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KERALA AGRICULTURAL UNIVERSITY

DIRECTORATE OF RESEARCH

Main Campus, Vellanikkara
KAU (P.O.) - 680 656, Thrissur - Kerala

No. R5/60051/16 **Dated: 29.12.2015**

GI APPLICATION No. 543

From

The Director of Research

To

The Registrar of Geographical Indications
Geographical Indication Registry
Intellectual Property Office Building
GST Road, Guindy, Chennai 6000 032, Tamil Nadu.

Sir,

Sub: KAU - DoR – GI Registration of Nilambur Teak - reg.

Ref: Arising.

***

Kerala Agricultural University (KAU) is supporting farmers and producers for registering unique products as Geographical Indications. I am hereby submitting the application for GI Registration of Nilambur Teak along with supporting/legal documents and DD (application fee) for favour of further necessary action at your end. KAU is the facilitator for this application and has provided all necessary legal and financial support for the producers in this venture.

Yours faithfully

Director of Research

Copy of documents enclosed:

1. Form GI – 1 A in triplicate
2. Statement of case in triplicate
3. DD for Rs.5,000/- DD No. 328871 dated 21.12.2015.
4. Affidavit in Rs. 20/- stamp paper
5. Geographical Map of the Area in triplicate
6. Logo of the Product
7. Copies of documents to support proof of origin
8. Additional representation of GI (5 copies).
9. List of members of the society as on 23.12.2015.
10. Registration certificate – copy
11. Bye-law of the society.

GOVT. OF INDIA
Geographical Indications Registry
18 JAN 2016
DY No. 663
CHENNAI.

GI APPLICATION No.
543

स्टेट बैंक ऑफ़ त्रावणकोर
State Bank of Travancore

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DEMAND DRAFT

Key: YEKKOS
Sr. No: 59765

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मांगे जानेपर REGISTRAR OF GEOGRAPHICAL INDICATIONS CHENNAI********** या उनके आदेश प

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अहर्ता शाखा / DRAWEE BRANCH:SBT-CHENNAI MAIN
कोड क्र . /CODE No: 70002

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शाखा प्रबंधक BRANCH MANAGER

₹ 50,000/- एवं अधिक के लिखित दो अधिकारियों द्वारा हस्ताक्षरित होने पर ही वैध है
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GI APPLICATION No.
543

Received Rs. 5000 in cash/ Cheque/DD/MO on 18.1.2016 vide entry no. 2822 in the register of valuables
Cashier
D.D.O
H.O

FORM GI-1(A)

Application for the Registration of a Geographical Indication in Part A of the Register, Section II (1), Rule 23(2)

1. a)	**Name of the applicant/applicants**	:	Nilambur Teak Heritage Society.
b)	**Address**	:	Nilambur Teak Heritage Society, Post Box No. 18, VIP Colony, Veliyamthode, Chandakkunnu Post, Malappuram District, Kerala India, 679329
	Facilitator	:	Kerala Agricultural University.
	Address		Kerala Agricultural University KAU P.O., Thrissur, Kerala 680656 Ph : 91-487-2438011 Fax: 91-487-2370019
c)	**List of Association of Persons /Producers**	:	Provided in a separate sheet
d)	**Type of goods**	:	Nilambur Teak falling in Class 31

e) Specification:

Teak (*Tectona grandis* Linn.f.) is the most important hard wood species of the world (FAO, 2013). Teak wood is highly priced by the wood industry due to its superior mechanical and physical properties, as well as its pleasing aesthetic appearance (Sanwo, 1987; Kjaer *et al.*, 1999). It occurs naturally in India, Myanmar,Thailand and Laos. Natural teak forests are estimated to cover 29.035 million ha in India. Nilambur in Malappuram district of Kerala is the source of quality teak in Kerala and hence is often christened as 'Mecca of Teak'. Nilambur forms the eastern sector of Malapppuram district in Kerala state and includes the ranges and spurs of Western Ghats. Nilambur teak wood is obtained from the forest areas, teak plantations, homesteads in Nilambur Taluk and Edavanna panchayath of Ernad Taluk of Malappuram district, Kerala, India. The undulating mid-lands on the West, Nilgiris in the East, Silent Valley National Park of Palakkad District on the South and Wayanad forests on the North, border the Nilambur Taluk. Teak

is the major plantation species in Nilambur. Among the timbers of India, teak has the realm of supreme quality and in olden days and historically, Nilambur was the major source of quality teak known as "Malabar teak" in trade as Nilambur was a part of then Malabar district. Currently, the forests and plantations in Nilambur are the major source of quality teak in India. Additionally, the homesteads and farmlands in Nilambur also supply substantial quantity of quality teakwood particularly to the domestic local market. Total teak forest area in Nilambur South and Nilambur North is approximately 8760.37 ha (www.forest.kerala.gov.in/images/pdf/fs2013), representing 10% of all teak plantations in Kerala. Plenty of standing stock of quality teak can be seen in the home gardens in Nilambur. It is estimated that home gardens contribute 33% of the total teak wood supply in Kerala (Krishnankutty, 2005).

History:

Nilambur teak has a long history and it began with Zamorin of Calicut who gifted the teak forests of Nilambur to local property owners of Nilambur. With the arrival of the British in the west coast and subsequent colonization and industrialization, Nilambur in Malabar Coast became the major source of teak wood required for the construction of navy and mercantile vessels of Britain. After identifying the forests and the teak in India, Britain was interested in administering forests in India especially in Malabar region. British domination gifted a new era to the history of teak forests of Malabar and this made India to integrate with international trade network even when it was administered by the West.

The wood resources from Kerala were a major attraction for the British colonial forces, primarily on account of their superior qualities and vast export potential. Kozhikode (formerly Calicut), the most important city of Malabar, enjoyed a prominent place in the international wood trade in the subcontinent. The British administered and managed the Indian forests predominantly for the requirements of the military particularly its navy. British used teak as an admirable substitute for the oak that they were using in navy and mercantile marines. In 1796, Mr. Machnochie of the medical services established a timber syndicate in Malabar with a perpetual aim of steady supply of first class timber, mainly teak, for the British Navy. The village Kallai in Kozhikode along the bank of Kallai river was once the 'hub of timber market' in south Asia which dictated the international timber prices for several decades. The first organized wood processing (saw milling) unit in Kerala was set up at Kallai in 1893 by A. Brown (Muraleedharan and Bhat, 1989). The primary reason for the glorious legacy of Kozhikode (Kallai) was attributed to the luxuriant supply of quality teak from Nilambur. The demand for specific wood products such as long teakwood planks for the manufacture and repair of large country boats (used in royal navy) was a major international wood trade sector. International wood trade was mainly focused on quality saw logs for ship building and furniture making. The Nilambur region is traversed by a major river, the Chaliyar, which flows westward and drains

into the Arabian Sea at Beypore, near to Calicut. The Chaliyar River and its tributaries played a prominent role in spreading the glory of Nilambur teak by providing cheaper mode of transporting Nilambur teak through rafts. Lengthy teak wood planks of size 35' to 40' were easily transported from the Nilambur forests in huge rafts through the Chaliyar River. Also, the major source of wood for railway sleeper making in southern India was delivered through Kallai.

· Different agencies opened outlets for the supply of teak to the Britain Navy and they plundered the natural forest resources of India including teak from Nilambur. The teak forests of Malabar were highly affected by this supply. The massive destruction of Nilambur forests led to the evolution of the concept of conservation of teak forests in the Malabar region. An order was issued in 1792 by the Bengal Bombay Joint Commission, prohibiting the felling of teak below 21 inches of girth in Malabar forests (Negi S.S, 1994).

Mr. Sheffield, who came to India, as the Principal Collector of Malabar in 1828 was highly disturbed at the wanton destruction of teak forests in Nilambur and brought it to the attention of the then government and suggested a total ban on felling of teak trees. However, the proposal did not materialize. Having realized the value of teak and to have a steady supply of good quality teak for British, Mr. H. V. Conolly, the then Collector of Malabar, in 1842 initiated action to plant teak in Nilambur area that resulted in the world famous teak plantations of Nilambur. Planting of teak as plantation at Nilambur was the earliest stone in the foundation of systematic forest management in India. On the basis of a letter from Conolly in 1842, in the forest lying to the west of Nilambur, 30000 teak seeds were sown and 10000 seedlings picked out from the natural forest were planted out. In 1844, Sri. Chathu Menon was appointed as Sub- Conservator and under the orders of Conolly, Sri. Chathu Menon, after a hard and pioneering struggle, raised the first 1500 acres of the Nilambur plantation in 1846 on the northern bank of Chaliyar River (KFRI, 1991). A part of this plantation is still maintained at Nilambur as "Connolly's Plot". This is one of the oldest surviving man made teak plantation of the world and even now has some of the trees planted by above two pioneers. Between 1844 and 1862, about 1512.71 acres of land were raised with teak. The Connolly's plot was declared as permanent preservation plot in 1943.This is one of the most famous forestry plots in the world where foresters from all over the world have come and continue to come to pay homage to H.V.Conolly and Chathu Menon. The Conolly's plot occupies an area of 2.31 hectares. Nilambur teak acquired worldwide reputation due to its superior qualities. Sail boats and small ships (Dhow or 'Uru' as it is called locally) made out of teak wood from Nilambur were built at Beypore in Calicut district and the yacht industry still prefers the beautifully figured and very durable teak wood from Nilambur. Even now 'Uru' making is a promising industry in Beypore and Chaliyam in Calicut. Most of the well-known palaces and other historical monuments in Kerala have immense wood work of teak from Nilambur. The Kerala Legislative Assembly

hall and the building contain considerable quantities of wooden furnitures and fixtures out of Nilambur teak. It is reported that the 108 year old British Brand (Rolls Royce) is sourcing teak wood from Malabar for its Ghost series. The report also told that the response to the Malabar wood interiors in the Rolls-Royce Ghost model has been very good both in India and internationally (Source: The times of India, Feb 2012).

