab scale autoclave was used whereas for the plant scale vacuum pressure impregnation plant/pressure vessel has been utilized. Use of the separate container rather than filling the pressure chamber with the dye directly simplifies the cleaning of the containers. After the veneer is dyed, the solution containing the dye can be reused once or twice depending on the colour with additional solvent poplar/birch veneer requires a higher pressure to obtain effective penetration of the dye through the veneer. The chamber is pressurized until the wood absorbs the amount of colour that is desired. At pressures of 1- 1.4 kg/cm^2 the time required for penetration is about 2 to 3 hours. Lower pressures will result in slower penetration times. When the colour is absorbed the pressure is released and the veneer is removed. The veneers taken for dyeing is given in Fig 1.

Fig 1. Veneers taken for dyeing in pressure impregnation plant

Washing of the dyed veneers

Washing of the dyed veneers place important role. The veneers need to be washed until the leaching stops if not washed thoroughly, it would affect in the production of the final product. The veneer is washed for 2-3 times with water until there is no bleeding and then air dried. The resulting veneer is consistent in colour such as yellow, green, blue, red and the penetration of the dye was through and through the veneer. The veneer can be sanded, cut etc without damaging or changing the colour avoiding the need to touch up these areas as in conventional methods which are difficult to get colour matches. A specially

formulated phenol formaldehyde resin of 55% resin solids having plasticizing effect were used as a binding material for making the compregs

The desired resin properties are as given below.

Viscosity: 80 ± 10 m Pa.s at 25°C

Flow time of 24 ± 2 sec, at 25°C when measured in B-4 flow cup of IS: 3944

Water tolerance: 1:12 ± 2.5 at 25°C

Glue spreading onto veneers

The dyed veneers of required thickness are dried to the required moisture content of 6% - 8% by passing it through band dryer. The veneers of 1.6 mm are coated with the glue mix of composition 4% filler added to the specially formulated phenol formaldehyde resin. The resin and the filler are mixed in a glue mixer for about 30 minutes to achieve homogeneity and then spreaded onto veneers. Adequate spread of 350-400 gm/m^2 was achieved. The above adhesive composition was employed in pressure impregnation plant to impregnate the veneers. The resin consumption by pressure impregnation method was found to be around 400 gm/m^2.

It was observed that the resin consumption by both the methods was about 30-35% onto veneers. This may be due to further penetration of resin being blocked by the dyes which would have filled up the pores thereby minimizing the void volume for the penetration of resin. However, the finish of the product made by both the methods were similar in appearance without much changes. The glue coated veneers were given open air drying time of 2 to 3 hr so as to bring down the glue coated veneer moisture content to 6% -8% and then taken for assembly.

Assembly of veneers

The glue coated dyed veneers of 1.6 mm about 53 veneers to achieve a thickness of 50 mm were assembled on aluminium metal cauls as per the choice of colour either 2 layers of same colour veneers were placed followed by 2 of the next colour or 3 veneers of same colour (Fig. 2). Care was taken to assemble the colour patterns in such a way that from the centre veneer of the total assembly the colours would run matching on the subsequent sides below the surface veneers. Lumber construction was adopted. BOPP paper was given on either side of the assembly which acts as a releasing agent.

The assembly was then loaded into the hot press. The pressing details are given in Table 1.

Table 1: Pressing Details

Sl. No.	Particulars	Adopted parameters
1	Pressure	80- 100 kg/cm^2
2	Temperature	140° ± 5°C
3	Pressing Time	Thickness + 10 minutes for curing and 30 minutes for cooling so as to bring down the temperature below 80° C.

The time of cooling designed for industrial hot presses is 15-20 minutes only.

Trimming and Checking

The hot pressed boards are trimmed to required size, in a DD saw. The trimmed boards are graded based on visual defects such as poor bonding, blisters, delamination, resin penetration, starved joints. This product does not require any sanding. The shaping and profiling functions are performed by CNC Router Machines. The CNC Routers used are of 2-axis, 3-axis or even multi axis for profiling of desired shapes, if required, by angular changes/rotation of the desired shape. In one exemplary case for cutting, shaping and profiling compreg slab into a wooden jewelry a 3-axis CNC Router is used alternatively, 3rd axis shaping could be done manually also using hand tools. Manual shaping and profiling is performed by marking the profile and then cutting by hack-saw, filing, sanding, grinding, template profiling, jig-saw and band saw. After obtaining the required shape either by manual process or with CNC routers, the product is then manually grinded on specially designed grinding machines in such a manner that the multicolour layers appear in steps on the

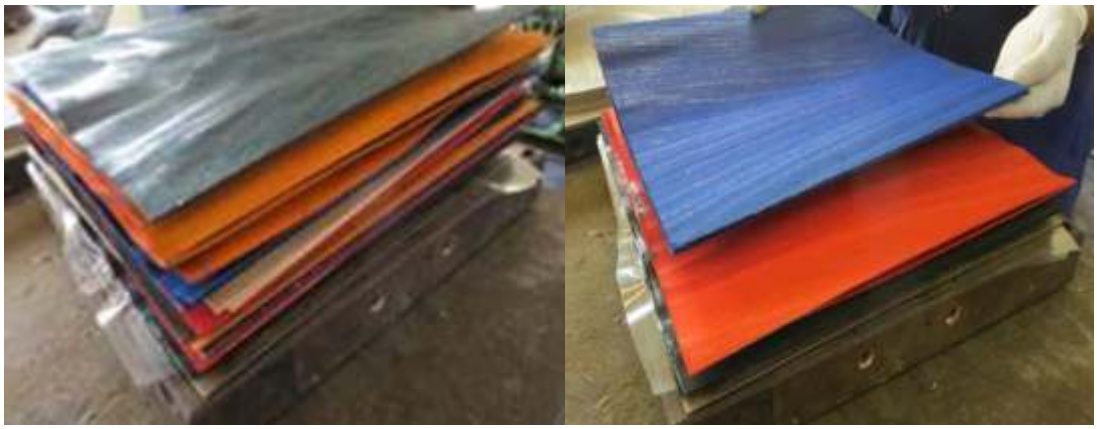

Fig 2. Assembly of coloured veneers

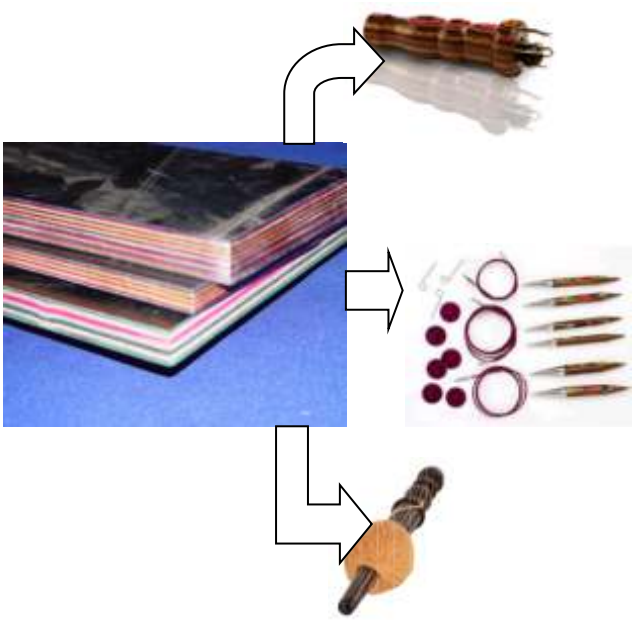

Fig 3. Multi coloured laminated compreg transformed to various utility products

Crochets

Single sided knitting needles

Single colored Knitting needles and Shawl pins

Fig 4. Final products made from compregs of 50 mm thick

compreg slab providing an attractive appearance to the slab. The final multi coloured laminated compreg transformed to various utility products are given Fig. 3.

