

# PRODUCTIVITY OF TEAK IN RELATION TO SITE CONDITIONS AND MANAGEMENT REGIMES

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Scientist



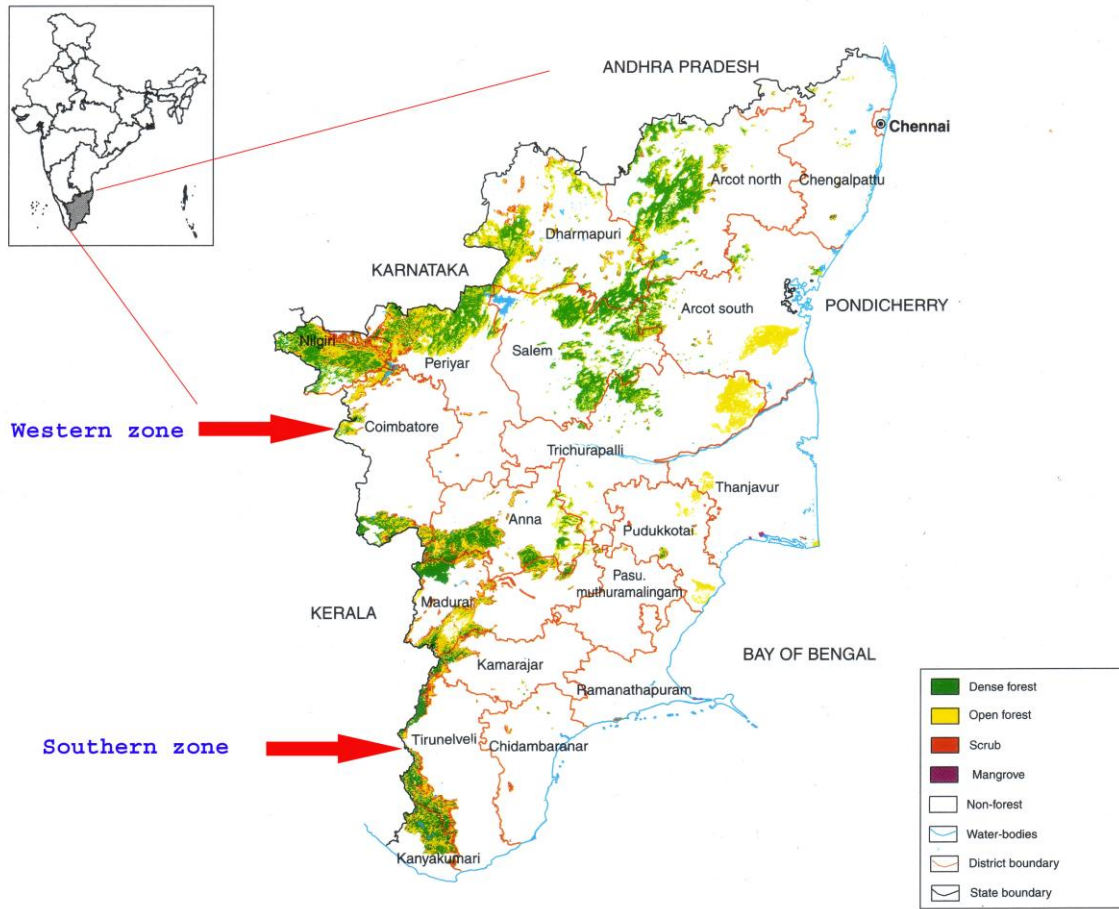
INSTITUTE OF FOREST GENETICS AND TREE BREEDING  
(INDIAN COUNCIL OF FORESTRY RESEARCH AND EDUCATION)  
COIMBATORE  
TAMIL NADU



• Studies on productivity at different locations having varied site potential will project productivity patterns as a prelude to enlarge plantation efforts.

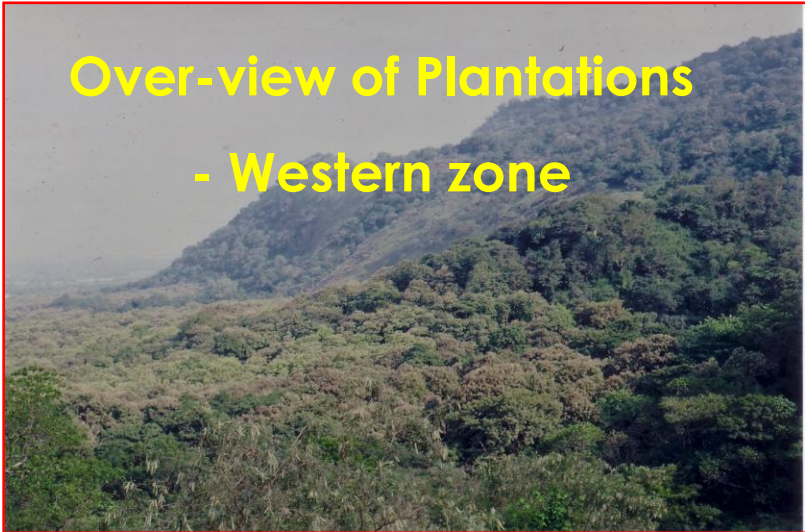
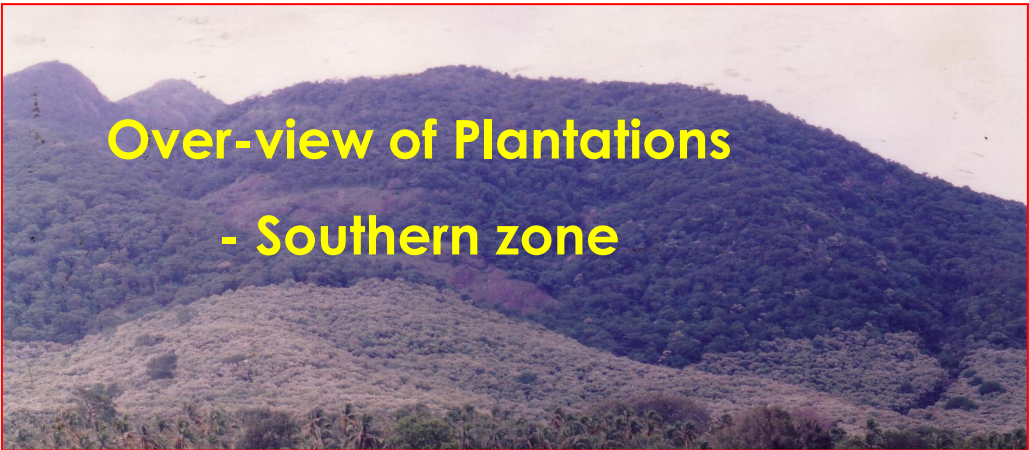
### Case study - I

- **To estimate productivity of teak plantations at different ages grown in two agro- climatic regions of Tamil Nadu.**
- **To study the influence of site factors on the wood properties.**



# STUDY SITES

- Southern zone  
–Tirunelveli Forest Division
- Western zone  
- Coimbatore Forest Division



# Methods

- 15 plantations
- Age groups - ranging from 20 to 47 years
- 20 sample plots of 20 x 20 m size in each plantation
- Stratified average tree technique (Art and Marks, 1971)
- Collected basic data on dry matter and volume production (Chaturvedi and Khanna, 1982).
- Productivity was worked out .



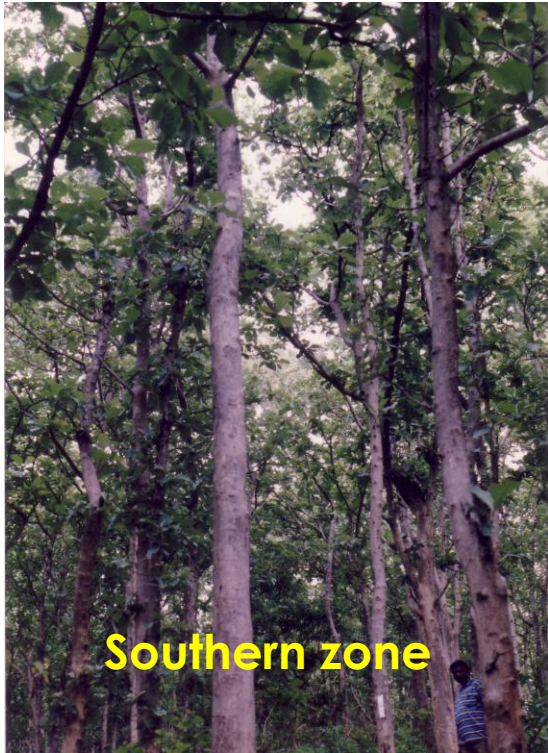
# Descriptive Statistics on girth in 33-years-old teak plantation

33-years-old Teak Plantation	
Mean <i>GBH</i> (cm)	98.87
Standard Error	1.37
Standard Deviation	23.35
Minimum	46
Maximum	166
Count	289
Confidence Level (95.0%)	2.70
CV%	<b>23.61</b>

Huge within plantation variation was observed  
(CV as 23.61%)

## While comparing the volume production in two zones :

- **Bole volume-ob:** Southern zone (272 m<sup>3</sup>/ha) > Western zone (240 m<sup>3</sup>/ha).
- **Similarly, Productivity** (bole volume) was higher in southern zone (12 m<sup>3</sup>/ha/year) than in western zone (8.6 m<sup>3</sup>/ha/year).



