

TEAK TREE INVENTORY AND AUDIT REPORT-2023

CONDUCTED FOR

ASIA TEAK GROUP

AT

CHON DEAN 1

THAILAND

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2023 April

Contents

Executive summary	3
1. Introduction.....	3
1.1. General Introduction of Teak (<i>Tectona grandis</i>) Plantation	4
1.2. Activities of teak stand maintenance.....	4
1.2.1. Pruning	4
1.2.2. Thinning.....	4
1.3. Spacing.....	5
1.3.1. Teak growth parameters.....	5
1.4. Positions of diameter measurement at different conditions	6
1.5. Tree height measurement	7
1.5.1. Method of tree height measurement.....	7
1.5.2. Plot size:.....	8
2. Results of inventory of teak plantation	9
2.1. Estate of Chon Dean 01	9
Recommendation	16

Content of Tables

Table 2.1	Number of trees and tree mean DBH values in plots in Chon Dean 1	9
Table 2.2	Estimated number of trees having more than 85cm GBH in Chon Dean 01 Teak plantation	14
Table 2.3	Comparison of tree parameters between year 2022 and 2023 in Chon Dean 1	14
Table 2.4	Sample plots information, planted area and tree inventory data of chon Dean 1	15
Table 2.5	Thailand Teak plantation tree count	15
Table 2.6	Determination of site index based on growth parameters of past years of Chon Dean 1	16

Content of Figures

Figure 2.1	Diameter tape used for the inventory	6
Figure 2.2	Total Tree height was measured by hypsometer and a pole, used instrument of Sununto meter is shown in above	7
Figure 2.3	Part of healthy plantation and canopy is not closed in this area	7
Figure 2.4	Part of the canopy of the plantation.	8
Figure 2.5	GBH measurement of teak tree is being taken	17

Content of Graphs

Graph 3.1	Number of trees against to average GBH range values in Blocks in Chon Dean 1.	10-13
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Executive summary

Teak plantations namely Chon Dean 1 , managed by Asia Teak Tropical Plantation was inspected by Mr.Paul Rockwood and Mr.J.M.P. Jayalath on 2023.2.19-20. Inventory data collected from the plantation was computerized. I analyzed the data and prepared this report.

Chon Dean 01 estate

Twenty sample plots having with total sample area of 30048m² have been permanently setup in different locations in Chon Dean 01 estate. It is found by this study that total estimated planted area is 27.93 ha and sample plots represent 10.7 % of population. In this study, 985 trees were measured for DBH measurement. Tree height measurement were not taken in this year.

The total tree number in 2023 is 8957 which is 127 less than previous year.

The average GBH of trees in the estate is 85.71cn (DBH is 27.3) cm. It is found that average trees per ha is 336. Details of block wise tree information are shown in table (2.4). It was observed that minor errors may occur when counting number of trees in few blocks comparing with last year. It is absolutely negligible and acceptable in forest inventory as human errors.

After analyzing the last 11 years of DBH data (2013-2023), periodic increment for block no.8 is 1.14 cm per year and this figure for block 05 is very low as 0.58 cm per year.

Analyzing inventory tree data it is found that more than 46% of trees are having GBH more than 86 cm. (see graph 3.1 and table 3.2 and 3.2.1 .The total tree number under this category is 4189 out of 8957 . Highest numbers (69%) of trees of this category were found in Block 8.

When analyzed the growth data (DBH) from 2013 to 2023, the periodic increment of DBH of the plantation is 0.82cm To get 0.8 m³ commercial log volume (11.5m length, minimum girth of 69cm at small end) , the tree needs to be with 116 cm GBH and 93 cm mid girth. At the moment, there are around 50 trees which are more than 116cm GBH.

These findings can be used for future planning of thinning and final mode of harvest. If we carefully and scientifically handle this valuable tree information, we will able to achieve highest turnover from this plantations at end of felling rotation.

This teak plantation is healthy and good condition according to received information. There are much more potential to get more growth increment particularly for tree stem diameter for next coming years as explained with figures in this report if the plantation is maintained and managed scientifically.

1. Introduction

1.1. General Introduction of Teak (*Tectona grandis*) Plantation

Teak (*Tectona grandis* L.f.) is a highly valuable timber in International trade sought by wood industries to produce good quality furniture and wood for house construction, carving, shipbuilding and many other purposes and Teak is an important timber species for tropical forestry. Today teak is a profitable plantation crop promoted by government agencies, the private sector and farmers. Teak plantations are widely established across Indonesia, Thailand, Sri Lanka etc. in some places, they have become an inseparable part of local cultural and socioeconomic systems.