Results and discussions

The trimmed compregs of 50 mm thick were evaluated for machining properties to make specialty products. It was found that the products could be easily transformed into knitting needles, shawl clips, crochets, knitting dolley, Nostepinne Ball winder that could match up the finish of the similar metal products. The products machined from the compreg by the sponsor are indicated in Fig 4.

Conclusions

From this study, it is concluded that compregs of 50 mm having a density of 0.9 - 1.2 gm/cm^3 can be developed using dyed veneers of poplar/birch species. The machining properties of the compregs made by lumber construction indicated superior machining properties for transforming to various utility products. Workability of compregs having a density of 1 gm/cm^3 were easy than that of higher densities. The production cost of the compregs made using poplar veneers is 75% cheaper than the imported cost of the same product while the compregs made using the imported birch veneers is found to be 55% cheaper.

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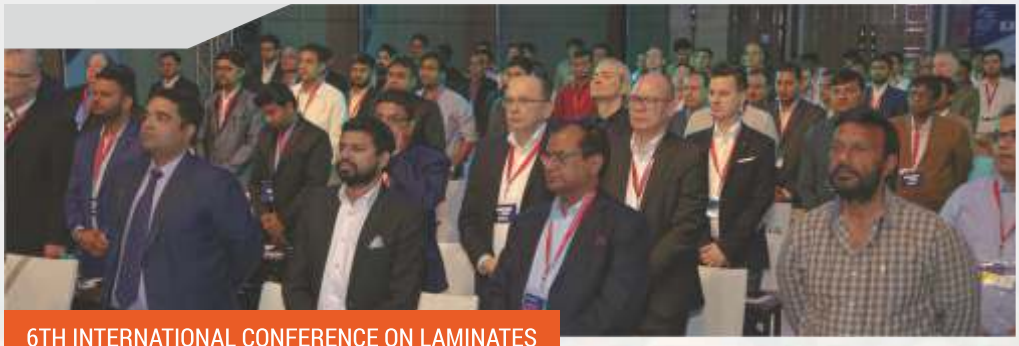

6TH INTERNATIONAL CONFERENCE ON LAMINATES

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)

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Gmelina arborea: A fast-growing timber species for handicraft

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Gmelina arborea (Family: verbenaceae family) is a fast-growing tree frequently planted in private lands to produce wood for light construction, crafts, decorative veneers, pulp, fuel, and charcoal. It is commonly called Gmelina, white beech (English) and white teak. *G. arborea* accounts 0.47% of total timber production of the country. Of lately, *Gmelina arborea* is very popular among the farmers and introduced in several countries, especially in Africa and Latin America due to its easy establishment, quick growth, short rotation, high yield (>35 m^3 per hectare per year, i.e. 500 cu. ft. per acre), consistent wood density, desired pulp quality. It has been successfully. Its vast natural distribution from 8° to 27° N and 72° to 96° E has contributed rich genetical diversity. It is cultivated widely in the agroforestry system for timber, furniture, pulp, fodder, ayurvedic medicines and handicraft. It is widely grown.

General description

Gmelina arborea is a moderate to large deciduous tree with opposite, broadly ovate, acuminate, usually cordate leaves. Bark is light grey, smooth, corky, inside yellow, rapidly turning brown on exposure, exfoliating in patches when old and exposing smooth paler coloured bark beneath. Wood is yellowish or greyish white, even-grained, soft, light, and strong, seasons well without warping and cracking, and is very useful for planking, panelling, carriages, furniture, boxes, and carpentry of all kinds. Under the most favourable conditions it attains a height of 100 ft. or more and a girth of 15 ft. The leaves fall as a rule about January-February, the new leaves appearing in March-April. The panicles of flowers appear from February to April, when the tree is more or less leafless, or with the young leaves, and the irregular tubular corollas, about 1 in. long, dull chestnut, with a yellow lip and throat, quickly fall from the trees and cover the ground in their neighbourhood. The fruits ripen from end of April to July. The fruit is a succulent ovoid or oblong drupe, 0.9-1 -2 in. long, yellow when ripe, with a leathery shining pericarp, a sweetish pulp, and a hard bony stone. The stone is 0.6-0.9 in. long, ovoid, pointed at one end, usually 2-celled and 2-seeded, but sometimes 1- or 3-celled and seeded. About 40 stones average 1 oz. in weight. The trees yield seeds every year. The germinative power of fresh seed is high, but if stored for a year a considerable proportion of the seed loses its vitality. The fruits are eagerly devoured by cattle and deer, and the stones are spread by their agency.

Candidate plus trees of Gmelina arborea in Jharkhand

Site factors

Gmelina arborea is well adaptable to a wide range of soil and climatic conditions. Although, it can tolerate acidic, calcareous and lateritic soil, it prefers moist, fertile sandy loam and well drained soils. It grows well up to altitude of 0 -1200m with mean annual temperature range 38-48°C and mean annual rainfall range 750-4500 mm. It reaches its largest dimensions in the mixed forests of moist regions. It does not thrive where the drainage is poor, while on dry sandy or otherwise poor soil, it remains stunted, and assume a shrubby form due to its frequent drought.

Silvicultural characters

The tree is a light-demander, though it stands rather more shade than the teak. It is moderately frost-hardy, and has good power of recovery when injured by frost. It does not stand excessive drought, especially in dry soil with a considerable proportion of sand, where the trees have in many cases either died outright or have died back and kept alive only in stunted bushy form. It coppices very well, the coppice-shoots growing vigorously. Saplings are readily browsed by deer, which do much damage in young plantations. Cattle also browse young plants, if there is an insufficiency of other fodder. It is good coppice. Although usually found in mixed deciduous forest, it is occasionally found in evergreen forest.