Southern zone

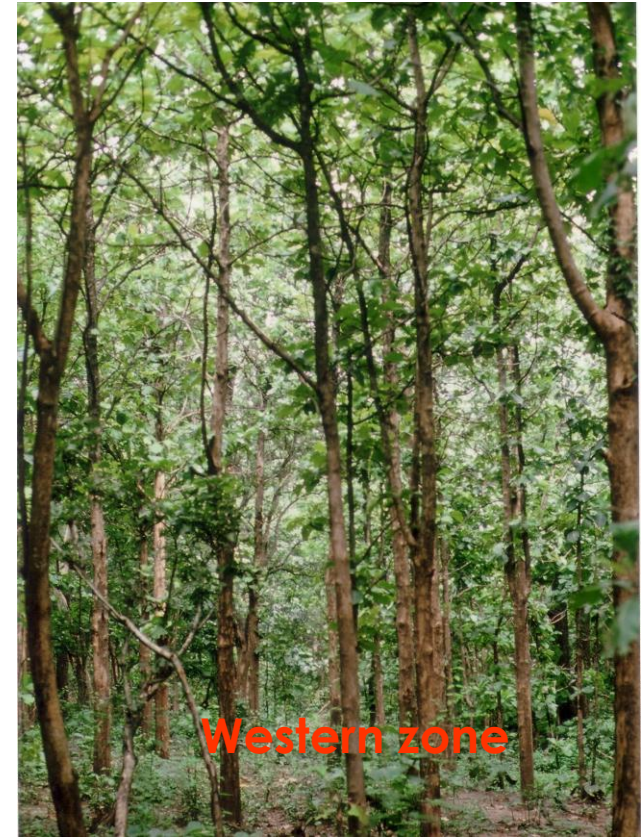
### Standard Stem Timber (m<sup>3</sup>/ ha / year):

- up to top diameter of 20 cm

9.6 in Southern

5.2 in Western

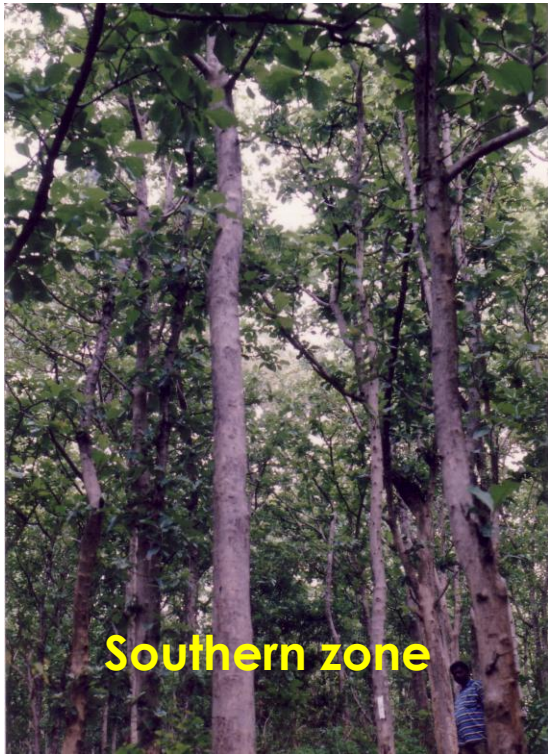
*Dry matter allocation to various biomass components in the same species at similar ages may vary in accordance with change in site conditions.*



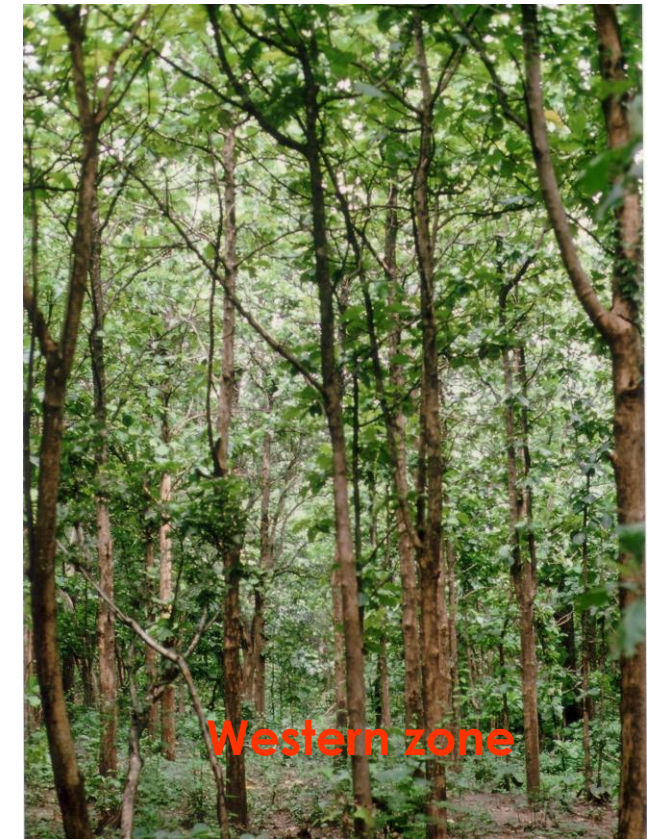
Western zone

## While comparing the volume production in two zones :

- However, **branch wood** (51 m<sup>3</sup>/ha) production was **much greater in western zone** - twice that of in southern zone (27 m<sup>3</sup>/ha).
- In terms of branch wood volume, greater mean productivity was in western zone (2.4 m<sup>3</sup>/ha/year) than southern zone (1.2 m<sup>3</sup>/ha/year).



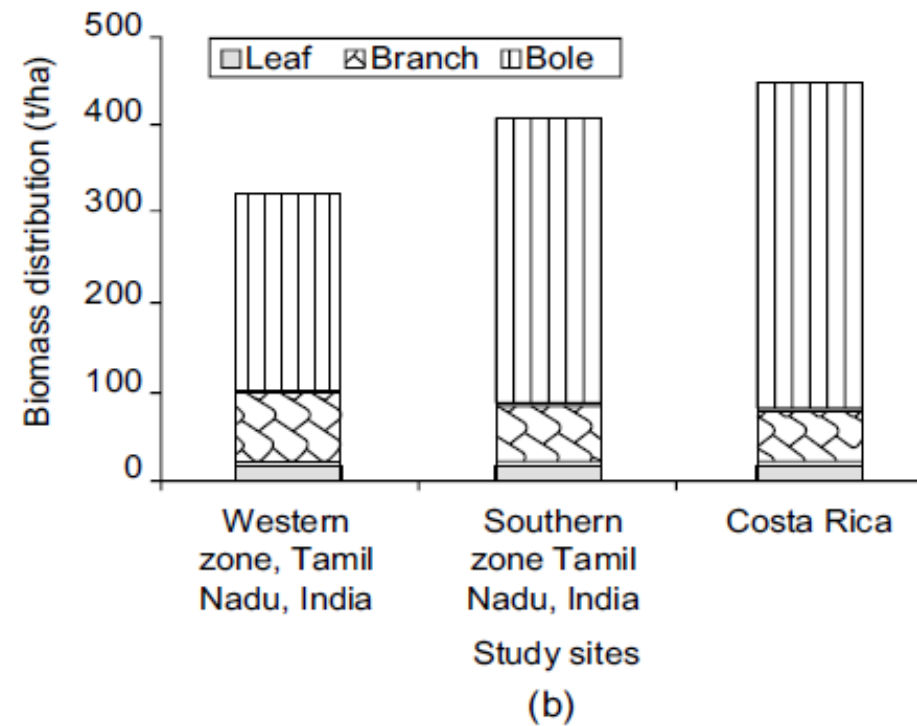
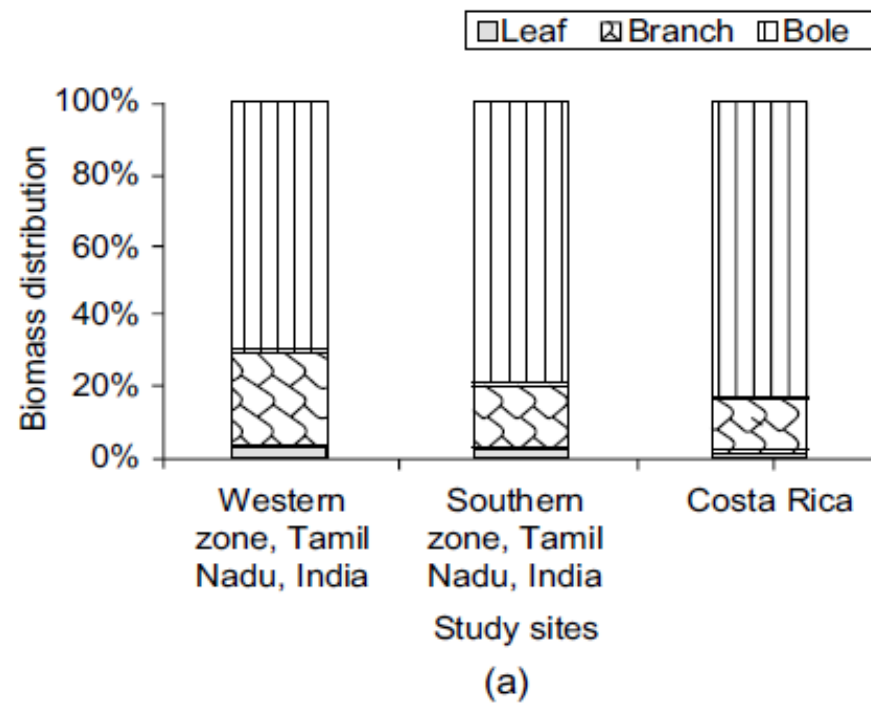
Branches with girth above 20 cm