Bole form

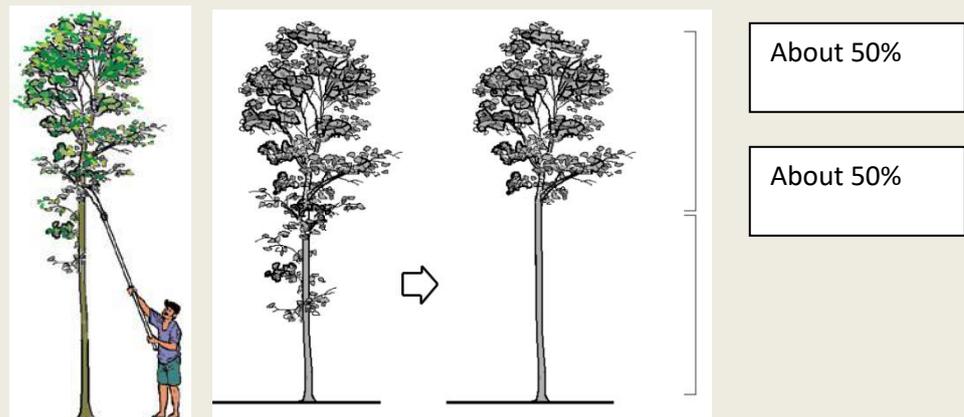
Fluting (irregular involutions and swellings) in the teak stem has been observed in a number of plantations. In some study, the mean heritability value of stem straightness was found to be 0.83, indicating that the character for stem straightness is strongly controlled by provenance and is thus genetically inherited (Kaosaard, 1999). Hence, fluting can be minimized if the appropriate provenance is used in breeding trials to produce plants that exhibit straight stems. The most important form characteristic determining the value of teak logs is the length of the clear bole.

1.2. Activities of teak stand maintenance

Teak grows well, grows fast, and produces high-quality timber when the land and trees are well maintained. Maintenance includes weeding, fertilizing, replanting, pruning, thinning, maintaining coppices and controlling pests and diseases.

1.2.1. Pruning

Pruning is the removal of branches which increases clear bole height and reduces knots on the main stem



Recommended height to which branches should be pruned

1.2.2. Thinning

By competition for light, water and nutrients is greater in closely spaced plantations causing slower tree growth and tall, skinny stems. Thinning will encourage better growth for the good quality trees that remain.

1.3. Spacing

The spacing of trees and the number, timing and intensity of thinning strongly affect the pattern of growth and the yield of the plantation. If thinning is practiced late, growth rates decline or cease, whereas if the stand is thinned too early or too heavily, the trees have a greater tendency to produce side branches and epicormic shoots. This also reduces the potential yield of the plantation since growth is diverted from the main stem, which should be free from defects such as those caused by side branches and epicormic shoots.

Table A: Trees left after thinning based on tree height

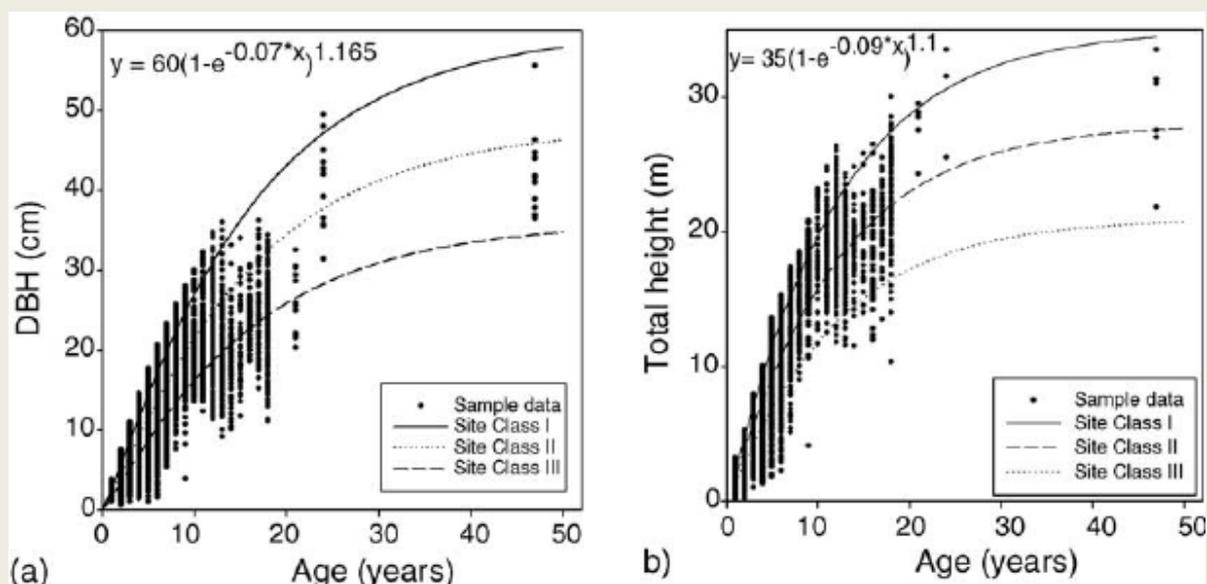
Tree height (m)	Trees remaining (trees/ha)	Age (yr) (range based on soil fertility)	Spacing (m)
11.0–13.0	1300–1500	5–11	2.5–3.0
13.5–15.5	1000–1100	7–17	3.0
15.5–17.0	800–850	10–21	3.5
17.5–21.0	500–550	15–34	4.0–4.5