Specific qualities:

Teak varies greatly from locality to locality in timber characteristics such as colour, grain, texture and figure (Bedell, 1989). The heartwood of teak is extremely resistant to attack of insects and fungi. The superiority of teak from Nilambur and surrounding regions for ship building and structural purpose are due to the large size and form of the tree, the color and workability of the wood and its ability to withstand weathering. Nilambur teak has unique qualities such as world renowned golden yellow color and attractive figure. It is famous for its elegance, class, grandeur, durability, antiquity, grace and strength. The durability of teak is the result of synergetic effect of total extractive compounds (12.44%-15.98%) especially the polyphenolic compounds mainly tectoquinone and naphthoquinone. It is proved that tectoquinone (2-methyl anthraquinone) which is characteristically present in Nilambur teak (heartwood) is a repellent to the dry wood termite, and it ranged between 0.23% and 0.34%. The resistance to fungal decay is mainly due to naphthoquinone (0.62%-1.26%) and its derivatives present in teak wood. The hydrophobicity, antioxidant properties and oily nature of teak wood were mainly due to Caoutchouc compound. This unique quality of Nilambur teak is the major factor that helped to gain the worldwide attention for it in the ship and yacht building. The total extractive content increases as the trees become older and there by the durability (Thulasidas and Bhat, 2006). Teak grows fast in Nilambur and yields large diameter logs. The wood has straight grain with golden yellowish brown colour, often with darker chocolate-brown streaks (Plate 1).

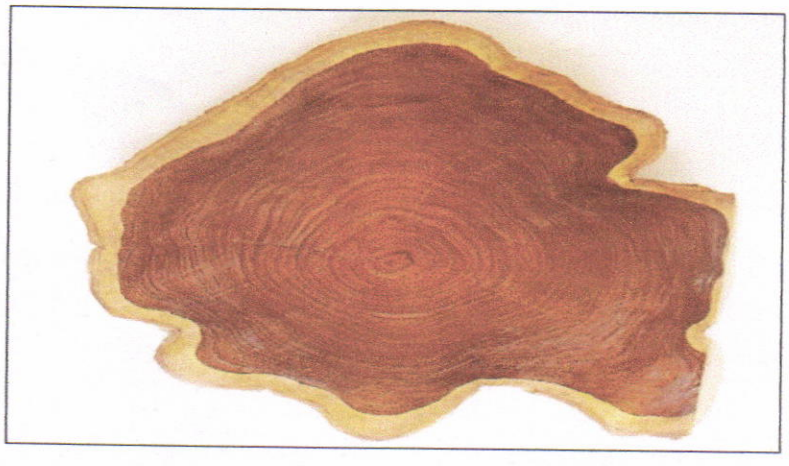

Plate 1. A cross cut section of Nilambur teak.

Studies also showed a profound influence of planting locations on wood, colour and texture in teak. Table 1 and Plate 2 show a comparison of wood color in teak from different locations.

Table 1. Variation in heartwood color with respect to sample locations.

Location	Munsell system			Colour description	
	Hue	Value	Chroma		
Nilambur	7.5	5	4	7.5YR/5/4	Brown
Benin	10	6	6	10YR/6/6	Brownish yellow
Ranni	7.5	4	4	7.5YR/4/4	Dark brown
Cameroon	10	6	8	10YR/6/8	Brownish yellow
Ghana	7.5	5	6	7.5YR/5/6	Strong brown
Tanzania	7.5	5	6	7.5YR/5/6	Strong brown
Vadavar	10	7	6	10YR/7/6	Yellow
Myanmar	10	5	6	10YR/5/6	Yellowish brown
Thailand	10	5	6	10YR/5/6	Yellowish brown
Betul	7.5	5	4	7.5YR/5/4	Brown
Konni	7.5	4	4	7.5YR/4/4	Dark brown
Sudan	10	5	8	10YR/5/8	Yellowish brown
Malayattoor	10	6	6	10YR/6/6	Brownish yellow
Trinidad	10	5	8	10YR/5/8	Yellowish brown

(Anish *et.al.*, 2015)

Nilambur teak (plantation)-FC*

Nilambur teak (plantation)-QC*

Nilambur teak-home garden

Teak- Burma

Teak-Columbia

Teak-Ecuador

Teak-Malaysia

Teak- Costa Rica

Teak- Benin

Teak- Ivory Coast

Teak- Togo

Teak- Ghana

Plate. 2. Comparison of wood color in teak from different locations.

* FC-Flat sawn; QC-Quarter sawn

(Source: Bhat *et. al.*, 2008)

The heartwood colour difference could be due to variation in percentage of extractive content in wood. Some 40 extractives compounds have been isolated from teak. Extractive content include n-heptyl amine, n-butyric acid, 2-methyl anthraquinone (tecto quinone), 2-hydroxy 3-methyl anthraquinone, anthraquinone 2 – aldehyde, lapachol etc. Puri, 1962 reported about 10.3% of outer heart wood total extractives from the ring number 91 from the pith of Nilambur teak. In another comparative study (Anish *et al.*,2015) it was found that extractive content (%) was more in Nilambur teak compared to extractive content in teak from Benin, Ranni, Cameroon, Sudan and Malayattoor (Table 2).

Table 2. Variation in extractive content (%) of teak from different localities.

Location	Extractive content (%)
Nilambur	8.053
Benin	6.607
Ranni	6.205
Cameroon	7.817
Ghana	6.885
Tanzania	7.132
Vadavar	7.472
Myanmar	9.643
Thailand	8.807
Betul	10.437
Konni	11.133
Sudan	5.022
Malayattoor	9.218
Trinidad	10.190

(Anish *et.al.*, 2015)

The major physical, anatomical and mechanical properties of teak wood from Nilambur are given below (Table 3 and 4).

Table 3.Gross physical, mechanical and working properties of Nilambur teak.

Sl. No.	Wood Properties	Description
A.	**Physical**	
1.	Colour	Heartwood golden brown or dark brown occasionally with black streaks with a waxy feel, lustrous, sapwood pale yellow or grey, well defined.
2.	Odour	Distinct aromatic odour with the smell of leather
3.	Weight	Moderately heavy (Air-dry specific gravity 0.55-0.70 with average value of 0.65)
4.	Grain	Straight, sometimes wavy
5.	Texture	Coarse
B.	**Mechanical**	
1.	Strength	Strong
	Static Bending	
	Modulus of Rupture (MOR) N/mm^2	106
	Modulus of Elasticity (MOE) N/mm^2	10000
	Compression parallel to grain	
	Maximum Crushing Stress (MCS) N/mm^2	60.4
2.	Drying and shrinkage	Dries well but rather slowly with little or no degrade; Shrinkage- radial (2.3%), tangential (4.8%), volumetric (7.1%). High resistance to water absorption.
C.	**Other properties**	
3.	Durability	Very durable; highly resistant to termite damage.
4.	Treatability	Extremely resistant
5.	Working properties	Easily worked with both hand and machine tools. Planning easy; Boring- easy; Turning- rather easy; Nailing- good but pre-boring necessary; Finish-good

(Bhat *et.al.*, 2008)

The above wood properties which has direct correlation with the utilization aspects of timber shows that Nilambur teak has most properties found in superior class timbers suitable for most end uses like cabinet making, interior and exterior joinery, flooring and fine furniture, carving, paneling, turnery, sliced for decorative and face veneers. It is highly durable, resistant to termite and fungal damage. It is easily workable with both hand and machine, with easily boring and turning. It dries slowly with little or no degrades. It is highly resistant to water absorption.

Table 4. Wood (physical and anatomical) properties specific to Nilambur Teak.

Sl. No.	Wood Properties	Values - Range
1.	Specific gravity (G)	0.70-1.42
2.	Specific gravity (AD)	0.60-0.79
3.	Specific gravity (OD)	0.58-0.77
4.	Radial shrinkage (G to AD)	0.39-1.75
5.	Radial shrinkage (AD to OD)	1.04-2.85
6.	Radial shrinkage (G to OD)	2.29-4.33
7.	Tangential shrinkage (G to AD)	0.54-3.96
8.	Tangential shrinkage (AD to OD)	0.89-3.18
9.	Tangential shrinkage (G to OD)	3.70-5.47
10.	Moisture content (G)	20.95-91.00
11.	Heartwood (%)	70.5
12.	Extractive content (%)	6.58-19.00
13.	Heartwood colour	Golden brown
14.	Munsel System (1976)	
	Hue	7.5
	Value	5
	Chroma	4
15.	Colour description 7.5YR/5/4	Brown

16.	Vessel diameter (µm)	210-290
17.	Vessel area (µm)	39850-92583
18.	Vessel frequency (mm-2)	2-6
19.	Ray height (µm)	368.8-671.3
20.	Ray width (µm)	28.8-78.8
21.	Ray frequency (mm-1)	2-6

G – Green; AD – Air Dry; OD – Oven Dry (Anish *et.al,* 2015, Thulasidas *et.al.*, 2006)

The above table shows the properties that are specific to Nilambur teak. Of significance are the colour, extractive content and shrinkage percentage of the heart wood of Nilambur teak. Nilambur teak has a hue of 7.5, Value of 5, and Chroma of 4. The occurrence of high extractive content in Nilambur teak is the major reason for its unique golden brown colour and durability. Nilambur teak is gold brown in colour whereas teak from Myanmar, Vadavar & Trinanad are yellow to yellowish brown in colour. The heartwood (%) of Nilambur teak is 70.5. The specific gravity (Green) ranged between 0.70-1.42, specific gravity (Air Dry) ranged between 0.60-0.79 and specific gravity (Oven Dry) ranged between 0.58-0.77 (Table 5). The higher specific gravity of Nilambur teak might be attributed to the presence of high percentage of mature wood which is characterized by lower percentage of parenchymatous tissues and lower vessel diameter (Tewari, 1992).

Table 5. Average wood specific gravity (green, air dry and oven dry) of Nilambur teak in comparison with teak from other localities.

Location	Specific Gravity (Green)	Specific Gravity (Air Dry)	Specific Gravity (Oven Dry)
Nilambur	0.92	0.73	0.68
Ranni	0.77	0.71	0.65
Konni	0.80	0.64	0.58
Malayattoor	0.86	0.76	0.67
Vadavar	1.17	0.81	0.71
Myanmar	0.86	0.71	0.63

Thailand	0.87	0.72	0.66
Ghana	0.64	0.60	0.55
Cameroon	0.80	0.68	0.62
Trinidad	0.92	0.69	0.60

(Anish *et. al.*, 2015)

Specific gravity, which is a very important physical property of wood, influences all the other properties such as anatomical, mechanical and other properties and therefore has an important role in deciding the utilization value of a timber. Higher the values, better will be the timber quality, particularly the strength. The above table shows that specific gravity values of the Nilambur teak, under all the three conditions (green, air dry and oven dry) are generally high compared to many other locations. As specific gravity is correlated with strength properties of wood, Nilambur teak is superior taking into account of the above important property (Anish *et. al.*, 2015).