## NOTES

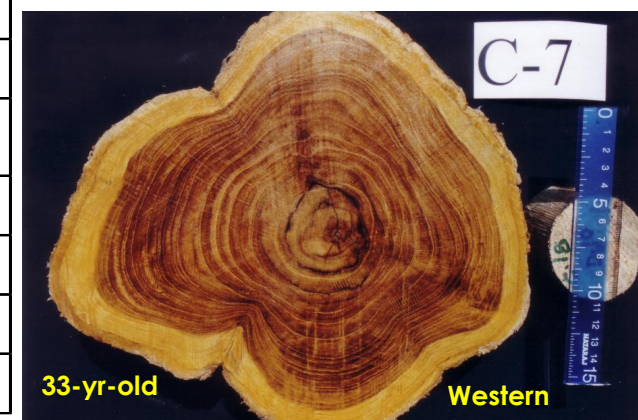
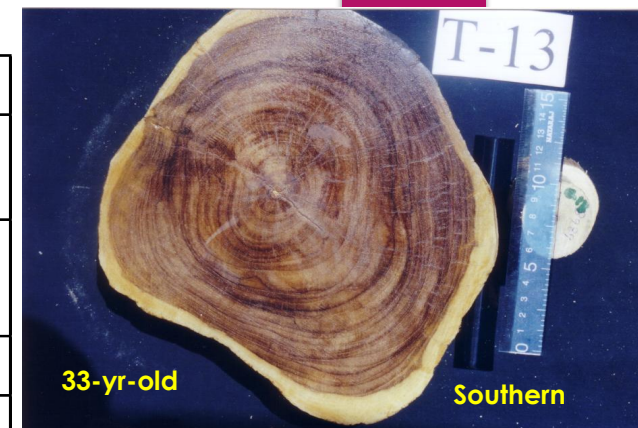
### BIOMASS OF TEAK PLANTATIONS IN TAMIL NADU, INDIA AND COSTA RICA COMPARED

C. Buvaneswaran<sup>1</sup>, M. George<sup>2</sup>, D. Perez<sup>3,\*</sup> & M. Kanninen<sup>4</sup>

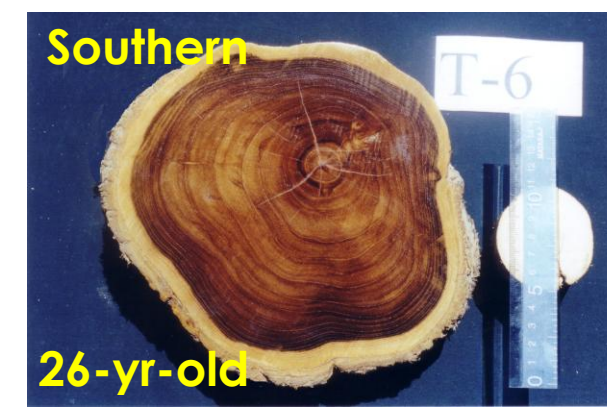
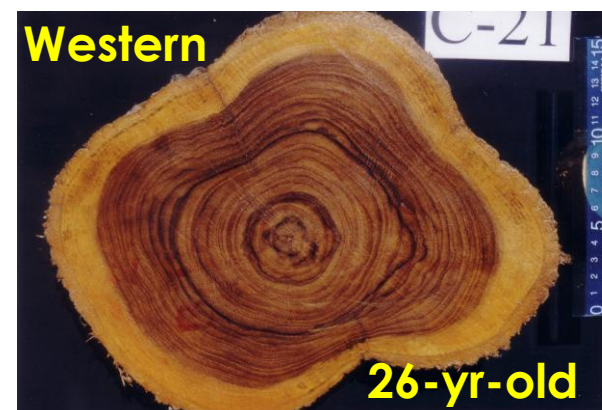


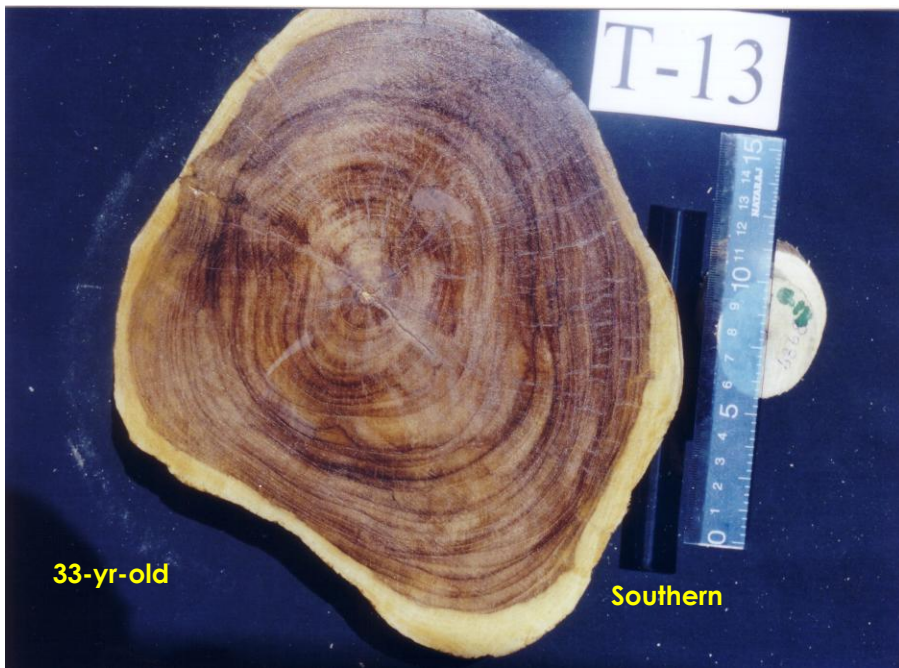
## Heartwood formation in relation to site conditions

Descriptive statistics on properties of wood in teak plantations					
Characteristics	HW area (sq.cm)	SW area (sq.cm)	HW (%)	SW (%)	Density (g/cc)
<b>Southern zone</b>					
Mean	449.7	100.4	<b>81.6</b>	<b>18.4</b>	0.73
Standard Error	38.80	9.50	1.10	1.10	0.009
Standard Deviation	245.0	59.8	7.1	7.1	0.059
CV%	54.5	59.9	8.8	37.2	9.4
<b>Western zone</b>					
Mean	346.0	121.8	<b>71.5</b>	<b>28.5</b>	0.72
Standard Error	29.98	9.13	1.63	1.63	0.006
Standard Deviation	177.4	54.0	9.7	9.7	0.038
CV%	51.3	44.3	13.7	33.1	5.2

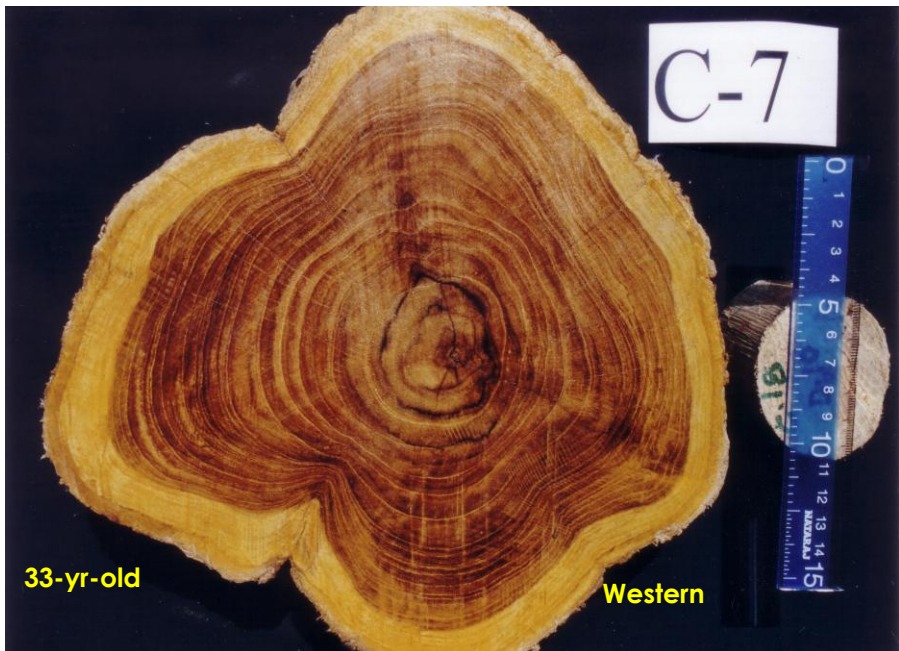


- **Heartwood %** : southern (82) > western (72)
- **Sapwood %** : southern (18) < western (28)
- **Wood density** : southern  $\cong$  western





- 1
  - More Canopy Biomass
  - Heavy wind flow
- 2
  - More transpiration
- 3
  - More Sapwood area to be retained



The primary role of sapwood in a tree is to conduct water from the roots to the crown (Gartner 1995). According to the pipe model (Shinozaki et al. 1964), sufficient sapwood is required to supply the foliage with water, and the amount of foliage on a tree often is strongly correlated to the amount of sapwood (Berthier et al. 2001; Ryan 1989; Dean and Long 1986; Whitehead et al. 1984).