Collection of fruits

In India, the species flowers from February e place by bees and birds. The change fruit color from green to yellow indicates its ripen. The only mature yellowish-green fruits should be collected by shaking branches. Seeds should be

collected twice a week because not all fruits are shed at the same time and further, ground fall fruits often be eaten by game and cattle. Seeds are dispersed with help of monkeys, bats and birds as these attracted by the smell of fruits. Some good provenances are identified in north, central-eastern, and southwest India, and Thailand Malaysia. Faster growing provenances have 2–3% lower wood density than average, corresponding to a weight decrease of approximately 12 kg/m3.

Processing and extraction of seeds

Collected fruits should be transported to the processing site in open baskets or nets within 24 hours to avoid fermentation. At the processing site, the fruits should be sorted into those that are ready for immediate processing (yellow and brown colour) and green and green-yellow fruits. The Khamari fruits should be immediately soaked in running water during the night to loosen the pulp. During the day they are dried in the sun. This is repeated for 1 week. The fleshy cover is then rubbed of the stones by hand. To remove the remaining dry pulp from the stones they are rubbed with sand and water. In case of large scale collection, removal can also be done with sand in a cement mixer. The stones need further washing and then drying in the sun. The seeds have no dormancy, and no pre-treatment is required. However, soaking of the seed in cold water for 24-48 hours before sowing is recommended. One kg of Gmelina seeds contain about 1500-2000 seeds. The size of the seeds varies between the trees. Although seeds can be stored for one year with slight decrease in viability, it is advised to use the fresh seeds. The seeds are stored for about 3 years at 4°C.

Flowers

Mature fruits

Processed seeds

Method of propagation

There are two modes of regeneration such as natural and artificial found in *Gmelina arborea*. Under natural conditions, germination takes place in the rainy season soon after the fall of the fruits. If the fruits are eaten by deer or cattle the stones are rejected during rumination; otherwise, the fleshy portion soon either roots off, or is softened and washed off by rain, or is eaten away by insects, leaving the stone exposed. Considerable amount of alternate heat and moisture enhances its germination.

Gmelina can be propagated by seeds, cuttings, and stumps. The tree can be raised easily either by transplanting from the nursery or by direct sowings. The direct sowings have proved much more successful than the former at Dehra Dun. Seeds are showed directly in the root trainer or raised beds can be 0.6m in height, 1m in within convenient length. The bed should be filled with sand up to height of 0.5 m. The seeds are closely placed the bed in a row with a gap of 5cm. The beds are to be watered twice in a day with the help of rose cane. Seed germination is epigeous, resembling that of the teak. The stone of the drupe opens by means of one or two lateral valves, the radicle emerging first and the cotyledons issuing shortly after. The stone is either left on or in the ground, or is carried up over the cotyledons, falling with their expansion. Often the germination will be more than 100% since more than one seeds will germinate from a stone. The optimal temperature for germination is about 30°C and low temperature will reduce germination. The seedling is fairly hardy as regards drought and frost. Seedlings are somewhat light-demanding. In the germinating stages, crickets are often destructive. Gmelina is also propagated through vegetative means with stem cuttings. Seedlings are ready for planting in the field when they reach a height of 30–45 cm, usually in 6 months. For stump planting, seeds should be sown at the rate of 90 seeds per square meter. Seedlings are usually ready for stump preparation in 7–8 months and should have a root collar diameter of at least 2.5 cm. The stem and roots of seedlings should be pruned back to 5 cm and 20 cm, respectively. But stump planting is not widely practiced due to high mortality.

Plantation and its establishment

Young seedlings in nursery bed

Seedlings for out-planting

Out-planting starts at the onset of the rainy season and the spacing of the plantations depends on the objectives of the plantation and the end-uses. Deep and fertile soils should be selected for planting sites. Gmelina does not do well on ridges and steep slopes where soils are shallow, and infertile. About 6-month old seedlings are planted in a pit (45x45x45 cm) with a basal application of 5 kg of FYM and 70 g of NPK complex fertilizer plus 10 g of borax. The normal spacing is 3 x 3m to 5 x 5m. A spacing of 2 x 2 m is commonly used for plantation programs, and a spacing of 4.5 x 4.5 m is used for agroforestry. Pruning of side branches is usually carried out in every six months. The pruned branches can be used as fire wood. Thinning is another important practice to enhance the production of saw log. The thinning begins at 4-5 years of age for the woods. The alternative trees in the row are to be thinned, to avoid competition between the trees and maximize the growth. Under favorable conditions the growth of the seedlings is rapid, particularly from the second year onward. Because Gmelina is shade-intolerant and sensitive to competition, 3–4 weeding are required during the first two years of growth. Stands on 10-year rotations are thinned to 50% at five years and another 50% at seven years. Rotations for pulpwood and sawn wood are usually 6 and 10 years, respectively. Rotations of 5–10 years are common for fuelwood. The second rotation is usually produced by coppicing. Seedlings and stumps are planted for a third rotation. If site is poor, survival of out-planted seedlings and growth is improved by application of complete fertilizer. Apply the fertilizer in the soil at the rate of 50 gm/seedlings (NPK-16-20-0) to improve diameter, height growth and survival 30 days after out-planting. Fertilizer should be placed in trench about 5 cm deep and 5 cm away from the base of the seedlings and covered with soil. The second application can be done about 90 days after out-planting time.

Agroforestry practices

Young plantation

Two year old sapling

Farmers prefer both the bund and stand plantation depending upon the availability of the land and labor. The bund plantation requires no land specially allocated as seedlings are planted along the bund of the cultivated field. The cost of establishment is lower in case of the bund as compared to the stand. Bund cultivation requires less effort in preparing field and hence requires minimum number of labors. One obvious benefit of the bund plantation to the plants is that they can use the manure and fertilizer applied in the field for the major crops. Spacing varies with objectives of the Plantation. It's a common practice that farmers prefer to have a one meter gap in case of bund plantation whereas in case of block, four different spacing are in practice i.e. 4x4 m, 3x2 m , 2x2 m, 3x3m. When objective is to produce fuel-wood and poles, narrow spacing (2x2m) is preferred to the wider one. For timber production, wider spacing, 4x4 m and 3x3 m and 4.5x 4.5m is preferred for agroforestry. As several crops were found compatible with Gmelina trees such as soybean, yam, cowpea, wheat, maize, mustard, rice, cowpea, groundnut and black gram, etc. Farmers in Tamil Nadu cultivating widely Gmelina arborea in agroforestry system as a commercial practice, of which Gmelina + Ground nut, Gmelina +Water melon, Gmelina +Pulses, Gmelina +Maize, Gmelina +Banana Multi - tier cropping system are successful models in Pudukkottai district, Tamil Nadu. Coconut + Gmelina + Banana + Pepper (pepper trained on the Gmelina trees). The bund plantation of G. arborea is most acceptable to the agrarians in Koraput and Bhawanipatna (Odisha) and Jagdalpur (Chhattisgarh). The net biomass accumulation in Gmelina was assessed in 10-year age old of plantations to be 371.54 tonne ha-1 over 279.89 tonne ha-1 in teak. It is also grown in association with yam or cassava in southern Nigeria. The *G. arborea* + Zea hedgerow agroforestry system is followed in Philippines. The species also used as a shade tree for coffee and cocoa.