Coefficient of anisotropy (Table 6) is the ratio between tangential shrinkage and radial shrinkage and it is a measure of dimensional stability of timbers which influences the ability of timbers to resist climatic variations. Lower the ratios, more dimensionally stable the wood is.

Table 6.Coefficient of anisotropy of teak wood from different locations

Sl. No.	Location	Coefficient of anisotropy *
1.	Nilambur	1.55
2.	Konni	2.27
3.	Malayattoor	2.22
4.	Ranni	2.20
5.	Vadavar	1.89
6.	Cameroon	2.42
7.	Ghana	2.37
8.	Myanmar	2.79
9.	Thailand	2.16
10.	Trinidad	2.23

*Green to oven dry

(Anish *et.al.*,2015)

The co-efficient of anisotropy is found to be less i.e., 1.55 for Nilambur teak which indicates better stability and low risk of deformation during drying and hence, improved timber quality (Anish *et. al.*, 2015). The percentage wood shrinkage in radial as well as tangential direction at three conditions like green to air dry, air dry to oven dry and green to oven dry, was in generally less for Nilambur teak, indicating its stability. The heartwood proportion, which is the naturally durable part of the timber for which teak is well known, is an important factor determining wood quality. As heartwood to sapwood ratio is high, the percentage of volume of heartwood obtained from an individual tree would be higher for Nilambur teak.

Table 7. Comparison of anatomical properties of Nilambur teak with teak wood from other regions.

Sl. No.	Location	Vessel Diameter (µm)	Vessel Area	Vessel Frequency (No./mm^2)	Ray Height (µm)	Ray Width (µm)	Ray Frequency (No./mm^2)
1.	**Nilambur (Kerala)**	206.02	50746.6	4	542.75	48.83	4
2.	**Ranni (Kerala)**	212.08	49657.3	7	554.42	44.75	9
3.	**Konni (Kerala)**	282.75	88583.4	6	1065.23	96.01	5
4.	**Malayattoor (Kerala)**	222.82	57890.0	9	669.67	52.67	8
5.	**Vadavar (TN)**	223.33	58794.3	8	717.17	64.33	8
6.	**Cameroon**	205.50	44985.7	6	645.58	80.08	7
7.	**Ghana**	230.42	58226.7	7	680.27	65.83	7
8.	**Myanmar**	342.92	117653.6	3	665.17^{bc}	47.41	5
9.	**Thailand**	143.67	28504.0	6	668.92	77.75	5
10.	**Trinidad**	258.67	73909.7	7	649.08	52.42	8

(Anish *et.al.*, 2015)

The above table (Table 7) shows the unique anatomical properties of Nilambur teak compared to teak wood from other regions within the country and abroad. Wood anatomical parameters (like vessel diameter, vessel area, vessel frequency, ray height, ray width, ray frequency) relate to its mechanical and physical properties which in turn affects wood quality. With regard to these anatomical parameters, Nilambur teak showed better values as compared to teak from other provenance which again indicates the superior quality of Nilambur teak. Lower vessel diameter and vessel area influences wood density inversely.

Lower vessel diameter can lead to higher wood density, which is a desirable wood quality. Nilambur teak has low vessel diameter compared to teak wood from many other regions. Similarly low ray frequency indicated better wood quality for Nilambur teak. Teak from Nilambur exhibited mechanical maturity of the timber at or before the age of 21 years offering scope for utilization of short rotation wood without compromising the quality in terms of timber strength (Bhat and Indira, 1997).

In another study analysis of the data on wood specific gravity and rate of growth of teak from two seed origins showed that locality had a highly significant effect, while the variation due to seed origin was not significant.

f) Name of Geographical Indication and particulars:

Nilambur Teak

Logo provided below:

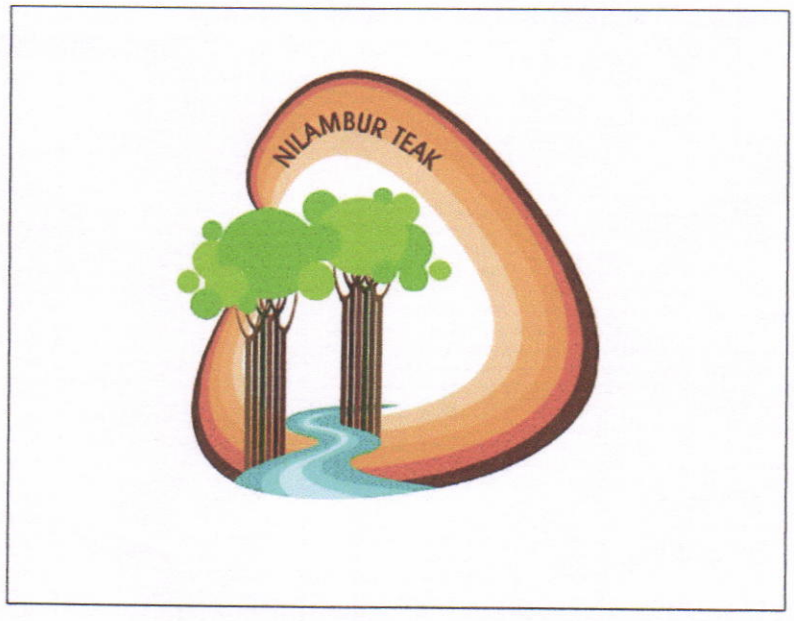

Plate 3. Nilambur Teak Logo

Topography:

The Nilambur region extends from 76°5' 40.4" to 76°33' 15.4" E longitude, 11°4'13.9" to 11°31' 40.5" N latitude respectively. Topographically, Nilambur area can be divided into plains, valleys and Ghats. The upper Ghats are covered by evergreen forests with very little biotic interference. The slopes are very

steep and are traversed by a large number of streams and rivulets. Rivers, especially Chaliyar, help in the transportation of teak wood from forests to port at Calicut and timber market at Kallayi. The plains are occupied by plantations and farm lands. The elevation is mostly 100 m, with a few hillocks rising up to 300 m.

Ecology and soil:

The Nilambur region is traversed by a major river, the Chaliyar, which flows westward and drains into the Arabian Sea at Beypore. The major tributaries are Chaliyarpuzha, Karimpuzha and Punnapuzha. The rich alluvial deposit in the river banks of Chaliyar enhance the soil fertility and thus enhance the quality of Nilambur teak. The well-drained alluvial soils on river beds provide the ideal site for regeneration of teak. Clay is formed in low-lying areas as a result of sedimentation. The soil is shallow and thin along the ridges and steeper slopes whereas it is deep and fine in plains and gentle slopes. Local belief is that the unique golden brown color of Nilambur teak is due to the presence of gold ore in the soils of Nilambur. The Nilambur valley was once famous for artisanal gold mining. Gold prospecting in the Nilambur belt by the Geological Survey of India (GSI) and the Department of Mining and Geology, Kerala, had revealed presence of deposits estimated to be worth Rs. 600 crores at current gold prices (Business Line, 2005). Scientific studies have also revealed the presence of placer gold grains in the Nilambur Valley (Santhosh *et al.*, 1992).

Naturally teak attains best potential in moist deciduous forests. It is found generally in mixture in association with *Terminalia tomentosa, T. bellarica, T. paniculata, Dalbergia latifolia, Lagerstroemia lanceolatal, Pterocarpus marsupium, Grewia tiliaefolia, Schleichera oleosa, Anogeissus latifolia, Adina cordifolia, Mitragyna parvifloora, Stereospermum chelenoides, Gmelina arborea* and *Xylia xylocarpa* (in lateritic soils).Lowest storey usually has been found consisting of *Cassia fistula*, Bauhinia, Emblica, *Bambusa bambos* while *Helicterisisora, Glycosmis pentaphyla* and *Lantana camara* dominate the understorey. The latter species are often regarded as site indicators for teak. Nilambur valley with its unique topography consisting of alluvial delta contributed by Chaliyar River and its tributaries acts as excellent moist deciduous habitat for teak and the above species.

Teak can grow on a variety of soils. The quality of its growth, however, depends on the depth, structure, porosity, drainage and moisture holding capacity of the soil (Rugmini *et al.*, 2007). The soils in Nilambur area have well developed profiles due to intensive leaching. Appreciable amount of gravel are found in the soil mass indicating good internal drainage. Accumulation of humus in the top soil gives it deep reddish

brown to dark brown colour, which changes to red in the sub-soil due to de-hydration of sesquicentennial deviation from the surface horizon. The surface soil has a structure which favours root development.

Soils of Nilambur plantations are loamy and medium acidic in all site quality classes (Balagopalan and Rugmini, 2006).The soil is medium in texture, moderately deep and non-calcareous in nature and acidic in reaction. They are rich in nitrogen and contain moderate quantities of potassium and phosphorous. Table 8 provides characteristics of the soil of Nilambur.

Table 8..Physico-chemical attributes of soils at Nilambur

Division	Site quality class	Sand (%)	Silt (%)	Clay (%)	BD* (g cm-3)	PD* (g cm-3)	WHC * (cm)	pH	OC (%)	N	P	K	Ca	Mg	$CaCO_3$
										kg ha-1					
Nilambur (North)	I	73	14	13	1.12	2. 25	38.44	5.9	0.76	45	8	53	38	22	0.008
	II	73	13	14	1.13	2.27	39.04	5.9	0.72	47	9	55	41	24	0.008
	III	74	14	12	1.16	2.3	38.33	5.9	0.74	42	9	53	38	22	0.008
Nilambur (South)	I	74	14	12	1.14	2.29	39.28	5.9	0.77	44	9	57	43	33	0.009
	II	74	12	14	1.13	2.31	39.56	6	0.78	46	10	57	44	34	0.009
	III	74	12	14	1.15	2.23	39.4	5.9	0.78	47	12	61	45	33	0.01

*BD – Bulk density, PD- Particle density, WHC – water holding capacity

Griffith and Gupta (1948) investigated laterization of teak soils and concluded that the molecular ratio of silica to sesqui oxides (oxides of Fe and Al) provides an indication of the suitability of soil for teak unless some factor such as a laterite under shallow soil, excessive boulders or high water table (3-4 feet in winter) intervenes.