# Relations Between Growth Traits and Wood Parameters of *Tectona grandis* L.f. in Even-Aged Plantations in Tamil Nadu

C. Buvaneswaran, M. George, K. Vinoth Kumar and R. Velumani

## Conclusions

The present study confirms:

- ✓ a significant correlation between tree diameter and heartwood content
- ✓ increased diametrical growth owing to genetics or environmental factors will not bring change in heartwood production.
- ✓ On the other hand, **the proportion of sapwood production is influenced by site factors.**
- ✓ Specific gravity remains unaltered in teak after the wood maturation age of 20 years and beyond.

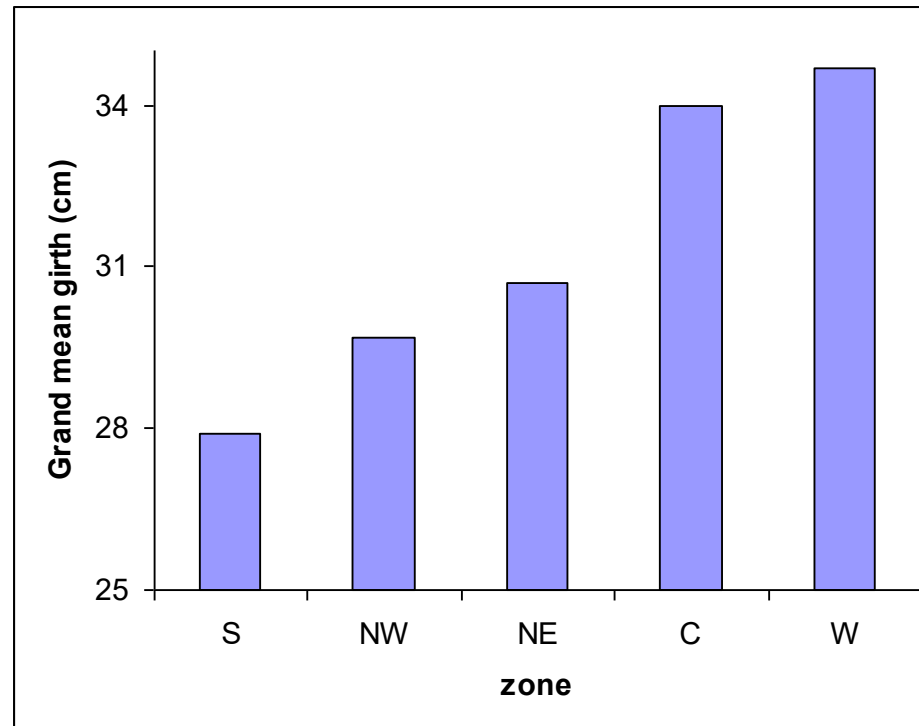
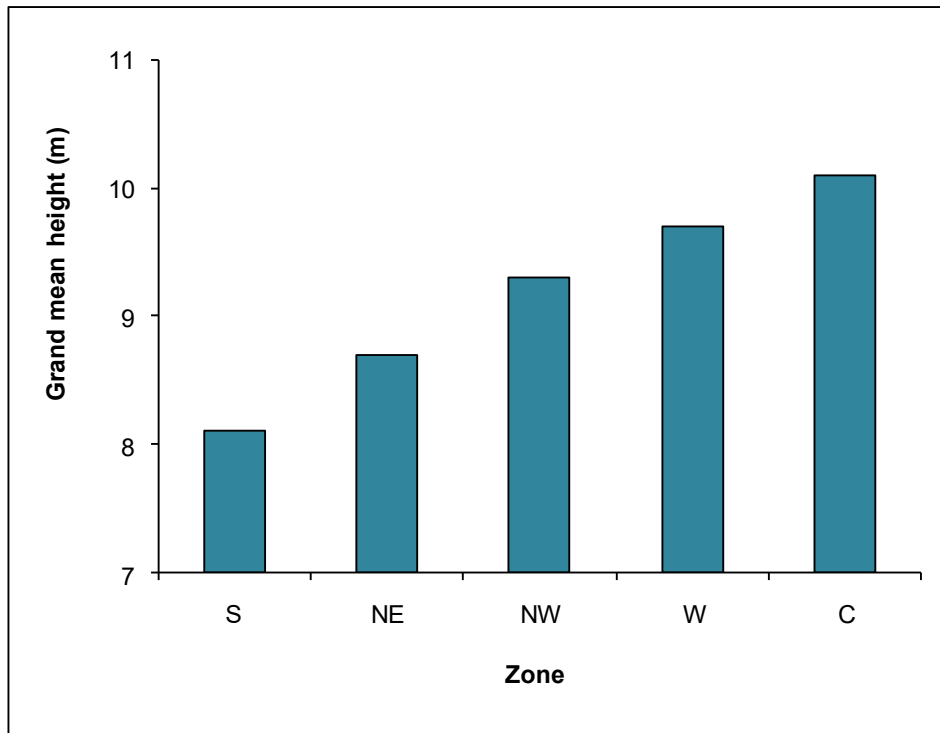
**In contrast to Sandalwood and Res Sanders.....**



## Case study - II

### CULTIVATION OF TEAK (*Tectona grandis* L.f.) IN FARM LAND UNDER DIFFERENT AGRO-CLIMATIC ZONES OF TAMILNADU

A study was carried out in seven agro climatic zones of Tamil nadu and a total of **425** plantations raised in farmlands were investigated with age group varying from two to twelve years.



Quality timber products of  
**TEAK** from  
sustainable forest management

K M Bhat  
K K N Nair  
K V Bhat  
E M Muralidharan  
J K Sharma

Kerala Forest Research Institute  
International Tropical Timber Organization

2003

# Wind – an unfavourable factor for Teak



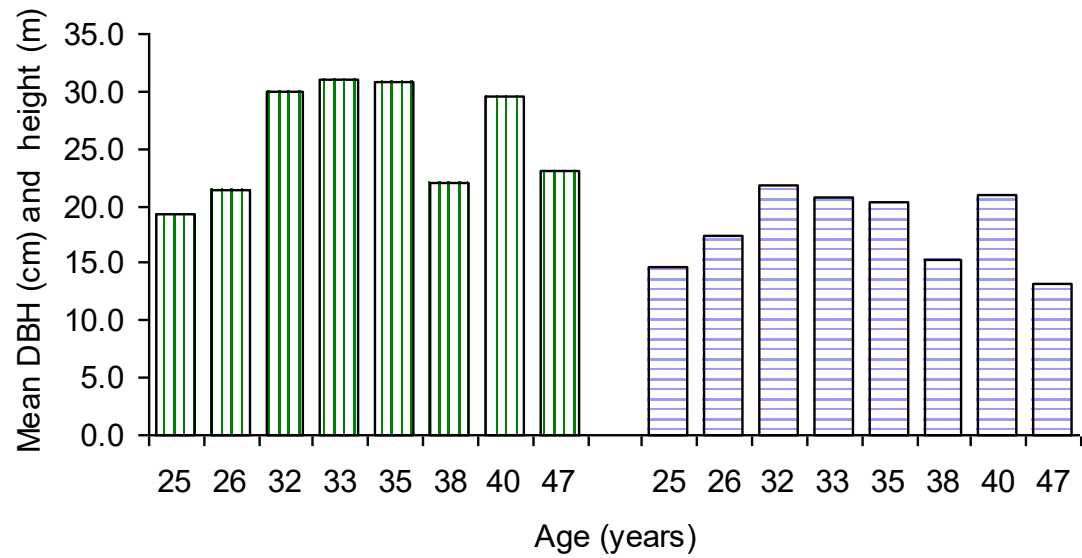
5-years-old Teak plantation in a windy location