Rate of growth and timber yield

The tree attains more than 30 m in height with about 60 cm dbh at maturity. The mean annual girth increment of 1.67 in. and mean annual girth increment of 3-3 in. Coppice growth is also rapid. It is reported that a stool of 14 years old had produced three coppice-shoots 42 ft. high and 3 ft., 2 ft. 3 in., and 1 ft. 8 in. in girth respectively, while dominant sal coppice shoots near it had a maximum height of 36 ft., and averaged 1 ft. 6 in. in girth. The growth of the species is remarkably fast and on good sites can reach 20 m height in 5 years. Form of the tree is fair to

good, with 6–9 m of clear bole. Some trees can reach 3 m after a year from planting and 20 m after 4.5 years. In Nigeria, the yield of Gmelina is 84 m^3 /ha at age 12 in poor sandy soils, 210 m^3 /ha at age 12 in clay or lateritic soils, and 252 m^3 /ha at age 10 in favorable alluvial soils—all volumes are under-bark to 7.5 cm top diameter (Adegbehin et al. 1988). In Sabah, Indonesia, Gmelina produces an average volume of about 25 m^3 /ha/year on clayey loam soils with adequate moisture (Wong and Jones 1986). The rotation period is 4 – 5 and 10-12 years adapted for pulp wood and fire wood and log productions, respectively. Under good management regime each tree yield about 1.5 to 2 tons. The total yield per hector is around 250 – 300 tones / Ha. The wood of G. arborea fetches Rs. 8000/ton in local market.

Pest and diseases

G. arborea is mainly infected by fungal pathogens viz., leaf spot disease is caused by *Colletotrichum gloeosporioides*, vascular necrosis and chlorosis infected by *Pestalosphaeria elacidis* & *Khuskia oryzae*, heart rot and root rot by *Ganoderma spp*, stem and branch canker also infected by *Ceratocystis fimbriata*. There are 10 insect pests viz. *Maladera* sp., *Hyperops coromandelensis*, *Lobotrachelus* sp., *Apion* sp., *Ectropis bhurmitra*, *Belippa lalean*, *Pagyda* sp., *Phromnia marginella*, and *Homeocerus inornatus*, *Megalurothrips peculiaris* are infesting to *G. arborea*.

General features and gross structure of wood

Heartwood not distinct. Wood pale yellow to cream colour or pinkish-buff, when fresh, turning yellowish-brown on exposure: soft to moderately hard, light to moderately heavy, lustrous when fresh, usually straight to irregular or rarely wavy grained and medium coarse texture.

A diffuse porous to semi-ring porous wood. Growth rings distinct to indistinct, when distinct, delimited by large and numerous pores and a fine line of soft tissue. Pores large to moderately large, fairly distinct to the eyes, few to moderately numerous, mostly solitary and in short radial multiples of 2-3, tyloses abundant-vessel line distinct on longitudinal surfaces. Soft tissues predominantly paratracheal, vasicentric forming a light coloured thin sheet round the pores, prominent under the lens and often also as fine line delimiting the growth rings. Rays broad to moderately broad, distinct to the eye, few, rather widely spaced.

Economics and trade

Gmelina logs with sizes 2ft, 3ft and 4 ft can be sold in higher price than sissoo logs of the same sizes. Its market price is exactly similar to the teak. The local level contractors buy the Gamari logs from farmers and sell them either in the local sawmills or in cities in Nepal. The preferred size by the local saw mills runners varies from 2 ft to 5 ft in girth and the price is fixed accordingly. The minimum length fixed for a log is 6ft. If any log smaller than 6 ft, that is not considered suitable for producing the desired size for furniture. Therefore, the rate for such timber will be fixed randomly by the sawmill owners. The biggest size is 8 ft, which is rarely produced and sold. In the last six years, there has been definitely a change in market price of Khamari wood in every size excluding the size 4 ft. The rate of growth in price is higher in smaller size timber than in the bigger ones. Therefore, in long run, producing small size timber is far better from financial point of view.

Uses

The tree has immense potential for its timber and medicinal value. It is a preferred species by farmers, forest departments and ayurvedic industries due to the multipurpose utility, rapid growth, and maximum economic returns. *G. arborea* timber is used in constructions, furniture, carriages, sports, musical instruments, handicrafts and artificial limbs. Once seasoned, it is very resistant to moderately resistant to termites. It is widely employed for the manufacture of drawing boards, plane tables, instrument boxes, thermometer scales and cheaper grade metric scales. It is also used in artificial limbs, carriages and bobbins. It is an approved timber for handles of tennis rackets, frames and reinforcements of carom boards and packing cases and crates. Khamari is used in papermaking and matchwood industry too. Its timber is highly esteemed for door and window panels, joinery and furniture especially for drawers, wardrobes, cupboards, kitchen and camp furniture, and musical instruments because of its lightweight, stability and durability. It is also being used widely in handicraft sector because of its good wood working qualities. The root and bark of *G. arborea* are stomachic, galactagogue laxative and anthelmintic; improve appetite, useful in hallucination, piles, abdominal pains, burning sensations, fevers, 'tridosha' and urinary discharge. Leaf paste is applied to relieve headache and juice is used as wash for ulcers. Flowers are sweet, cooling, bitter, acrid and astringent. They are useful in leprosy and blood diseases.

Dalbergia latifolia Roxb. (Indian Rosewood): Silviculture practice and usage in handicrafts industry

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Dalbergia latifolia Roxb. popularly known as 'Indian Rosewood' is one of the vulnerable and most precious timber species of India. The tree is commonly called 'sitsal', 'beete', 'sisham', 'Bombay blackwood' in India, and 'sonokeling' or 'sonobrits' 'Indian palisandre', 'Java palisandre' in Indonesia. The genus *Dalbergia* consists of around 200 species among which 25 species are found in India. Many species of *Dalbergia* are important timber trees, valued for their decorative and often fragrant wood, rich in aromatic oils (Wealth of India, 1972).

Distribution

It is native to low-elevation tropical monsoon forests of south India. It is drought hardy and grows in both evergreen and deciduous monsoon forests of India. The natural range of *D. latifolia* stretches from the sub-Himalayan tracts to southern tip of India and the island of Java in Indonesia. Its best growth occurs in the Western Ghats forests of Karnataka, Kerala and Tamil Nadu. It is also grown in Kenya, Malaysia, Myanmar, Nepal, Nigeria, Philippines, Sri Lanka and Vietnam. It is grown as a plantation wood in both India and Java.