The following factors are generally considered responsible for the high quality of teak in Nilambur valley (Kadambi, K. 1972):

- High $Si0_2/R_20_3$ ratio in the soil. (Less than 1.33- pure laterite; between 1.33 and 2.00- lateritic soil; more than 2.0- non laterite)
- Deep alluvial soil
- High content of bases, especially Ca and Mg in the soil.

- Good moisture availability due to appropriate water table.
- Good sand and loam texture and consequent good soil drainage.

In the more or less pure teak areas, two extremes of growth are observed, the best in the deep alluvial soil with perfect drainage, and the worst in the lateritic soil and under swampy conditions. A gradation in growth is found between these two extremes. The best growth is limited to more or less long, narrow strips along the river banks or to small patches followed by deep disintegrated gneiss soils.

It is observed that where the soil depth is at its optimum teak retains its foliage for a longer period even during summer. This may be due to the fact that the roots can go much deeper and get moisture from lower levels also. In the case of alluvial soils of depth greater than the optimum, the roots fails to reach the main water level which is still deeper and thus the tree has to be content with moisture available from the upper layers. This retards the growth.

Mere proximity to river do not account for best growth. The height of the bank and river bed also plays a part in the good growth of teak. When the actual bank of the river bed is comparatively low, from the top of which the ground slopes directly up to the main level of the alluvial land, the area supports the very best growth. Commonly it is seen that in alluvial sands, the actual river bank is somewhat higher than the adjacent land. If there is sufficient surface drainage the very best growth can be seen on the river bank. It may be because of the washing down and deposition of organic compounds formed on the higher lying banks to the lower ground thereby increasing the fertility of lower lands (Alexander et. al, 1987). Apart from the river banks, homesteads in the Nilambur premises acts as potential source of quality teak. In particular the homesteads in villages in the Nilambur valley bordering the Western Ghats such as Karulai, Kalikavu, Chaliyar, Pookkottumpadam, has high quality teak trees mostly coppiced from the old natural teak trees.

A study on the productivity of Teak plantations in Konni, Kozhikode,Nilambur and Wyanad Forest Divisions showed that Nilambur Division had the highest productivity among the four Divisions (KFRI, 1979).

Climate:

The temperature of the area is very much influenced by rainfall and it varies between 21°C to 38°C. The heavy rainfall and bright sunshine lead to a humid and warm climate, excellent for luxuriant plant growth including teak. Frost is generally absent. In the plains and foothills, humidity varies from 30% to 90%

reaching saturation point during monsoons. Mist is frequent in higher elevation, with dew during December to February. Both Southwest and Northeast monsoon bring rains (Table 9). Southwest monsoon is often torrential and incessant. From May to October, the area receives Southwest monsoon with bulk of the rain during June-July. Showers are also received from Northeast monsoon during October-November. The area also receives pre-monsoon showers during April-May.

Table 9.Rainfall data (mm) at Nilambur during last 10 years.

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2004	0	0	0	119.80	408.4	634	281.6	374.4	140	264.4	71	0
2005	7.4	0	0	115.2	25.6	698.4	662.7	213.2	299.8	334.8	155.4	7.8
2006	0	0	68.6	8.8	453.7	689.8	620.8	390.8	700.6	251.8	142	0
2007	0	0	0	25.8	167	615.1	1319	455.2	498.4	305.6	78	0
2008	0	34.4	175	30.8	108.8	641.1	279.7	177.8	293.8	421.7	13.2	0
2009	0	0	48	80	103.4	332.3	965.6	219.6	240.3	290.4	227.4	2.8
2010	4.2	0	11.6	58.8	69.6	466	483.4	237.4	182.1	425.2	232.2	46.8
2011	0	11.8	2.4	122	51.6	809.2	457.4	410.6	371.6	157.8	137.8	0
2012	0	0	0	115.2	8.8	269.2	331.7	343.2	144.1	110.6	40.4	16.2
2013	0	5.0	13	3.6	59.2	848.4	753.7	337.5	331.4	155.8	75	40
Average	1.16	5.12	31.86	68.00	145.61	600.00	615.56	315.97	320.2	271.81	117.24	11.36

(Source: Kerala Agricultural University)

g) Description of the good:

Nilambur teak is the teak wood obtained from the forest areas, plantations and homesteads in Nilambur Taluk and the nearby panchayat of Edavanna in Ernad Taluk in Malappuram district in Kerala, India. Furniture and other teak wood products, including ships and sea vessels are manufactured from Nilambur teak wood. Teak tree is a large deciduous one with rounded crown. Branches are quadrangular, channeled with a large quadrangular pitch. Leaves opposite, large, broadly elliptical or ovate usually 1' to 2' long but often larger in coppice shoots and young plants, rough above, stalletely grey tomentose beneath, with minute glandular dots which are red in young leaves, afterwards turning black. Heart wood is dark

golden yellow sometimes with dark streaks, turning brown with age, oily with a characteristic color, and leathery smell, extremely durable and does not warp or split.

Nilambur forests and teak plantations along with the homesteads in Nilambur are the major source of quality teak wood in India. It is the most important timber tree of India and known worldwide for its unique quality for shipbuilding and yacht manufacture. In olden days sail boats and small ships (Dhow or 'Uru' as it is called locally) were made, entirely out of teak wood from Nilambur, at Beypore in Calicut district and the yacht industry in Europe and Arabian countries still prefers the beautifully figured and very durable teak wood from Nilambur. Most of the well-known palaces and other historical monuments in Kerala have immense wood work of teak from Nilambur. The Kerala Legislative Assembly hall and the building contain considerable quantities of wooden furnitures home decorations and fixtures out of Nilambur teak. It is also used extensively for general carpentry work including furniture and fixtures for construction work, bridges, building, wharfs, piles, cabinetwork, railway carriages, carvings, ordnance work, wheel spokes, etc. Nilambur teak is famous for its elegance, class, grandeur, durability, antiquity, grace and strength.

Nilambur teak has acquired worldwide reputation due to its specific qualities. It is considered as a very valuable wood due to its ability to withstand fluctuating climatic conditions characteristic of the humid tropics. It is very stable, which means that it does not warp when subject to variations in humidity and temperature. The superiority of teak for ship building and structural purpose are due to the large size, tree form, color and workability. It is a privileged wood withstanding termite and fungal attack. The heartwood of teak is extremely resistant to attack of insects and fungi. The superiority of teak from Nilambur and surrounding regions for shipbuilding and structural purpose are due to the large size and form of the tree, the color and workability of the wood and its ability to withstand termite attack. It is proved that tectoquinone (2-methyl anthraquinone) which is characteristically present in Nilambur teak (heartwood) is a repellent to the dry wood termite, and it ranged between 0.23% and 0.34%. The resistance to fungal decay is mainly due to naphthoquinone (0.62%-1.26%) and its derivatives present in teak wood. The durability of teak is the result of synergetic effect of total extractive compounds (12.44%-15.98%) especially the polyphenolic compounds mainly tectoquinone and naphthoquinone. The hydrophobicity, antioxidant properties and oily nature of teak wood were mainly due to Caoutchouc compound. The major physical properties of Nilambur teak wood is provided in Table.10. These unique qualities of Nilambur teak were the major factors that helped it to gain the worldwide attention in the ship and yacht building dockyards. Nilambur teak has other unique qualities such as world renowned golden yellow color and attractive figure. More over teak grows fast in Nilambur and yields large diameter logs.

Table 10. Gross physical, mechanical and working properties of Nilambur teak.

Sl. No.	Wood Properties	Description
	Physical	
1.	Colour	Heartwood golden brown or dark brown occasionally with black streaks with a waxy feel, lustrous, sapwood pale yellow or grey, well defined.
2.	Odour	Distinct aromatic odour with the smell of leather
3.	Weight	Moderately heavy (Air-dry specific gravity 0.55-0.70 with average value of 0.65)
4.	Grain	Straight, sometimes wavy
5.	Texture	Coarse
	Mechanical	
1.	Strength	Strong
	Static Bending	
	Modulus of Rupture (MOR) N/mm^2	106
	Modulus of Elasticity (MOE) N/mm^2	10000
	Compression parallel to grain	
	Maximum Crushing Stress (MCS) N/mm^2	60.4
2.	Drying and shrinkage	Dries well but rather slowly with little or no degrade; Shrinkage- radial (2.3%), tangential (4.8%), volumetric (7.1%). High resistance to water absorption.
	Other properties	
3.	Durability	Very durable; highly resistant to termite damage.
4.	Treatability	Extremely resistant
5.	Working properties	Easily worked with both hand and machine tools. Planning easy; Boring- easy; Turning- rather easy; Nailing- good but pre-boring necessary; Finish-good

(Bhat *et.al.*, 2008)

The wood of Nilambur teak is strong and moderately heavy with an attractive figure and dark golden yellow heart wood turning to brown, dark brown and finally almost black with age. It is dimensionally very stable and is highly resistant to termite damage and other fungal pathogens. The wood has oily feel, strongly and characteristically scented when fresh without characteristic taste. It is easily worked with both hand and machine tools. Planning of this wood is easy because of which it is called as 'Carpenter's delight'. It can be worked by hand to a good smooth surface, and can be brought to a fine wax polished finish with little filling. Specific gravity, which is a very important physical property of wood, influences all the other properties such as anatomical, mechanical and other properties and therefore has an

important role in deciding the utilization value of a timber. Higher the values better will be the timber quality, particularly the strength. Specific gravity values of the Nilambur teak, under all the three conditions (green, air dry and oven dry) are generally high compared to other locations. As specific gravity is correlated with strength properties of wood, Nilambur teak is superior (Anish *et. al.*, 2015). In another study analysis of the data on wood specific gravity and rate of growth of teak from two seed origins showed that locality had a highly significant effect, while the variation due to seed origin was not significant.