# Wind - an unfavourable factor for teak growth (2003)

- My Forest, 39 (3): 247-249

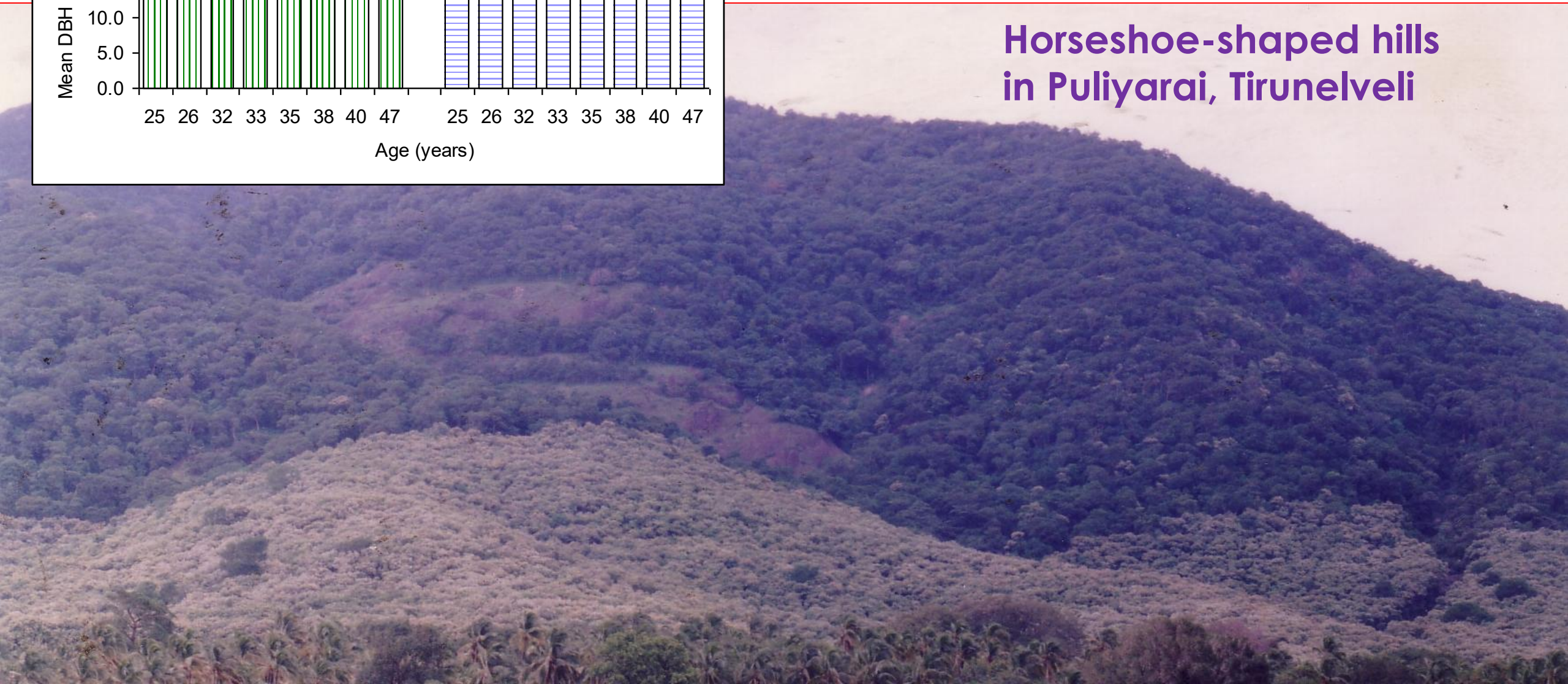


Growth parameters											
Plantation descriptions	Age (Yr)	Girth (cm)					Height (m)				
		Min	Max	Mean	S.D	C.V	Min	Max	Mean	S.D	C.V
Windy location	5	6.5	15.0	10.16	1.82	17.91	1.8	3.5	2.38	0.44	18.44
Wind protected location	5	16.5	27.0	22.74	2.34	10.29	5.5	8.50	6.75	0.61	9.04



**Oldest plantation (47-years-old) recorded lowest mean height owing to its location in top ranges of hill**

**Horseshoe-shaped hills in Puliyarai, Tirunelveli**



**Morgan (1884)** also reported that Teak grows well on the some of the hills in Wayanad over 3,000 feet in elevation, **but does not stand drying easterly winds.**

He has also reported that tree rings in teak on one side it will be wider than those on the other and opined that this is due to the prevailing wind – the exposed side showing slow growth.

FORESTRY IN SOUTHERN INDIA,

BY

MAJOR-GENERAL H. R. MORGAN,  
LATE DEPUTY CONSERVATOR OF FORESTS, MADRAS.

EDITED BY

JOHN SHORTT, M.D., M.R.C.P. & S., F.L.S., &c.,  
RETIRED DEPUTY SURGEON-GENERAL, MADRAS ARMY.

MADRAS:

HIGGINBOTHAM AND CO.  
By Appointment in India to His Royal Highness the Prince of Wales,  
and Publishers to the Madras University.  
1884.

# Growth Assessment of Farm grown Teak (*Tectona grandis* Linn.f) in Tamil Nadu

Case study - III

Total Plantations Covered : 327

Total Block Plantation : 169

Total Boundary Plantation : 158

Age-Class : 3 (5-10, 11-15, 16-20)