Ecology

The annual rainfall in *D. latifolia*'s native habitat ranges from 750-5000 mm. As a seedling *D. latifolia* is shade tolerant but sensitive to drought and fire. In maturity it is tolerant of drought and ground fire, but susceptible to crown fire. It is classified as a moderate light demander (Troup, 1921). It survives maximum temperature of 37°C -50°C, minimum temperature of 15°C - 0°C, relative humidity of 40-100 percent. It cannot withstand frost. *D. latifolia*'s occurs from the low plains to roughly 1500m. It grows on variety of soil formation such as laterite, alluvial and bolder. It grows best on moist soil and grows well on black cotton soil. It normally appears in areas with annual rainfall of 750 to 5000 mm along with it mean annual temperature range of 8 to 44^0 C. *D. latifolia* is an important flagship species, considered as an important indicator of forest health. It commonly grows with *Tectona grandis*, *Terminalia* sp, *Anogeissus latifolia*, *Cassia fistula*, *Albizia chinensis* and bamboos.

Morphology

Dalbergia latifolia is a deciduous tree, predominantly a single stemmed, with a dome shaped crown of lush green foliage; tree grows up to a height of 40 m and girth up to 2 m. Being a Leguminosae member, it fixes atmospheric nitrogen' into the soil. It has a thin bark, grey in colour that peels in long fibre with irregular short cracks. Leaves of *D. latifolia* are 10-30 cm long, compound with 5-7 unequal sized leaflets; flowers are small, white and generally 5-20 cm long. Fruits are brown pod up to 15 cm long and 1.5-2.5 cm wide along with pointed ends (Fig. 1).

Fig. 1 A-F Dalbergia latifolia; (A) Habit, (B) Inflorescence, (C) Branch with pods, (D) Bark, (E) Natural regenerating seedling and (F) Mature pods and *seeds.*

Phenology

New leaves appear in April-May and Flowering begins by December and normally continues to March or rarely October, fruiting in February-April.

Threat factors and Conservation status

There exists an internationally high demand and price for the wood due to its excellent qualities of having a long straight bole, its strength and its high density. Rapidly increasing demand for rosewood across the world especially in China, has led to increased and illegal exploitation in many producer countries in Asia and Africa (Treanor, 2015). Due to illegal exploitation of *Dalbergia* sp. in other parts of the world like Cambodia, Vietnam etc. mainly for the 'Hongmu' trade, Convention on International Trade of Endangered Species (CITES) of Wild Fauna and Flora decided to list the whole *Dalbergia* sp., under Appendices II during the 17th conference of the parties meet that held in Johansburg, South Africa 24th September 2016 onwards to regulate over-exploitation of the species. *Dalbergia latifolia* was listed in CITES Appendix II on 2nd January 2017 (CITES, 2017). It is a matter of great concern that due to over-exploitation, illicit felling, reproductive constraints and adverse field conditions, its population has been fast dwindling and the species is categorized as "vulnerable" by IUCN [IUCN 2017.2; The IUCN Red List of Threatened Species," https://www.iucnredlist.org/, 2018].

India being a major supplier of *D. latifolia* mainly for the musical instrument industry worldwide, does have the Forest management in place and also necessary working plans are being followed in order to ensure the sustainability and legal trade of this rosewood species throughout India. The major part of the supply for the species *D. latifolia* is from Karnataka amounting to more than 50% of the total supply in India whereas, another important source for rosewood is Kerala smaller traces can be found in Tamil Nadu, Gujarat and Madhya Pradesh. Due to slow growing nature and consequent difficulty in realizing the economic returns within a reasonable period and restriction imposed by the Government for felling and utilization of the timber, the cultivation of Indian Rosewood has not gained momentum among the tree growers in India. Due to difficulty encountered by the species in its early phase of establishment in the field, it was not a preferred species for afforestation.

Silviculture techniques

Seed collection and storage

The best time for seed collection is February-March. Ripe fruits are available from October to April depending on locality. The fruits remain on the trees until the onset of the rainy season. When the pods turn dark brown they are collected from the trees by lopping the branches. The pods are usually stored in gunny bags until they are required. The seeds will lose their viability appreciably when stored for one year or more. Seeds remain viable for six months when stored in gunny bags or earthern pots and they lose their viability after one year. Seeds insufficiently dried before storage usually lose viability in relatively short time. No pretreatment of seed is generally carried out in practice. The unit for sowing is a pod segment with one seed.

Nursery Techniques

Fresh seed normally germinates 50-75% in 1-2 weeks. The seeds are sown in containers i.e. polythene bags and root trainers. Seeded sections of pods are sown either in containers or germination beds. Seedlings from germination beds are pricked out at stage of 2-3 pairs of leaves and transplanted in the containers. Only one seedling is allowed to grow per container. Alternatively, seeds are sown in raised nursery beds having porous sandy loam in drills, 22.5 cm apart or in longitudinal lines about 45 cm apart, accordingly as the planting is to be done in the first or second rains. About 3 months after sowing the seedlings are ready for planting in the field. The seedlings have a long taproot and thorough root pruning is necessary. To ensure a good survival, the stumps are planted out during the rainy season. Stump planting is regarded as the best method of raising *D. latifolia* (Sukhadiya et al., 2020). Regular weeding is essentially done for successful establishment and until the trees are tall enough to compete. In the early stages, loosening of the soil around the plant will improve growth of the plant. Weeding and soil loosening are done before weeds become dense.

Uses

Timber

Indian rosewood ranks among the finest woods for furniture and cabinet work. It is fragrant, decorative and is used to make premium grade furniture, paneling and veneers and interior as well as exterior joinery. Secondary uses of the wood include knife handles, musical instruments, agricultural implements, calicoprinting blocks, mathematical instruments and boat keels as well as screws (Orwa et al., 2009).

Handicrafts

In this skilled labours are employed to carve wood to create items with bare minimum tool such as garden decorative, wooden toys and games, wooden decorative etc. There are huge number of handicrafts made out of rosewood such as, dining chairs, dining table, spring basket, collapsible basket, flower vases, carving jewellery

box, captain box, Tissue box, Key chains, Photo frames, tea mats, tea coaster, wall clocks, lamps, candle holder, window and doors, mirror frames, jharokhas, dry fruit tray, serving tray, cots (Fig. 2).

Ethnomedicinal uses

Fig. 2 A-F Dalbergia latifolia woodcrafts, (A) Part of the timber log carved to show the colorful heart wood, (B) Cross section of wood log showing annual rings, (C) Elephant miniature made up of rosewood, (D) Rosewood in different shades, (E) Guitar made up of rosewood and (F) Rosewood Mantapam.