Coefficient of anisotropy is the ratio between tangential shrinkage and radial shrinkage and it is a measure of dimensional stability of timbers which influences the ability of timbers to resist climatic variations. Lower the ratios, more dimensionally stable the wood is. The percentage wood shrinkage in radial as well as tangential direction at three conditions like green to air dry, air dry to oven dry and green to oven dry, is less for Nilambur teak, indicating its stability. The co-efficient of anisotropy is found to be less i.e., 1.55 for Nilambur teak which indicates better stability and hence, improved timber quality. The heartwood proportion, which is the naturally durable part of the timber for which teak was well known, is an important factor determining wood quality. As heartwood to sapwood ratio is high in Nilambur teak, the percentage of volume of heartwood obtained from an individual tree would be higher for Nilambur teak.

h) Geographical area of production and map:

Nilambur teak is the teak wood obtained from the forest areas, plantation and homesteads in Nilambur Taluk and Edavanna panchayath in Ernad Taluk of Malapuram district, Kerala.

Teak is the major plantation species in Nilambur. Total teak forest area (in Nilambur South and Nilambur North) is approximately 8760.370 ha (www.forest.kerala.gov.in/images/pdf/fs2013). Plenty of standing stock of quality teak is available in the home gardens in Nilambur. Geographical map of area of production of Nilambur teak is provided in Plate 4. Certified copy of the map is provided separately.

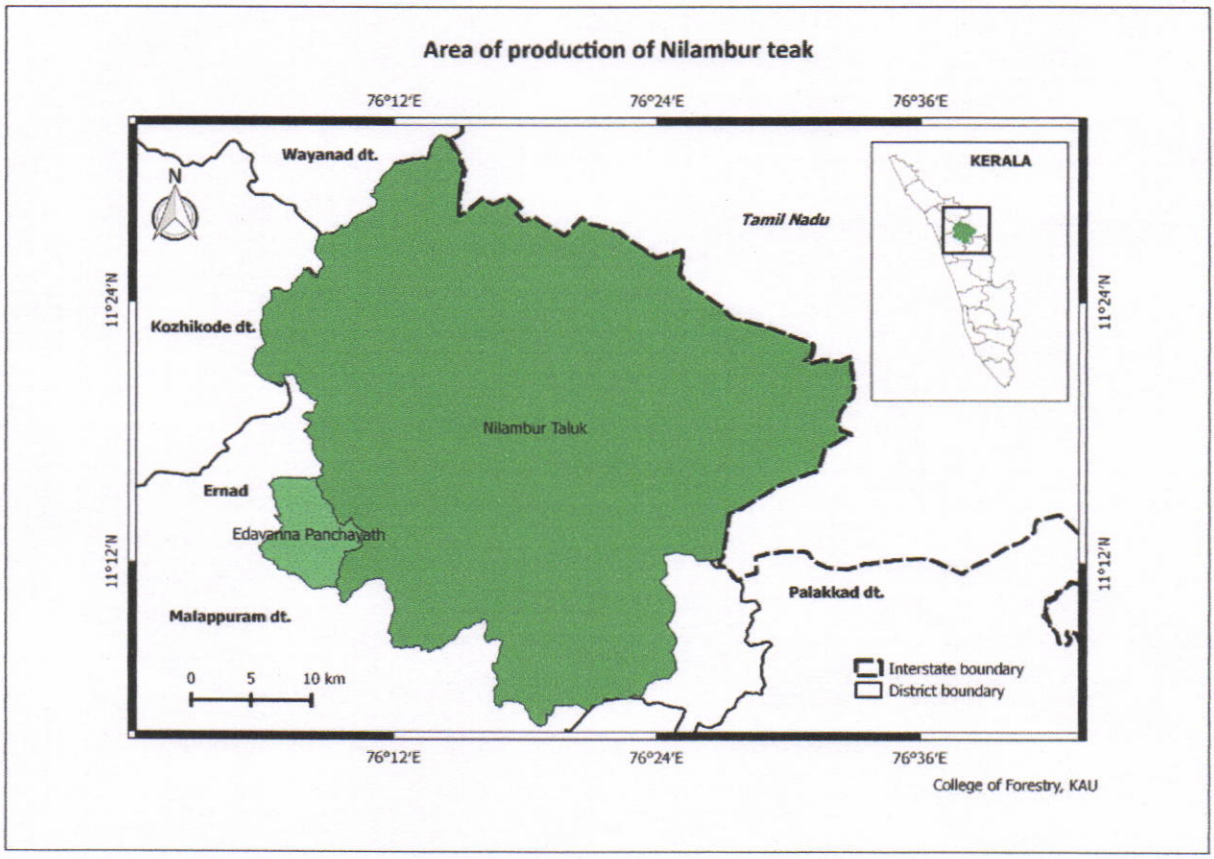

Plate 4. Geographical map of area of production of Nilambur teak

i) Proof of origin:

Numerous articles and journals had reported the history of Nilambur teak. One of the earliest known mentions of the Indian teak is that the boats which carried the soldiers of the army of Alexander the Great, back to Greece from India were made of Malabar teak (Shanmuganathan, 1997)

Following are the details related to proof of origin of Nilambur teak extracted from different books.

1. "Malabar Manual" by William Logan, a British Officer of the Madras Civil Service under British Government mentioned about the establishment of government teak plantations at the Nilambur region. Memorandum on the Conolly teak plantations at Nilambur, the then Malabar district, included "the Nilambur teak plantations was suggested in 1840 by Mr. Conolly, Collector of Malabar who described the objective as to replace those forests which have vanished from private carelessness and rapacity- a work too new, too extensive and too barren of early return to be ever taken up by the native proprietor". It also included the different experiments done to germinate and establish Teak plantations at Nilambur

Valley. Ref: William Logan, 1887. Nilambur Teak Plantations in Malabar Manual Vol. 2, page ccclxv (Copy enclosed)(Annexure 1)

2. A book titled '*Indian forestry through the ages*' also describes the history of Nilambur teak as in 1840, Conolly, the Collector of Malabar initiated the world's first teak plantations at Nilambur which led to regular plantations of this valuable timber. Lushington prepared the first working plan for the Nilambur forests in 1895. The technique for teak planting was perfected at Arienkavu near Kollam, Kerala in 1891. In 1922, the system of taungya for raising plantations was introduced in Kerala."
   Ref: Negi S.S. 1994, '*Indian forestry through the ages*' (Copy enclosed) p. 41.(Annexure 2)

3. A book titled '*Cultural Heritage of Kerala*' by A. Sreedhara Menon, mentioned about the efforts of British to improve teak plantations in Kerala especially at Nilambur. He mentioned that the forest in erstwhile south Malabar owed their commercial importance and financial success entirely due to these plantations. He also mentioned about the planting of teak seedlings in 1842 on deep alluvial soil of Nilambur and thus starting world's oldest teak plantations at Nilambur.
   Ref: Sreedhara Menon A, *Cultural heritage of Kerala*. East-West Publications, 1978, Page 44 and 45. (Copy enclosed) (Annexure 3)

4. Having realized the value of teak and to have a steady supply of good quality teak for British, Mr. H. V. Conolly, the then Collector of Malabar, in 1842 initiated action to plant teak in Nilambur area that resulted in the world famous teak plantations of Nilambur. According to a letter of Conollyin 1842, in the forest lying to the west of Nilambur, 30000 teak seeds were sown and 10000 seedlings picked out from the natural forest were planted out. In 1844, Sri. Chathu Menon was appointed as Sub-Conservator. Under the orders of Conolly, Sri. Chathu Menon, after a hard and pioneering struggle, raised the first 1500 acres of the Nilambur plantation in 1846 on the northern bank of Chaliyar river (KFRI. 1991). A part of this plantation is still maintained at Nilambur as "Conolly's Plot". This is one of the oldest surviving man made teak plantation of the world and even now has some of the trees planted by above two pioneers.

5. It is often recalled with pride that "Teak from Idayara [In Kerala] sent by Mathu Tharagan was used in connection with the battle of Trafalgar [1805].
   Ref: One Hundred Years of Indian Forestry, Vol. II, p. 7.In http : //cpsindia.org/index.php/art/114-science-sustainability-and-indian-national- resurgence/d-science-and-technology-under-the-british-rule/159-2-the-story-of-modern-forestry-in-india#_edn60 (Copy enclosed) (Annexure 4)

6. **Buckingham palace** was originally built in 1705 for the Duke of Buckingham. It is told that Nilambur teak was largely used in the construction of Buckingham palace (Abdulssalam, M., Personal Communication, 2013)

7. **RMS Titanic** was one of the largest and luxurious passenger liners and was considered as unsinkable. In April 10, 1912 the RMS Titanic embarked on its maiden voyage sailing from Southampton England to New York City. The mast and major decoration of the ship were believed to be constructed using Nilambur teak. (Hyder Ali A.K., 2013; Personnel Communication)

8. **The Kabba building** located in Mecca, Saudi Arabia, is the holiest shrine of Islam. It has been reconstructed several times. Nilambur teak is believed to be used in the renovation of Kabba building (Abdullakutty, T.K. Personnel communication).

9. **Malabar teak in majestic Rolls – Royce**: A report in 2012, revealed that the 108 year old British Brand (Rolls Royce) is sourcing teak wood from Malabar for its Ghost series. The report also told that the response to the Malabar wood interiors in the Rolls-Royce Ghost model has been very good both in India and internationally. (Source: The times of India, Feb 2012). Copy enclosed. (Annexure 5)

j. Method of Cultivation

By using improved seeds and quality planting stock, growth of teak plantations can be increased up to 25 per cent. Improved seeds can be obtained from Seed Production Areas and Seed Orchards, and also by adopting seed handling techniques. Seeds for the production of planting stock are collected from phenotypically superior 25 to 35-year-old trees/plantations during the peak maturity period, i.e., during January -March. Fruits are usually collected from the ground. Grounds beneath the trees are kept clean before seed collection. For ease of collection, a cover, like tarpaulin, can be spread out on the ground. Daily collections are suggested. Shaking the branches manually using a pole fitted with hook facilitates fall of mature fruits on to the clean ground or on the tarpaulin. Generally, seed production in intensively managed Seed Production Areas /Seed Orchard is about 200-300 kg $ha^{-1}year^{-1}$. The seeds are pretreated (as given below) before sowing-

Pretreatment of seeds

1) Scorching in a light fire of leaves and grasses
2) Boiling water treatment, i.e., putting seeds in boiling water and allowing it to cool
4) Immersion in cold water for a number of days
5) Alternate soaking and drying
6) Burying the seed for about a year near and hill so that white ants destroy part of the testa
7) Placing seeds in a paste of cow dung and water
8) Weathering, i.e., exposing to sun and rain in the open for a few weeks or months
9) Acid treatment

In humid conditions of Kerala the most effective method of pretreatment is found to be alternate wetting and drying of seeds. This simple technique involves immersion of gunny bag filled seeds in water during the night times and spreading in sun during day time. This process is to be continued for 7 days. This assures almost 70-80% seed germination. Generally, the pre- treated seeds will have about 25-45% germination. Germination commences from six days after sowing and culminates by 45 days (Kadambi, K. 1972).