Age Class	No.of Fields
5-10	109
11-15	98
16-20	120

2023

## Block Plantations



NEZ



NWZ



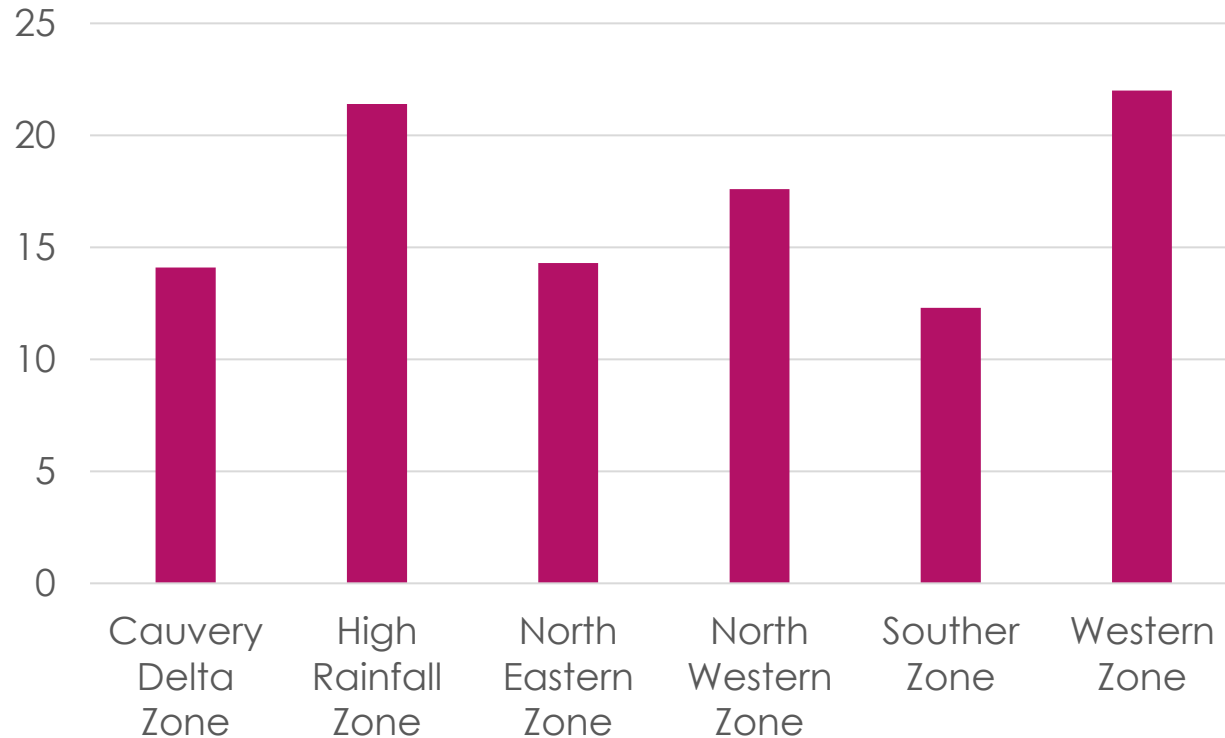
CDZ



WZ

# Productivity of Teak (*Tectona grandis*) in Block under different agro-climatic zones of Tamil Nadu

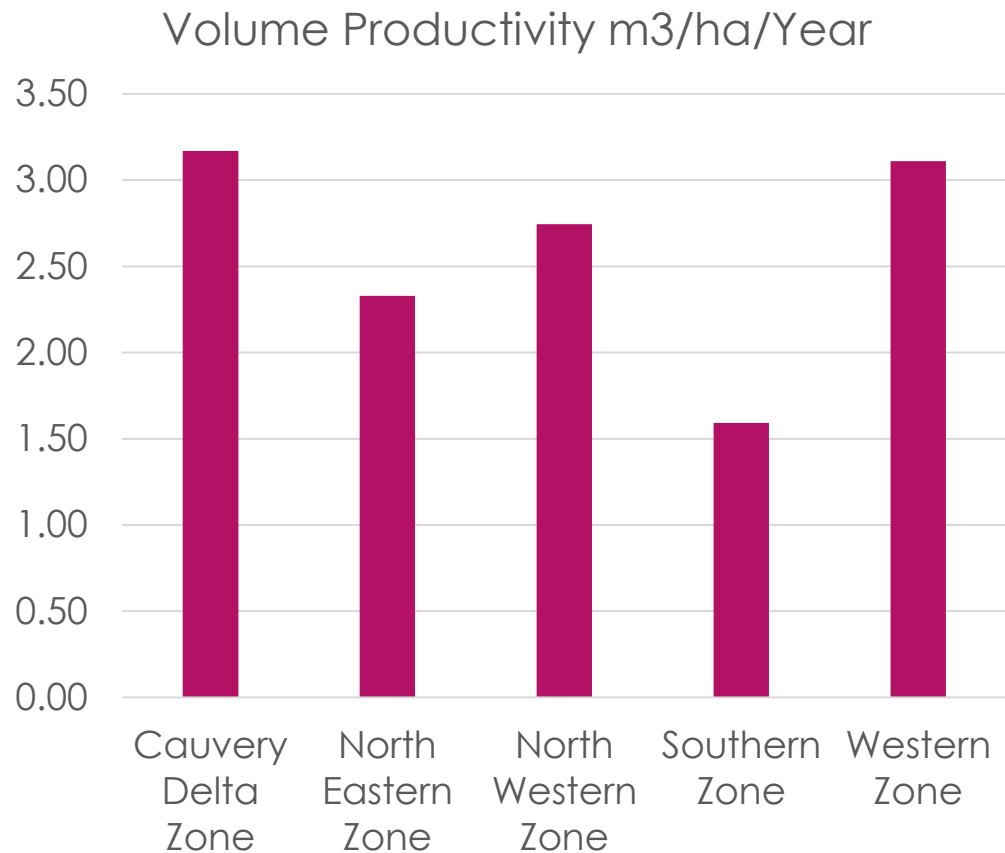
Volume Productivity m<sup>3</sup>/ha/Year



The optimal annual rainfall, equable weather conditions – particularly maximum temperature - and a medium alluvial soil in WZ have attributed to the highest productivity when compare to other agro-climatic zones

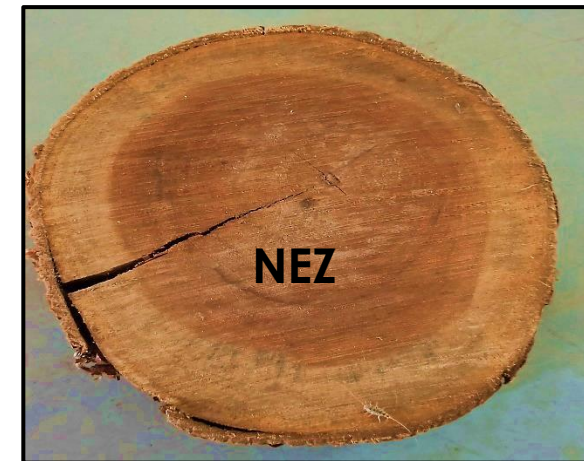
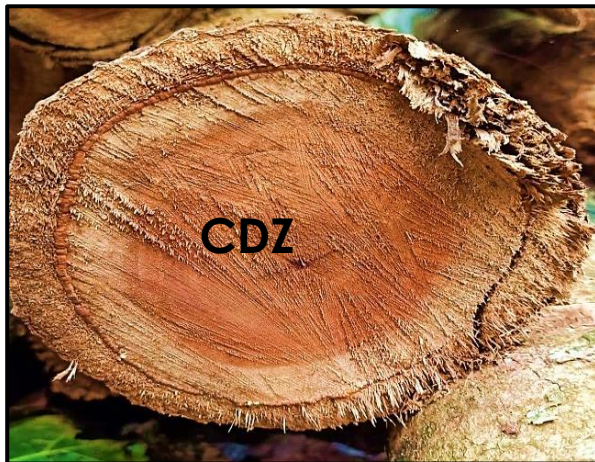


# Productivity of Teak (*Tectona grandis*) in Boundary under different agro-climatic zones of Tamil Nadu



## Wood Fractionation study in Block plantations Teak (*Tectona grandis*) in different agro-climatic zones of Tamil Nadu

Zone	Wood Density (g/cm <sup>3</sup> )	HW Volume (m <sup>3</sup> )	SW Volume (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	HW Volume (%)	SW Volume (%)
NEZ	0.69	0.114	0.072	0.186	61.3	38.7
NWZ	0.68	0.114	0.064	0.178	64.0	36.0
CDZ	0.68	0.048	0.056	0.104	46.2	53.8
WZ	0.68	0.082	0.047	0.129	63.6	36.4



# Wood Fractionation study in block plantations of Teak (*Tectona grandis*) at different ages

Age Class	Wood Density (g/cm <sup>3</sup> )	HW Volume (m <sup>3</sup> )	SW Volume (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	HW Volume (%)	SW Volume (%)
5 to 10 cm	0.62	0.030	0.042	0.071	40.8	59.2
10 to 15 cm	0.70	0.072	0.054	0.126	56.5	43.5
15 to 20 cm	<b>0.75</b>	0.167	0.085	0.252	<b>64.7</b>	35.3

North eastern zone



5-10 Years



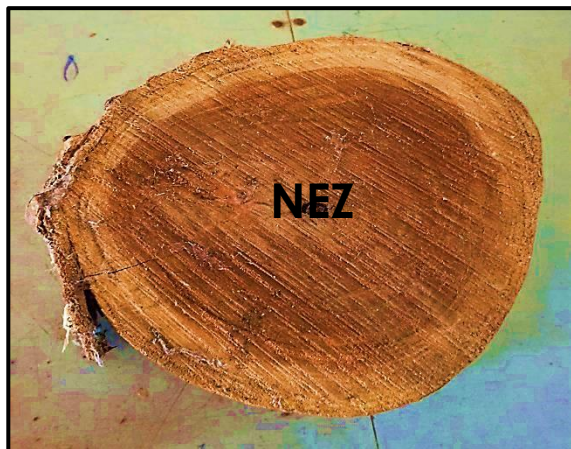
10-15 Years



15-20 Years

## Wood Fractionation study in Boundary plantations Teak (*Tectona grandis*) in different agro-climatic zones of Tamil Nadu

Zone	Wood Density (g/cm <sup>3</sup> )	HW Volume (m <sup>3</sup> )	SW Volume (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	HW Volume (%)	SW Volume (%)
NEZ	0.73	0.197	0.06	0.257	76.7	23.3
NWZ	<b>0.74</b>	0.21	0.052	0.262	<b>80.2</b>	19.8
CDZ	0.71	0.154	0.078	0.232	66.4	33.6
WZ	0.73	0.261	0.1	0.361	72.3	27.7



## Wood Fractionation study in boundary plantations of Teak (*Tectona grandis*) at different ages

Age Class	Wood Density (g/cm <sup>3</sup> )	HW Volume (m <sup>3</sup> )	SW Volume (m <sup>3</sup> )	Total Volume (m <sup>3</sup> )	HW Volume (%)	SW Volume (%)
5 to 10 cm	0.68	0.080	0.049	0.12825	62.3	37.7
10 to 15 cm	0.73	0.1895	0.069	0.258	72.6	27.4
15 to 20 cm	<b>0.78</b>	0.3475	0.101	0.448	<b>77.8</b>	22.2

Western zone  
(WZ)



5-10 Years



10-15 Years



15-20 Years

# Western zone (WZ)

**Block**



**5-10 Years**



**10-15 Years**



**15-20 Years**

**Boundary**



**5-10 Years**



**10-15 Years**



**15-20 Years**

# Cauvery delta zone (CDZ)

**Block**



**5-10 Years**



**10-15 Years**



**15-20 Years**

**Boundary**



**5-10 Years**



**10-15 Years**



**15-20 Years**

## Investigation on the causes of hear-rot disease problems on Teak (*Tectona grandis*) and develop suitable management strategies

V. MOHAN AND K. PALANISAMY  
Division of Forest Protection  
Institute of Forest Genetics and Tree Breeding  
COIMBATORE – 641 002

- Investigated the damage and decay indicators in different Teak plantations of **Cauvery canal bank areas** in Tamil Nadu **over a period of 3 years.**
- It was recorded that **stem canker, punk knot, hollowness and top broken symptoms are very common** in all the canal bank plantations surveyed.
- Occurrence of decay causing basidiomycetous fungus, *Trametes sp.* was reported on the decay portion of the Teak stem in 30-year old plantation at Neyvasal of Thanjavur division. In the same plantation, another decay causing fungus, *Ganoderma sp.* was recorded at the stem base of Teak trees.



## Thinning and DMP

Farmers are generally reluctant to carry out thinning operations.

# Thinning and DMP

## Case study - IV

Dry matter production (MT ha<sup>-1</sup>) of different biomass components of *Tectona grandis* in thinned and un-thinned block plantations\*

Tree density per ha	Age (years)	Leaf	Branch	Stem	Bark	AGB	BGB
2500	15	3.7	32.9	<b>100.1</b>	16.5	153.1	30.6
1250	15	3.9	29.9	<b>69.0</b>	10.6	113.3	22.7

\*thinning done at 10 years age.