The constituents of this plant have a tremendous impact on the health care system and provide medical health benefits including the prevention and or treatment of diseases. Medicines made from the bark tannins are used against diarrhoea, worms, indigestion, leprosy and as appetizer (Kirtikar and Basu, 2005; Rao Konda et al., 2013). The bark is used for ethno-veterinary medicine for treating body pain, dyspepsia, diarrhea etc. (Selvaraju et al., 2011). Further, its leaves are used locally as a medicine for treating joint-pain, inflamation in mouth and throat (Jain et al., 2005; Padal et al., 2010). Traditionally various species *Dalbergia* are used as remedy for burning sensation, skin diseases, ulcers, diseases of the blood, aphrodisiac, abortifacient, expectorant, anthelmintic, antipyretic, allays thirst, syphilis, stomach troubles, leprosy, leucoderma, scabies and ringworm (Parrotta, 2001).

Shade tree

D. latifolia is used as a shade tree in agroforestry in India and Indonesia, in coffee plantation, for afforestation of eroded soils

Fodder

The nitrogen rich foliage is locally an important source of fodder for livestock animals. This will helps to overcome the fodder shortage particularly in rural areas during lean periods

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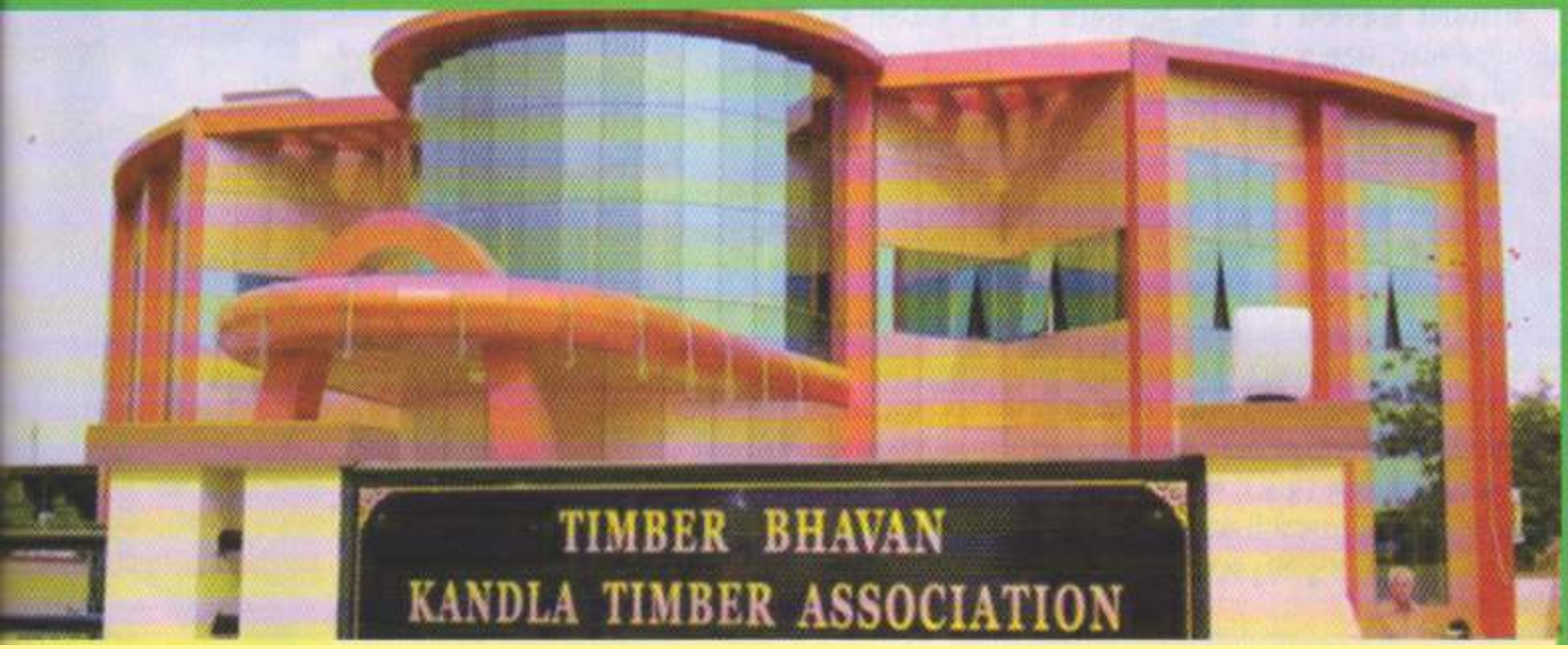

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Ivory wood (*Wrightia tinctoria*): Natural choice for Channapatna toys

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The "Ivory wood" tree (*Wrightia tinctoria*) is one of the multipurpose trees (MPT) used for different purposes viz., wood, fodder, fuel, medicine, dye and fibre. As the wood turns to ivory colour with age, it is called "Ivory wood". Its wood used for making world famous Channapatna toys. It belongs to the tribe Nerieae of the sub family Apocynoideae). It is one of the beautiful avenue trees in Mysuru, which attracts passersby during summer months with its handsome blooms of white, star-shaped vanilla scented showy flowers. Other common names are 'Sweet Indrajao', 'Pala', 'Dyer's Oleander' or 'Dyer's Indigo'. Vernacular names are — Kannada: Beppale, Alemara, Kodesige, Ajamara, Kodamurki; Tamil: Vetpalai, Irumpalai; Telugu: Repala, Tedlapala, Jediapala; Malayalam: Mayilampaala, Nettampala; Hindi: Dudhi, Indrajau; Sanskrit: Krishna Katuja. The scientific name is *Wrightia tinctoria*, belonging to the family Apocyanaeceae. The generic name 'Wrightia' is in honour of William Wright, the 19th Century Scottish Physician and Botanist. The specific name "tinctoria" refers to "tinct" in Latin meaning "dyed, tinged". Ivory wood is a boon for the toy makers as it grows well in dry regions, needs little inputs and is locally available as a common agroforestry species. Though, it is exclusively used for the craft, it produces many other minor uses such as firewood, leaves for green manuring and mulching and bark and leaves for treating skin and stomach ailments.

Distribution

The Ivory wood" tree is widely distributed in Asia, Africa and Australia and are known to be the native of South East Asia. The plant mostly occurs in the Western, Central and Peninsular India. The plant grows well in arid, semi-arid and moist regions with a wide range of soil types. This plant is especially common along hillsides and valleys and is often found as undergrowth in deciduous forests. It grows up to 1200m elevation.