1.3.1. Teak growth parameters

Height (H) and diameter at breast height (dbh) are the most important measures of tree growth and their relationship is useful in determining site-index, calculating tree volume, evaluating site –quality and predicting future growth of the stand (Jayaraman and Zakrzewski,2001).

Following growth information published by researchers can be used to develop the yield prediction table for present teak plantation of Asia Teak group.



(a) Teak growth curve : DBH against age (b) Teak growth curve : Total height against age

1.4. Positions of diameter measurement at different conditions

We followed following standard governing rules when take measurement of diameter at breast height of tree stem. Ex: clean the bole surface where we measure the stem diameter, diameter tape always correctly handled and read data carefully for reporting.

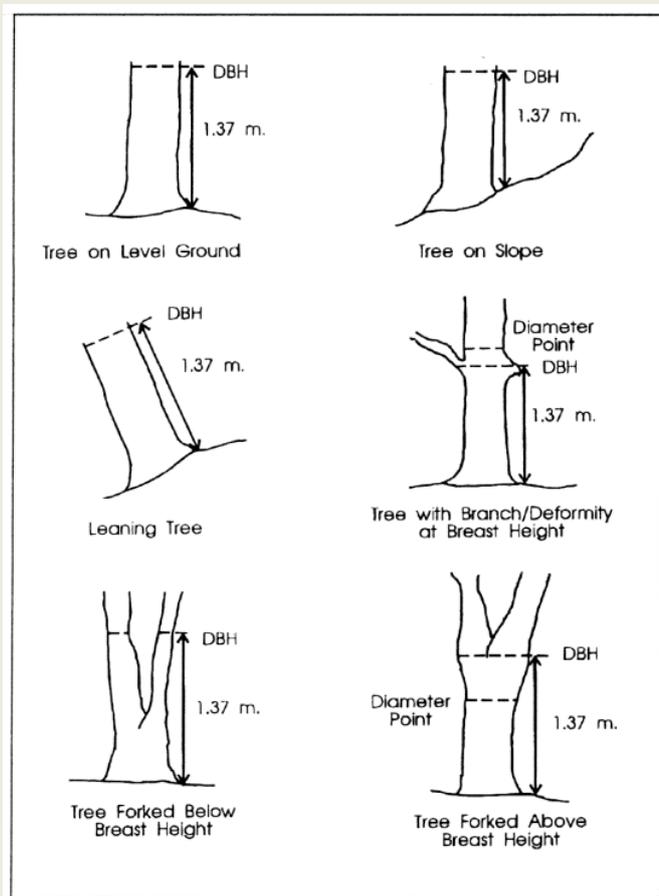


Figure: 2.1 Diameter tape used for the inventory

1.5. Tree height measurement

Height is a tree variable that is used to estimate or determine the volume of a tree. The total height is the distance between the ground and top of the tree and bole height is the distance between the ground and the Crown Point. Merchantable height: the distance between the ground and the terminal position of the last useable portion of the tree stem. Tree height is defined to be the perpendicular distance between the ground level and the top of the tree. While, Tree length is the distance between the stem foot and the top along the stem