Nursery techniques

Commonest type is temporary dry nursery with watering facilities. Best situation is near plantation site. The nursery site for teak seedling production should be well drained and free from weeds. Watering is necessary only in very dry zones or in cases of exceptional droughts. Lateral shade avoided, soil well dug up and mixed with ashes resulting from slash burning. In moist localities beds are to be raised to avoid water logging. Seeds in the bed are covered with ½ to 1" layer of earth. Mulching is useful, in drier parts. Young seedlings require protection from sun. Seeds are sown between February and June.

The recommended standard size of nursery bed is 12 m x 1.2 m x 0.3 m. About 3-5 kg of seeds can be sown in a bed. The beds are also mulched with green leaves to reduce evaporation losses. The bed is then dusted with carbaryl 10 per cent to prevent insect attack. Germination commences within 6-15 days after sowing. Periodical weeding, fertilizer applications, watering and pest management can potentially improve the health of seedlings. Damping-off and collar-rot are the important diseases of seedlings in the teak nursery. Timely application of systemic fungicide can control such diseases. The planting stocks must be ready for main field planting immediately after the onset of monsoon during June-July. Three types of planting materials are commonly used in teak planting.

1. Stump
2. Seedling
3. Root trainer seedling

1.Stump planting: Transportation and the planting cost are minimum for stump planting compared to seedling planting. One year old seedlings of 1-2 cm (thumb thickness) at the thickest portion below the collar are uprooted from mother beds and used for making stumps. Stumps with 15-20 cm of root and 2-3 cm of stem prepared with sharp knife are commonly used for planting. The food material stored in the stump is utilized directly by the sprouting shoots and boosts their initial growth until the establishment of root system. Stump planting must be done immediately after the onset of rains, in order to avail full benefits of them.

2. Seedling: Teak seedlings can be produced in shorter duration by using polythene bags or root trainers. Three to four month old teak seedlings are transformed from the germination beds into polythene bags (30cm x 20 cm) in the month of March/April. The planted seedlings grow by absorbing nutrients from soil through the existing root system. Seedlings can be planted at any time if irrigation facilities are available.

3. Root trainer seedlings: Three-month-old root trainer seedlings are also used for planting. A mixture of well rotten FYM with coir pith/saw dust can be used as potting mixture.

Field planting

Depending on the area available teak can be grown in blocks, in linear strips or staggered planting. Suggested spacing for block planting is 2x2m or 2.5x2.5m. Prior to planting the site should be prepared with adequate soil and water conservation measures, terracing is suggested in sloppy areas. After staking and alignment, one year old stumps are planted in crowbar holes. Adequate precautions are to be taken to avoid water stagnation at the planting hole. Preferred time of planting is just after the pre monsoon showers. Teak is highly amenable to suppression by weeds. Hence, three weedings are invariably required during the first planting season followed by two weedings in the second year and one in the third year. Fertilizer additions are not recommended during the first year. However, application of well rotten FYM or cow dung @ 3 kg per plant is suggested during 2nd and 3rd year. After the third year when the seedlings get fully established, cover crops such as pureria or calapagonium may be grown with dual purpose of weed suppression and soil enrichment. The trees need to be thinned out for the proper growth of the remaining trees. The recommended thinning cycle is 5, 10,20,30,40 years (Balasundaran and Gnanaharan, 1997).

Marketing

Natural teak forests occur in only four countries in the world; India, Lao PDR, Myanmar and Thailand. Sites suitable for vigorous teak growth are confined to tropical zones around the equator below1000 meter altitude, with annual rain fall in excess of 1500 mm, and fertile, deep and well-drained soils. In the 19th century, India was the world's leading teak producer. Under the British colonial government, large quantities of teak were exported to Europe, mainly for ship building and luxury furniture. Asia holds more than 90% of the world's teak resources and India alone manages 38% of the world's planted teak forests. Production of high quality teak wood in relatively long rotations of 50-70 years has been the traditional practice ever since the first world's teak plantation was established in Nilambur, Kerala in 1840s. Due to dwindling supply of teak from natural forests, teak logs from shorter rotations of 20-30 years appeared promising and are being practiced for veneer and saw log production for relatively quick returns.

Price and quality

As general rule it can be established that teak prices are very closely related to wood quality. Quality in teak is determined by dimension, bole shape (roundness and straightness), heartwood/sapwood ratio, and regularity of annual rings, number of knots, colour, texture and the soundness of the butt log. Teak from natural forests in general possesses many of these features to some extent and is sold at comparatively high prices. Forest department has a long tradition of producing and marketing timber. Timber depot is one of the marketing options for teak wood maintained by forest department. In an auction conducted on February 3, 2005, at the Timber Sales Division in Palakkad Circle, one log of Nilambur teak fetched Rs. 2,33,539 i.e. Rs. 90,100 per cubic meter.

Table 11.Criteria for major classification of teak wood in India

Straightness and soundness		**Girth**		**Length**	
Grade	**Criteria**	**Girth class**	**Middle girth (cm)***	**Length class**	**Length(m)**
A	Logs straight and sound without any defects	Export	185 and above	SL(Short Length)	Above 1&below2.5
B	Fairly straight and sound logs	I	150-184	ML(Medium Length)	2.5 -7.3
C	Defective and crooked logs	II	100-149	LL(Long &Lengthy)	Above7.3
D	Highly defective and crooked logs	III	75-99	-	-

Table 12.Prices of Teak logs of major quality classes auctioned at the Timber depots of Kerala Forest and Wildlife Department, Government of Kerala in 2013. (Index in Table 11).

Date of Auction: March 6& 25, 2013 Timber Depot: Nedumgayam

Girth class	Straightness and soundness	Length	Quantity sold (m^3)	Average Price/m^3	
				INR	US$*
II	B	LL	0.223	85099	1564.17
III	B	LL	32.948	71188	1308.48
III	C	LL	11.973	56848	1044.90
IV	B	LL	15.224	50952	936.53
IV	C	LL	13.065	43129	792.74

Source: Teaknet, 2013

Table 13. Source wise supply of teak wood in Kerala 2000-01

Sources of supply	Volume(m^3round wood)	Total (%)
Home gardens	31,437	32.6
Forests	50,265	52.5
Import	14,592	15.2
Total supply of teak wood	96,294	100.0

(Krishnankutty *et .al.*,2005)

Table 14. Source wise demand of teak wood in Kerala during 2000-01

Sources of demand	Volume(m^3round wood)	Total (%)
Household	73,855	76
Industries	6,481	6.7
Service	2,033	2.1
Export	13,925	14.5
Total supplyof teak wood	96,294	100

(Krishnankutty *et .al.*, 2005)

k. Uniqueness

Teak is considered as one of the royal wood obtained from the tree *Tectona grandis*. Nilambur teak is the teak wood obtained from the teak plantations forest areas and homesteads in Nilambur Taluk and Edavanna panchayath of Ernad Taluk of Malappuram district, Kerala, India. Teak is a large deciduous tree with rounded crown. Heart wood is dark golden yellow in colour sometimes with dark streaks, turning brown with age, oily with a characteristic color, extremely durable and does not warp or split. Nilambur Teak is considered a very valuable wood due to its ability to withstand inclement weather. It is very stable, which means that it does not warp when subjected to variations in humidity and temperature. Nilambur teak being a moderately fast-growing tree species, in the initial years attains about 50 m height. The superiority of teak from Nilambur and surrounding regions for ship building and structural purpose are due to the large size and form of the tree, the color and workability of the wood and its ability to withstand weathering. This unique quality of Nilambur teak is the major factor that helped to gain the worldwide attention for it in the ship and yacht building. Nilambur teak has unique qualities such as world renowned golden yellow color and attractive figure. It is famous for its elegance, class, grandeur, durability, antiquity, grace and strength. Teak grows fast in Nilambur and yields large diameter logs. The wood has straight grain with golden yellowish brown colour, often with darker chocolate-brown streaks.It is the most important timber tree of India and unique for shipbuilding. Nilambur teak is famous for its elegance, class, grandeur, durability, antiquity, grace and strength. The durability of teak is the result of synergetic effect of total extractive compounds(12.44%-15.98%) especially the polyphenolic compounds mainly tectoquinone and naphthoquinone. The hydrophobicity, antioxidant properties and oily nature of teak wood were mainly due to Caoutchouc compound. It even prevents any metal used in it from rusting. It is proved that tectoquinone (2-methyl anthraquinone) which is characteristically present in Nilambur teak (heartwood) is a repellent to the dry wood termite, and it ranged between 0.23% and 0.34%. The resistance to fungal decay is mainly due to naphthoquinone (0.62%-1.26%) and its derivatives present in teak wood. The world renowned golden yellow colour of Nilambur teak is due to the presence of high percentage of extractive content in wood. In a comparative study it was revealed that extractive content (%) was more in Nilambur teak compared to extractive content in teak from many other locations (Table 20). The total extractive content in teak increases as the trees become older and there by the durability (Thulasidas and Bhat, 2006).

The superiority of teak for ship building and structural purpose are due to the large size, tree form, color and workability. Teak is a privileged wood withstanding termite attack. Unique wood properties of Nilambur teak is provided in Table 15, 16, 17, 18, 19 and 20.

Table 15. Unique wood properties of Nilambur teak wood.