General description

The Ivory wood" tree is a small, deciduous tree, sometimes looks like an evergreen shrub generally up to 1.8m tall and often under 60 cm in girth with milky latex, scaly, smooth and ivory colored bark, sometimes up to 7.5 m high distributed in Rajasthan, Madhya Pradesh and Peninsular India. Tree bole cylindrical, straight, occasionally crooked, up to 60 cm in diameter, not buttressed but often fluted at base; bark surface fissured longitudinally, pale grey to yellowish-brown, inner bark granular or fibrous, yellow, exuding milky latex; branch lets glabrous or puberulous, with elliptical, white or greyish lenticels. Leaves are about 8 -15 cm, opposite, variable, elliptic lanceolate or oblong lanceolate. Leaves are acute or rounded at the base, acuminate at the apex, petioles 5 mm long stout, glabrous with lamina of 3.5-11 x2-4 cm. Flowers are scattered inflorescence, usually seen at the tip of branches with 6 cm long terminal cymes, and they are bisexual, follicles in pairs pendulous white with fragrance. Calyx and corolla with 5 lobes. Anthers are

Fig 1. Wrightia tinctoria young tree, flower and leaves

sagitate, ovary bilocular and stigma bifid. Flowering and fruiting occur between March to November.

Fruits are long follicles in pairs cylindric, pendulous, up to 50 cm with adhered tips. Seeds are linear with basal coma, 1-2 cm long, pointed at the apex. The seeds are released as fruit dehisces. The pods of *W. tinctoria* are 20-30 cm long paired follicles joined at their tips, they are cylindrical, and pendulous with a greenish color turning straw-yellow when ripe. The hairy seeds are released as the fruit dehisces. Fruits are to be collected in January-April when the pods are split open releasing the seeds, greenish in color, slowly getting changed to yellowish and usually this stage is during the months of January-February. The seeds are 1 cm to 1.6 cm long, linear, light yellowish grey in color with white silky hairs on the top which assists in wind dispersal and scaly smooth bark.

Fig2. Pods and seeds of Wrightia tinctoria

Silvicultural characters

The tree is moderate light demander, and is often found as under growth species in deciduous forest. It requires mixture of peat, loam and sand, and is propagated by seeds and cuttings. It produces root suckers, and growth is slow to moderate, the annual increase in the girth being 1.16 to 2.3 cm. The height growth of the seedlings was very poor during the initial 30 months after out-planting in the field. Though a promising species for rehabilitation of degraded sites, it seems to be more suitable for drier tracts with low rainfall. Also, its survival and growth are not good in high water table during the initial stages. Trees are good coppice. Insects pollinate the flowers and wind disperses the seeds, both factors bolstering the natural growth of the species.

Nursery and seedlings production

Mature pods are collected and sun dried for 3-7 days in cloth bags and the seeds separated and winnowed. About 32250 seeds weigh one kilogram. Freshly collected and winnowed seeds are broadcasted on raised sand beds of (10m x 1.2 m x 30 cm size). Seeds are thinly covered with fine soil and watering is done twice in a day. The seed germination will take place after seven days and was completed in about 21 days. Germination percentage without any pre-treatment was 85-90% and the initial growth of the seedlings is slow to moderate. At 2-leaf stage, the seedlings are transferred into polythene bags filled with potting media (red soil, sand and FYM, 1:1:1). The seedlings attained only about 22-28 cm tall, even after 14 months period in the nursery.

Wood and its properties

The wood is uniformly white when first exposed turning ivory-colored with age. Heartwood is whitish to pale yellow, not distinctly demarcated from the sapwood. Grain is straight or shallowly interlocked. The wood is rather lustrous, with smooth feel, straight or somewhat wavy or curly grained in the radial plane, very fine and even – textured, extremely close grained, moderately hard and light. Growth rings are absent or indistinct and then marked by differences in fiber diameter and wall thickness. It is not difficult wood to season. It is easy to saw and work either by hand or on machine, turns beautifully and finishes to a surface which requires little sanding. Vessels are diffuse, usually 17-25(-28)/mm^2, solitary and predominantly in radial multiples of 2-5(-8), 70-90(-100)μm in tangential diameter; perforations simple; inter-vessel pits alternate, vestured, fine, c. 3μm in diameter; vessel-ray and vessel-parenchyma pits almost similar to inter-vessel pits but half-bordered; tyloses absent. Fibres are 0.9-1.4 mm long, non-septate, ranging from very thin-walled to thick-walled, walls usually c. 3 μm thick, with slit-like pits with minute borders and more numerous in the radial than in the tangential walls. Parenchyma is apotracheal, diffuse-in-aggregates, abundant, mostly in 8-celled strands. Rays are 12-18/mm, 1-2(-3)-seriate, 450-2000(-2800) μm high, markedly heterocellular with more than 4 rows of upright marginal cells and multiseriate portions almost as narrow as the much taller-celled uniseriate ones. Crystals are prismatic, elongated and styloid, in chambered cells, up to 30 in radial chains, in upright and procumbent ray cells. Latex tubes are absent.

Fig 3. Ivory logs for toys making

Pest and diseases

Many fungal diseases and pests are cause damage to the tree. The *Cercospora wrightiae* is found on the leavesin Bangalore and Bhopal. *Hemileia wrightiae* infects the tree in many parts of Tamil Nadu. A beetle *Xylorrhiza adustaattracts* the trees producing rings on the stem and branches. The green bug of coffee (*Coccus viridis*, green) also feeds on this plant. Immature stages of *Lygropiao brinusalis* larva defoliating tree in Shimla, Punjab and the Nilgiris. It acts as a host to the lac insects, *Laccifer communis*. The tree is parasitized by *Dendrophthoe falcate*, and *Viscum monoicum* and *V. oraentale*.

Uses of wood

As the wood is easy to saw, finishes well with little polishing, it widely used in handicraft sector for many centuries. It is extensively used for all classes of tennary and handicrafts. It is used making beautiful wooden cups, plates, combs, chessmen, pen- holders, cheap-grade pencils and bedstead- legs. It is also commonly used for carving, frames, spoons with carved handles, small boxes, combs and screens and also, wooden idols. The wood is suitable for match boxes and splints, and for making bobbins, engraving and printing blocks and various types of mathematical instruments and rulers. It is also suitable for stained wood inlay work. It is most preferred wood for making GI tagged celebrated "Channapatna toys" in Karnataka. Channapatna lacquerware toy-making, an age-old traditional craft, provides livelihood to around 4,000 artisans, mostly women and belonging to

Fig 4. Toys made up of ivory wood at Channapatna

marginalized communities. The craft industry wholly depends on ivory wood (*Wrightia tinctoria*) or hale mara in Kannada.