**Commercial volume - 3.67 cft per tree in thinned plot**

**- 1.81 cft per tree in un-thinned plot**

# Effect of mixed planting of Teak with *Casuarina*

## Case study - V

In the context of deploying Clonal Teak plants

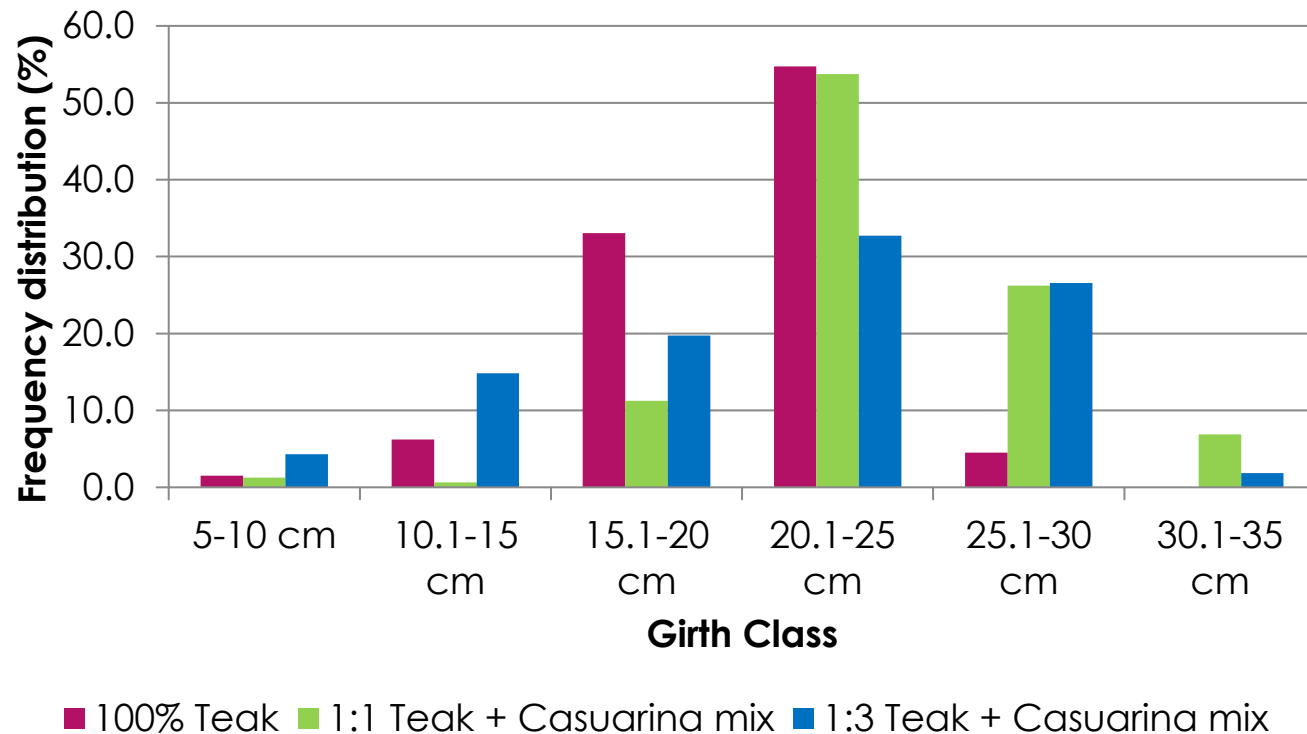
	GBH (cm)			Height (m)		
	Pure Teak (100%)	Teak (1:1)	Teak (1:3)	Pure Teak (100%)	Teak (1:1)	Teak (1:3)
Mean	20.9	24.4	21.6	8.1	9.0	7.9
Standard Error	0.2	0.3	0.4	0.1	0.1	0.2
Minimum	8.0	9.0	7.0	2.5	3.0	2.0
Maximum	30.0	35.0	34.0	10.5	12.0	13.0

Recorded greater girth and height growth under Teak + *Casuarina* in 1:1 proportion



# Effect of mixed planting of Teak with *Casuarina*

There was greater percentage (33.2%) of bigger girth trees (having girth above 25 cm) under trial plot with Teak + *Casuarina* in 1:1 proportion than in pure teak plot (4.5%)



# Statistical Analysis of growth of teak under mixed plantations

ANOVA for girth of teak under 3-year-old pure and mixed plantations						
Source of Variation	SS	df	MS	F-calculated	P-value	F critical
Between Groups	1499.3	2	749.6	45.8	1.5E-19	3.0
Within Groups	12875.5	787	16.3			
Total	14374.8	789				

ANOVA for height of teak under 3-year-old pure and mixed plantations						
Source of Variation	SS	df	MS	F-calculated	P-value	F critical
Between Groups	123.9	2	61.9	31.1	9.67E-14	3.0
Within Groups	1564.8	787	1.9			
Total	1688.7	789				

There exist statistically significant differences among mean girth as well as mean height growth of teak in pure plantations and in mixed plantations at 1:1 and 1:3 proportions of teak and Casuarina

The interim results are encouraging for promoting Teak + *Casuarina* based mixed plantations for harnessing three-pronged benefits *viz.*

- i) enhancing productivity
- ii) reducing of planting stock requirements up to 50% and
- iii) providing short-term and interim economic returns to the teak growers through harvesting of *Casuarina* in 3<sup>rd</sup> or 4<sup>th</sup> year of planting.



# TEAK – AS A SHORT ROTATION CROP

## Case study - VI

Attributes	Farmland		Forestland
	Rows in bunds	Block	Block
Age (years)	12	12	20
Stem wood Volume (cft/tree)	9.9	3.4	4.4
MAI (cft/tree/year)	0.825	0.283	0.220
Percentage of heartwood	40.5	45.8	73.6
Air dry Wood density (g/cc)	0.801	0.813	0.846





# TEAK IN BOUNDARY PLANTING



## Case study - VII

# Effect of mixed boundary planting of Teak with *Casuarina*

1<sup>st</sup> Year

A photograph showing a man standing in a young plantation of Teak and Casuarina trees. The trees are small and newly planted, with a dirt path leading through them. The man is wearing a blue and white patterned shirt and shorts.

2<sup>nd</sup> Year

A photograph showing a view of the Teak and Casuarina plantation in the second year. The trees are slightly taller and more established, with a dirt path leading through them. The ground is dry and sandy.

3<sup>rd</sup> Year

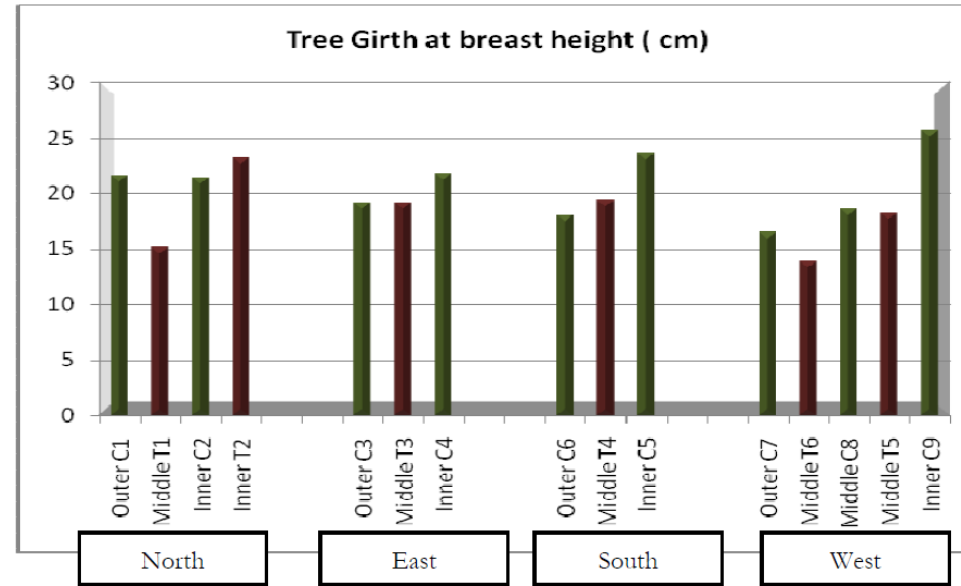
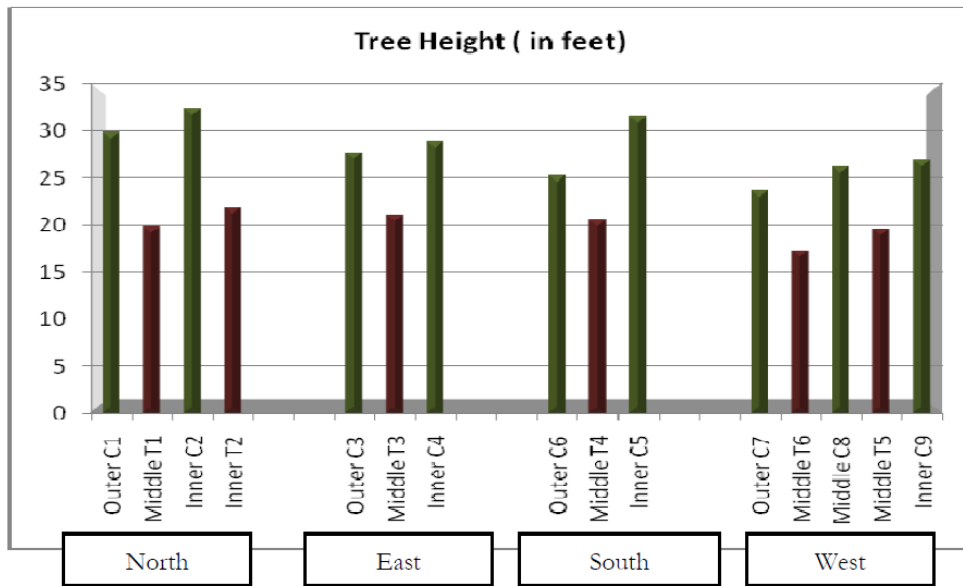
A photograph showing a view of the Teak and Casuarina plantation in the third year. The trees are taller and more densely packed, with a dirt path leading through them. The ground is dry and sandy.