Sl. No.	Wood Properties	Values - Range
1.	Specific gravity (G)	0.70-1.42
2.	Specific gravity (AD)	0.60-0.79
3.	Specific gravity (OD)	0.58-0.77
4.	Radial shrinkage (G to AD)	0.39-1.75
5.	Radial shrinkage (AD to OD)	1.04-2.85
6.	Radial shrinkage (G to OD)	2.29-4.33
7.	Tangential shrinkage (G to AD)	0.54-3.96
8.	Tangential shrinkage (AD to OD)	0.89-3.18
9.	Tangential shrinkage (G to OD)	3.70-5.47
10.	Moisture content (G)	20.95-91.00
11.	Heartwood (%)	70.5
12.	Extractive content (%)	6.58-19.00
13.	Heartwood colour	Golden Brown
14.	A. Munsel System - Hue	7.5
	Value	5
	Chroma	4
15.	Colour description 7.5YR/5/4	Brown
16.	Vessel diameter (µm)	210-290
17.	Vessel area (µm)	39850-92583
18.	Vessel frequency (mm-2)	2-6
19.	Ray height (µm)	368.8-671.3
20.	Ray width (µm)	28.8-78.8
21.	Ray frequency (mm-1)	2-6

Nilambur teak wood has oily feel, strongly and characteristically scented when fresh without characteristic taste. It is easily worked with both hand and machine tools. It is called as 'Carpenter's delight'. It can be worked by hand to a good smooth surface, and can be brought to a fine wax polished finish with little filling.

Table 16. Average wood specific gravity (green, air dry and oven dry) of Nilambur teak in comparison with teak from other localities.

Location	Specific Gravity (Green)	Specific Gravity (Air Dry)	Specific Gravity (Oven Dry)
Nilambur	0.92	0.73	0.68
Ranni	0.77	0.71	0.65
Konni	0.80	0.64	0.58
Malayattoor	0.86	0.76	0.67
Vadavar	1.17	0.81	0.71
Myanmar	0.86	0.71	0.63
Thailand	0.87	0.72	0.66
Ghana	0.64	0.60	0.55
Cameroon	0.80	0.68	0.62
Trinidad	0.92	0.69	0.60

(Anish *et.al.*,2015)

Specific gravity, which is a very important physical property of wood, influences all the other properties such as anatomical, mechanical and other properties and therefore has an important role in deciding the utilization value of a timber. Higher the values better will be the timber quality, particularly the strength. The above table shows that specific gravity values of the Nilambur teak, under all the three conditions (green, air dry and oven dry) are generally high compared to other locations. As specific gravity is correlated with strength properties of wood, Nilambur teak is superior taking into account the above important property. (Anish *et.al.*, 2015).

Table 17. Variation in Tangential shrinkage of teak from different localities

Location	Radial Shrinkage			Tangential Shrinkage		
	Green to air dryness	Air dry to oven dryness	Green to oven dryness	Green to air dryness	Air dry to oven dryness	Green to oven dryness
Nilambur	1.05	1.95	3.04	2.43	2.05	4.60
Ranni	0.88	1.84	2.74	2.56	2.59	5.29
Konni	0.75	1.44	2.21	2.08	2.49	4.66
Malayattoor	0.74	1.34	2.09	1.89	2.22	4.19
Vadavar	1.23	1.51	2.77	2.65[a]	2.17	4.95
Camaroon	1.08	1.29	2.39	2.19	2.59	4.89
Ghana	1.03	1.47	2.53	2.25	2.78	5.14
Myanmar	0.92	1.07	2.01	2.76	2.54	5.44
Thailand	0.96	1.23	2.22	2.18	2.45	4.73
Trinidad	0.75	1.30	2.06	2.10	2.09	4.28

(Anish *et.al.*, 2015)

Table 18. Coefficient of anisotropy of teak wood from different locations

Sl. No.	Location	Coefficient of anisotropy *
1.	Nilambur	1.55
2.	Konni	2.27
3.	Malayattoor	2.22
4.	Ranni	2.20
5.	Vadavar	1.89
6.	Cameroon	2.42
7.	Ghana	2.37
8.	Myanmar	2.79
9.	Thailand	2.16
10.	Trinidad	2.23

*Green to oven dry

(Anish *et.al.*, 2015)

Coefficient of anisotropy is the ratio between tangential shrinkage and radial shrinkage and it is a measure of dimensional stability of timbers which influences the ability of timbers to resist climatic variations. Lower the ratios, more dimensionally stable the wood is. The percentage wood shrinkage in radial as well as tangential direction at three conditions like green to air dry, air dry to oven dry and green to oven dry, is less for Nilambur teak, indicating its stability. The co-efficient of anisotropy is found to be less i.e., 1.55 for Nilambur teak which indicates better stability and hence, improved timber quality. The heartwood proportion, which is the naturally durable part of the timber for which teak was well known, is an important factor determining wood quality. As heartwood to sapwood ratio is high, the percentage of volume of heartwood obtained from an individual tree would be higher for Nilambur teak.

There is a profound influence of planting locations on wood colour and texture in teak. The Nilambur teak is gold brown in colour whereas teak from Vadavar, Myanmar and Trinidad are yellow to yellowish brown in colour. Scientific studies had shown that the vessel diameter, vessel area, ray height, ray width and ray frequency are low in Nilambur teak compared to the other teak locations. It also has a higher extractive content. Teak from Nilambur exhibited mechanical maturity of the timber at or before the age of 21 years offering scope for utilization of short rotation wood without compromising the quality in terms of timber strength (Bhat and Indira, 1997).

Table. 19. Comparison of wood properties of Teak from Nilambur and other locations

Sl. No.	Location	Vessel Diameter (µm)	Vessel Area (logarithmic Transformed± SD)	Vessel Frequency (No./mm^2)	Ray Height (µm)	Ray Width (µm)	Ray Frequency (No./mm^2)
1.	**Nilambur (Kerala)**	206.02	50746.6	4	542.75	48.83	4
2.	**Ranni (Kerala)**	212.08	49657.3	7	554.42	44.75	9
3.	**Konni (Kerala)**	282.75	88583.4	6	1065.23	96.01	5
4.	**Malayattoor (Kerala)**	222.82	57890.0	9	669.67	52.67	8
5.	**Vadavar (TN)**	223.33	58794.3	8	717.17	64.33	8

6.	**Cameroon**	205.50	44985.7	6	645.58	80.08	7
7.	**Ghana**	230.42	58226.7	7	680.27	65.83	7
8.	**Myanmar**	342.92	117653.6	3	665.17^{bc}	47.41	5
9.	**Thailand**	143.67	28504.0	6	668.92	77.75	5
10.	**Trinidad**	258.67	73909.7	7	649.08	52.42	8

Table 20. Variation in extractive content (%) of teak from different localities.

Location	Extractive content (%)
Nilambur	8.053
Benin	6.607
Ranni	6.205
Cameroon	7.817
Ghana	6.885
Tanzania	7.132
Vadavar	7.472
Myanmar	9.643
Thailand	8.807
Betul	10.437
Konni	11.133
Sudan	5.022
Malayattoor	9.218
Trinidad	10.190

(Anish *et.al.*, 2015)

The studies on genetic diversity of teak using AFLP markers (Fig. 1) revealed that Kerala populations viz., Konni, Thrissur, Parambikulam and Wayanad together with Tamil Nadu (Pollachi) fall into a separate cluster with its own sub clusters with Nilambur standing out separately from all these populations. The uniqueness of Nilambur teak with respect to growth and wood quality is world famous. It is a different category compared to teak from other Kerala locations as evident from AFLP analysis. The Malabar teak (Nilambur, Kerala) from the Western Ghat region in India, had good growth and log dimensions with desired wood figure with golden yellowish Brown colour (Bhat and Priya, 2004). Nilambur valley is reported to have the most suitable alluvial soil and climatic condition required for good quality teak. The unique edaphic and climatic factors in Nilambur might have resulted in a different type of evolution in the natural teak populations (Balasundaran *et al.*, 2010).

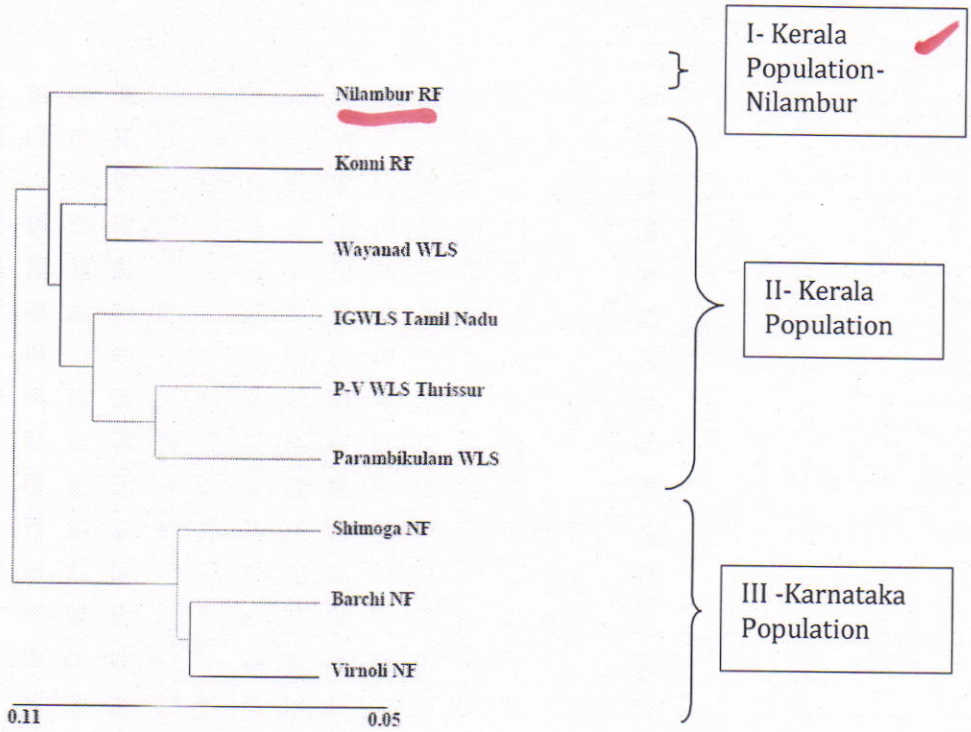

Fig.1. Dendrogram constructed based on Nei's (1978) genetic distance coefficients of nine natural populations of teak.