Medicinal uses

The juice extracted from fresh unripe fruits is used for coagulating milk. The seeds are reported to have aphrodisiac and *anti-helminthic* properties. The oil emulsion of the pods, "777 Oil," is used to treat psoriasis. The leaves are lopped as livestock fodder. The pods contain floss, which is used for stuffing cushions. The cream-colored latex derived has a rubber content varying from 2 to 28% that can be exploited commercially. District of Maharashtra state of India, infusion of bark is administered to mothers for a week to increase lactation. People inhabiting in Seshachalam hills of Andhra Pradesh, India apply a paste of crushed stem bark along with bark of *Ailanthus excelsa* on wounds once in a day for 3 days. In tribal villages of Chitheri Hills of Dharmapuri district in Tamil Nadu, the bark decoction is given to cure piles, whereas bark and seeds are used together to treat various ailments. A crushed fresh leaf when filled in the cavity of decayed tooth relieves toothache. The native practitioners in and around Chittoor district, India, have claimed that the leaves of *W. tinctoria* are used for treating diabetes. Tribes of Southern Rajasthan use the latex of plant externally on vagina for easy delivery. These claims of medicinal properties are to be substantiated by clinical trials in humans. The flowers, tender leaves, pods, fruits and seeds of the species are used as vegetables. The bark is commonly used as an adulterant of the well-known drug conessi, tellicherry or kurchi bark, which is obtained from *Holarrhena antidysenterica*. The bark possesses proteolysis activity. The bark is used as an anti-dysenteric, especially useful in piles, to treat skin diseases and biliousness in AYUSH. The dried and ground bark is rubbed over the body in dropsy. The seeds are useful as anthelmintic, antidiarrhoeal, antidysenteric, astringent, febrifuge, seminal weakness and as an aphrodisiac. The seeds also possess aphrodisiac and anthelmintic properties. The leaves decoction is used, as febrifuge, in toothache, stomachic and tonic in bowel complaints. The fresh leaves are very pungent and are chewed for relief from tooth ache. Alcoholic and aqueous extracts of the leaves and roots possess hypotensive properties. The leaves are the source of a blue dye, indigo, called Mysore-Pala Indigo. The leaves are also used as wrappers of Bidis. The flowers are slightly bitter and require thorough washing before use. The handsome clusters of white, jasmine-scented, star shaped flowers are much esteemed by Hindus for temple offerings.

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Can We Manage Our Forests Differently?

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Our relationship with forests is complex. Apart from food, fiber, fuel and timber etc. many across the world, depend on forests for their livelihoods. Being a rich repository of biodiversity, conservation of forests plays an important role in soil and water conservation, hydrological cycle, nutrient cycle, pollination, pest and disease control as well as cultural services. Though we depend on forests for many of our needs as well as ecosystem services, contribution of ecosystem services has always been undermined and undervalued. There are at times a conflict regarding the way forests need to be managed for its productive as well as ecosystem services. Independent India's National Forest Policy have tried to address these conflicts since 1950s and has been a guiding document for planning and management of forests and forest resources.

However, such dilemmas and conflicts are not limited to India. Countries like China have tried to address this issue by adopting to a phased manner on policy planning. Prior to 1980, China did not have clear planned priorities—similar to what India follows today. During the era of economic development, China clearly divided the forest areas into different functional entities. It dedicated large parts of its forests for commercial use apart from clearly demarcating critical areas to be reserved for conservation purposes. Under the plan, if a forest area had a critical role in terms of conservation as well as providing ecosystem services, it was put to conservation and protection, however, rest of the forest area could be used for maximum productive value. Forests were properly marked and segregated depending on their environmental and commercial value. There was a country level clarity on what needs to be done in each of the forest area and type of forests. Most of the countries, except India, went through the similar process, though the extent of areas earmarked for conservation and production as well as intensity of management for the same, varied from country to country.

Similar was the case in Malaysia in its province of Sabah and it is relevant to detail this case as it may provide valuable insights to policy makers and forestry professionals, regarding what a clarity of purpose and priority can achieve for a forest area in terms of conservation and commercial production, combining both, and without harming either of the objectives. It is sensible, that an agency which is responsible for commercial production in the forests should also be entrusted with responsibility to conserve the critical areas of the said forests, because such conservation efforts in terms of water, soil, ecosystem system services, not only helps local communities and biodiversity but it also helps in sustained commercial production of earmarked areas. A close examination of different collaborative forest management systems shows that to succeed, in most of the cases, such systems need to be backed by clearly written, accountability driven and independent monitoring. At least this has been the case in Sabah, where ~0.3 million ha (or 3000 km2) of forests was leased to Sabah Forest Industries (SFI) the largest manufacturer of integrated pulp and paper in Malaysia in 1990s for 99 years. SFI has been a private entity with a certain share (less than 5%) share of Government of Malaysia.

The key features of SFI collaborative arrangement in 0.3 million ha of forests, was allocation of almost ~0.1 million ha of forests for commercial production of pulpwood of acacia and eucalyptus species which could sustainably produce ~2.5 million MT of wood per annum, and also making SFI responsible to conserve balance ~0.2 million ha of high value forests for ecosystem services, out of the revenue that it generates from its commercial business. Each of the activity and accountability were clearly indicated in Management Plan, drawn jointly by Sabah Forest Department and SFI. Few key features of collaborative working arrangement have been:

- Acacia / eucalypts plantation of 7-year rotation, each year 12.5k ha plantation
- 99 years lease from Sabah Forest Department (SFD) to Sabah Forest Industries
- Industry bearing all plantation and conservation costs
- Wood owned by industry with royalty to SFD (~INR100/MT)
- 10 years' basis sustainable management plan
- Regulatory functions with Forest Department
- Plan implementation monitored annually by third party/certification agency with appropriate financial penalty
- Annual generation of 5 million man days and 2.5 million cum wood

Above model could show that a collaborative working by the Sabah Forest Department (SFD) and SFI could ensure

Acacia Plantation-SFI

Clonal Multiplication Area-SFI

sustainable management of ~3000 km of forests with required production and conservation objectives, with presence of a skeleton staff from SFD and without much investment required from the Government. Also it provides substantial revenue to the Government in terms of royalty of wood produced for commercial use. It creates millions of man days of employment in remote areas. Engagement of an independent professional monitoring agency and drawing up an objective and accountability driven management plan is critical in sustainable working of the collaborative model.

Such collaborative models could ensure sustainable management, conservation and enhanced productivity of forests with proper planning. These models are not only environmentally feasible but also ensure employment and economic development, by adding revenue to government exchequer. Many countries went through similar process of demarcating the conservation and commercial area of forests, but not India.

India has more than 70 million ha under forests but produces only ~3 million MT of commercial wood. Apart from this, India has an import substitution potential of more than INR 50,000 cr. per annum in terms of wood and wood-based products. What India produces out of ~70 million ha of forests, is equivalent to what can be produced out of just 0.4 million ha of forests, if appropriate public-private partnerships with user industries like SFI can be implemented in India. India has vast scope of learning relevant details from such cases, which can give insights to both policy makers and forest professionals.

By adapting to innovative and collaborative models, India can not only enlarge its wood production capacity, but can also reduce import substitution and can substantially reduce pressure on forests earmarked for conservation. In most cases, forest management systems do not fail because of lack of intent or imagination, but due to vague and unfocused policies, plans, accountability and monitoring systems. If the policy gaps are addressed, and the priorities and objectives properly defined, India can soon achieve its long-term goal of wood self-sufficiency, import substitution, forest conservation, with increased employment and livelihood opportunities.

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