4<sup>th</sup> Year

A photograph showing a view of the Teak and Casuarina plantation in the fourth year. The trees are taller and more densely packed, with a dirt path leading through them. A white van is parked on the path, and a person is standing nearby. The ground is dry and sandy.

# Effect of mixed boundary planting of Teak with *Casuarina*

## Growth of *Casuarina* and teak in inner, outer and middle rows

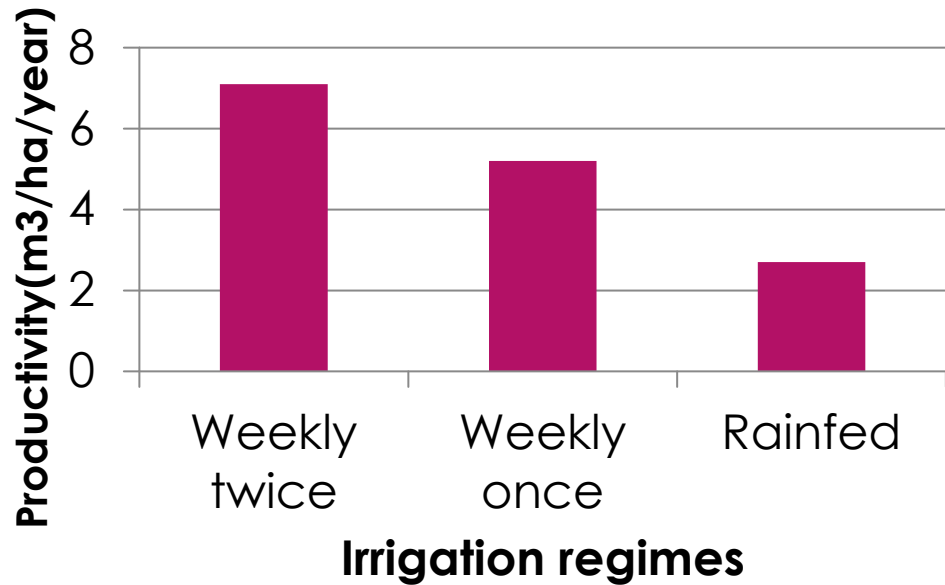


(Age of trees: 3 years)

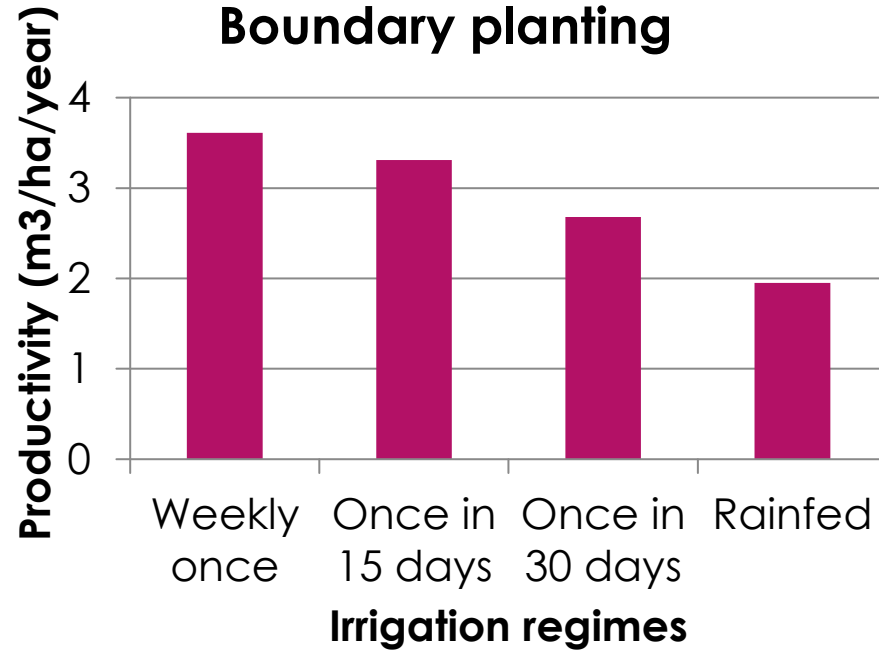
## Case study - VIII

### Productivity (m<sup>3</sup>/ha/year) of Teak under different irrigation regimes

#### Block planting



#### Boundary planting



# Way Forward

- ▶ **More research on “WIND” as a factor for growth of TEAK**
- ▶ **Harness the potential of indigenous nitrogen-fixing tree species through their strategic integration in mixed teak plantations to enhance soil fertility and overall productivity.**
- ▶ **Investigate the influence of silvicultural interventions on heartwood formation in teak to improve timber quality and economic returns.**
- ▶ **Examine the relationship between site factors and heartwood development in teak to identify optimal growing conditions.**
- ▶ **Develop and refine breeding and silvicultural strategies to minimize branching, with special emphasis on boundary planting systems.**
- ▶ **Establish clear and region-specific criteria for land suitability to ensure successful and sustainable teak cultivation.**

# Acknowledgement

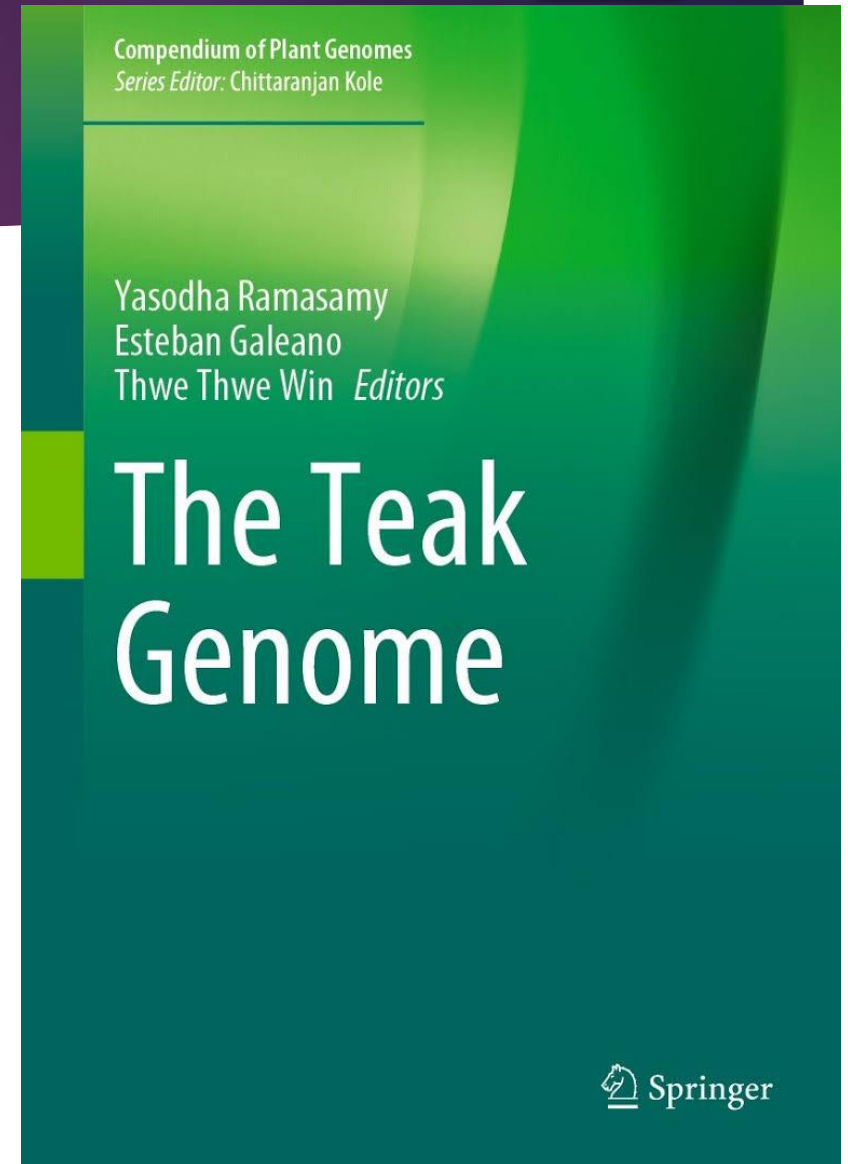
- ▶ Dr. R. Yasodha, Scientist, ICFRE-IFGTB, Coimbatore
- ▶ Prof. Yongyut Trisurat, Kasetsart University, Thailand

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Modern Silvicultural Practices  
and Productivity of Teak

3

Buvaneshwaran Chelliah, Anurag Ravi,  
and Nagarnambi Muthurasu



**THANK YOU**