RF: Reserve Forests; WLS: Wildlife Sanctuary; IGWS: Indira Gandhi Wildlife Sanctuary; P-V WLS: Peechi – Vazhani Wildlife Sanctuary; NF: Natural Forests.

(Source: Balasundaran *et .al.*, 2010)

Nilambur teak, historically know as Malabar teak, showed good log dimensions having golden yellowish brown colour and highest per cent of heart wood among Indian teak provenances had excellent reputation in world trade (Bhat *et .al.,* 2008). Nilambur teak has got a separate identity by virtue of its wood quality, growth, genetic distance from other population from the Western Ghats and the SSR study- reported allelic richness. In spite of all these facts AFLP diversity for Nilambur teak (0.1980) was lesser than that of other Kerala populations. The lowest gene diversity showed by Nilambur teak was not unexpected considering the centuries of natural teak extraction and fragmentation of teak forest of Nilambur valley (Kunhikrishnan, 1997; Sreekanth *et. al.*, 2012).

The cluster analysis based on AFLP data from 180 genotypes using PHYLIP 3.66 software generated a unique dendrogram (Fig. 2). The dendrogram divided 180 genotypes into two main clusters of six populations from Kerala and Tamil Nadu, and three populations from Karnataka. The first cluster comprised of three sub clusters to which the Nilambur population is joined as it stood out separately. Thrissur and Parambikulam constituted one sub cluster while Pollachi and Wayanad formed the other sub cluster. Konni population remained as a separate entity. The observations of the genetic structure inside each cluster clearly revealed tight grouping of 20 genotypes from each population justifying the different geographic origin of the populations (Sreekanth *et al.*, 2012) (Annexure 6 - copy enclosed)

The Principal coordinate analysis (PCoA) revealed three distinct clusters of genetic relationships between the nine populations used in this study (Sreekanth *et al.*, 2012). The populations from Kerala (viz. Konni, Thrissur, Parambikulam and Wayanad) and Pollachi were grouped in Cluster II, whereas the genotypes from Nilambur population grouped separately in Cluster I. The Karnataka populations (viz. Shimoga, Barchi and Virnoli) clustered along Cluster III (Fig. 3).

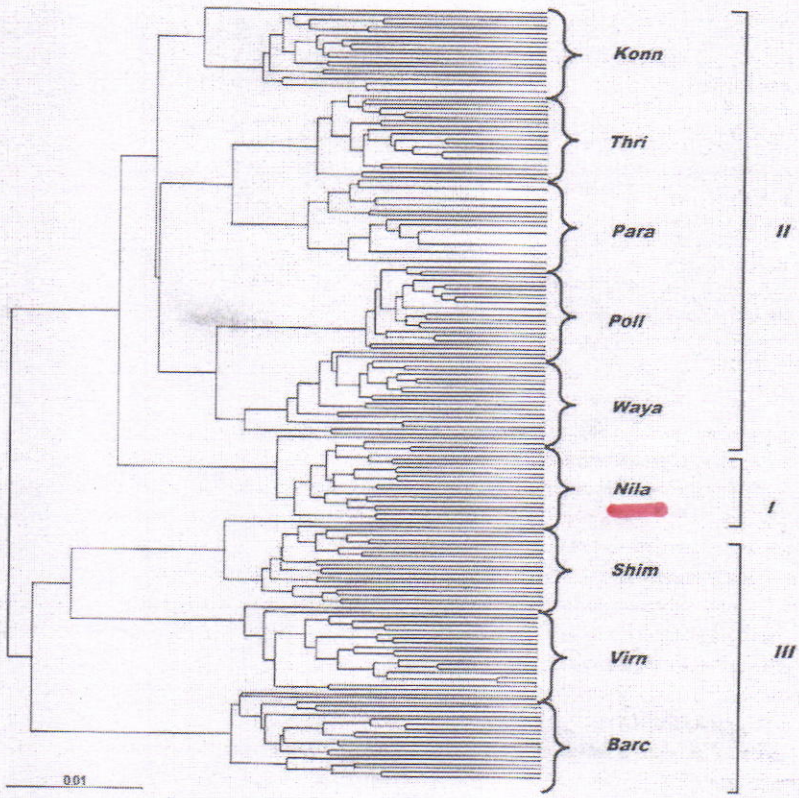

Fig. 2 UPGMA dendrogram of genetic relationships of 180 natural teak trees. *Virn* Virnoli, *Barc* Bârchi, *Shim* Shimoga, *Waya* Wayanad WLS, *Nila* Nilambur, *Poll* Pollachi IGWLS, *Thri* Thrissur P-V WLS, *Para* Parambikulam WLS, *Konn* Konni

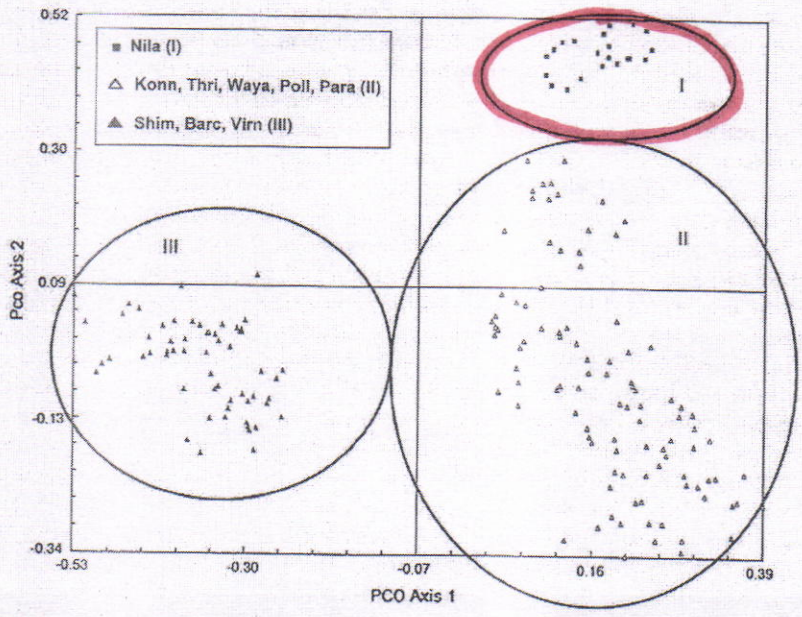

Fig. 3 Principal coordinate analysis (PCoA) of 180 genotypes of natural teak. *Filled square box* indicates Nila (*I*), *unfilled triangle indicates* Konn, Thri, Waya, Poll, Para (*II*) and *filled triangle* indicates Shim, Barc, Virn (*III*)

(Sreekanth *et al.*, 2012)

The morphological and molecular analysis of Nilambur teak proved the uniqueness of this population, compared to other populations of Kerala and Tamil Nadu.

Teak thrives well on a variety of soils but it grows better in well drained soils with high oxygen content and neutral pH, and beyond 8.5 pH, the tree suffers growth. Griffith and Gupta (1948) showed the superiority of alluvial sites over other sites for teak in Nilambur. In Nilambur, Kadambi (1972) noted that the following factors were helpful for high quality of teak, viz. high SiO_2/R_2O_3 ratio in the soil, alluvial site, high content of bases, especially Ca and Mg in the soil, good moisture availability, sandy loam texture and good drainage.

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GI APPLICATION No.
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Inspection body:

Inspection body will be constituted with the following members

1. President, Nilambur Teak Heritage Society, Nilambur
2. Secretary, Nilambur Teak Heritage Society, Nilambur
3. Director of Research, Kerala Agricultural University, Thrissur
4. Dean, College of Forestry, Kerala Agricultural University, Thrissur
5. Co-ordinator, IPR Cell, Kerala Agricultural University, Thrissur
6. Divisional Forest Officer, Nilambur North Division
7. Divisional Forest Officer, Nilambur South Division
8. Scientist in Charge, KFRI Sub Centre, Nilambur

Along with the Statement of Case in Class 31 in respect of Nilambur Teak in the name of Nilambur Teak Heritage Society, Malappuram District whose address is

Nilambur Teak Heritage Society,
Post Box No. 18, VIP Colony,
Veliyamthode, Chandakkunnu Post,
Nilambur Taluk, Malappuram District
Pin - 679329

who claim to represent the interest of the producers of the said good to which the geographical indications relates and which is in continuous use since time immemorial in respect of the said goods.

1. Other necessary particulars called for in rule 32(1) are given in the Statement of Case
2. All communications related to this application may be sent to the following address in India.

Director of Research,
Kerala Agricultural University
KAU (P. O), Thrissur – 680 656
Kerala, India

For NILAMBUR TEAK HERITAGE SOCIETY

K.M.RAGHUNATH

GENERAL SECRETARY

Signature

Name of the signatory in block letters

NILAMBUR TEAK HERITAGE SOCIETY ★ NILAMBUR ★ Date

Teak Plant Morphology

Flower

Inflorescence

Leaf

Seed

Stem

Canopy

Teak museum- in the Mecca of Teak, KFRI Subcentre, Nilambur

Teak information system at teak museum

Library at teak museum

Foot Prints of History- Conolly's Plot At Nilambur

Conolly's Plot At Nilambur

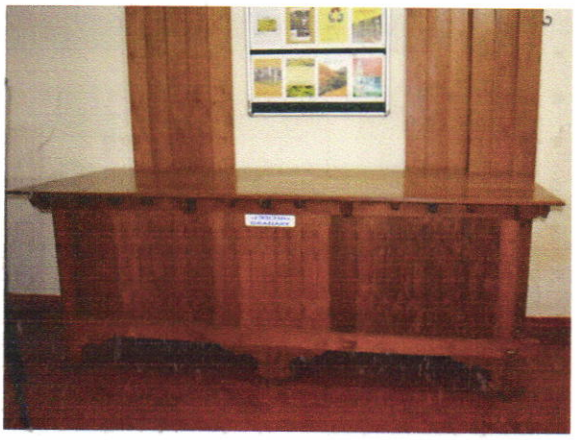
Bridge over Chaliyar river

Mr. H.V.Connoly

Teak for auction at Aruvacode depot, Nilambur

Teak depot at Aruvacode, Nilambur

Teak depot at Nedumkaym



Teak wood products

Construction of Uru at Chaliyam