1.5.1. Method of tree height measurement

There are two methods; one is direct method which involves using height measuring rods only for small trees. Other method we used is trigonometric principles. Sunnto hypsometer used as instrument for this purpose



Figure 2.2. Total Tree height was measured by hypsometer, used instrument is shown in right side

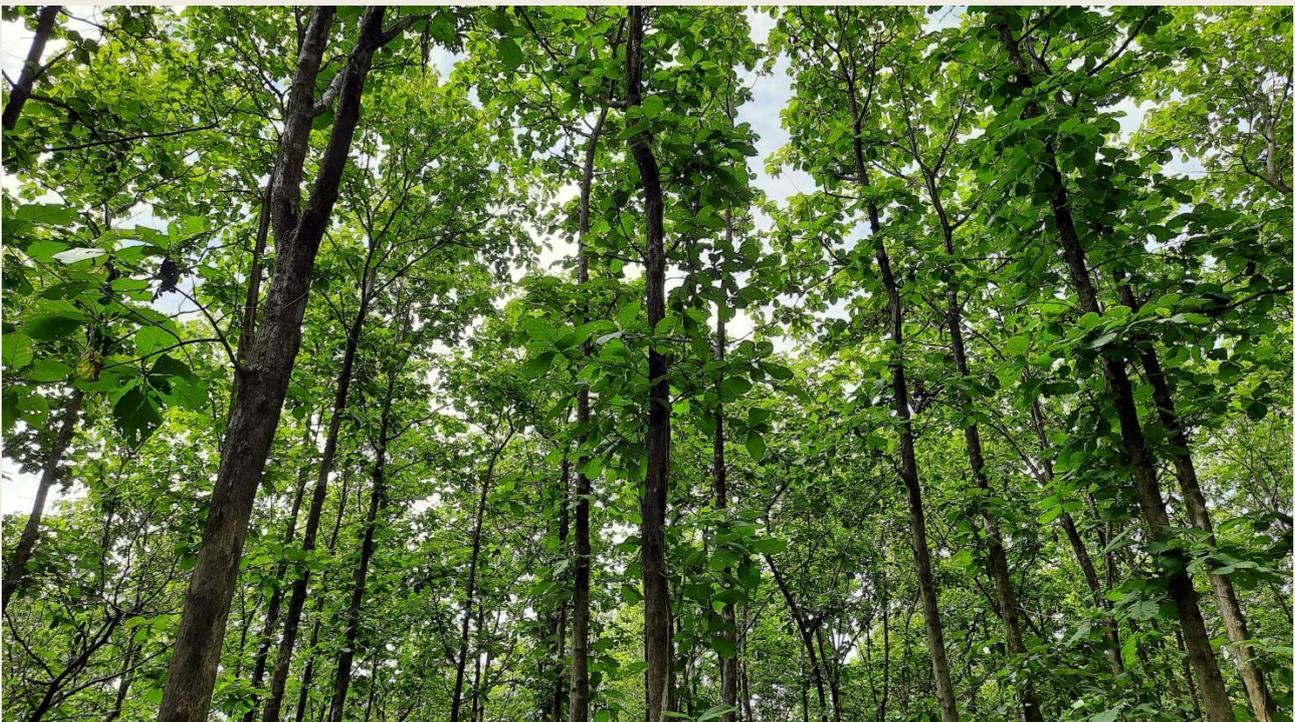


Figure 2.3: Part of healthy plantation and canopy is not closed in this area

1.5.2. Plot size:

All the plots of block 01, Block 3, Block 4, Block 6, block 7 and Plot 1 of Block 8 are 40m x 40m. Plot 1 of Block 2 and Block 5 are 28m x 28m. Plot 2 of Block 8 is 40m x 32m.

Figure :Tree girth measurement (cm) and absent of trees (x) in Chon Dean 1 plantation. Sample plot C1 B4 P3.

- (i) 40m x 40 m =1600m² size of plots in Chon Dean 1
- (ii) 12m x12m=144m² plots in Chon Dean 224

98	115	x	92	x	91	x	89	x	x
x	x	x	x	63	71	x	x	x	x
x	86	96	x	x	x	x	81	67	x
80	x	60	x	88	65	x	x	x	95
x	69	100	x	x	x	x	x	x	x
x	x	x	92	x	x	97	95	x	x
x	103	x	x	x	101	x	66	67	74
80	x	x	87	61	x	x	x	78	x
71	83	89	x	x	68	65	85	70	x
72	81	82	x	85	59	70	59	x	62

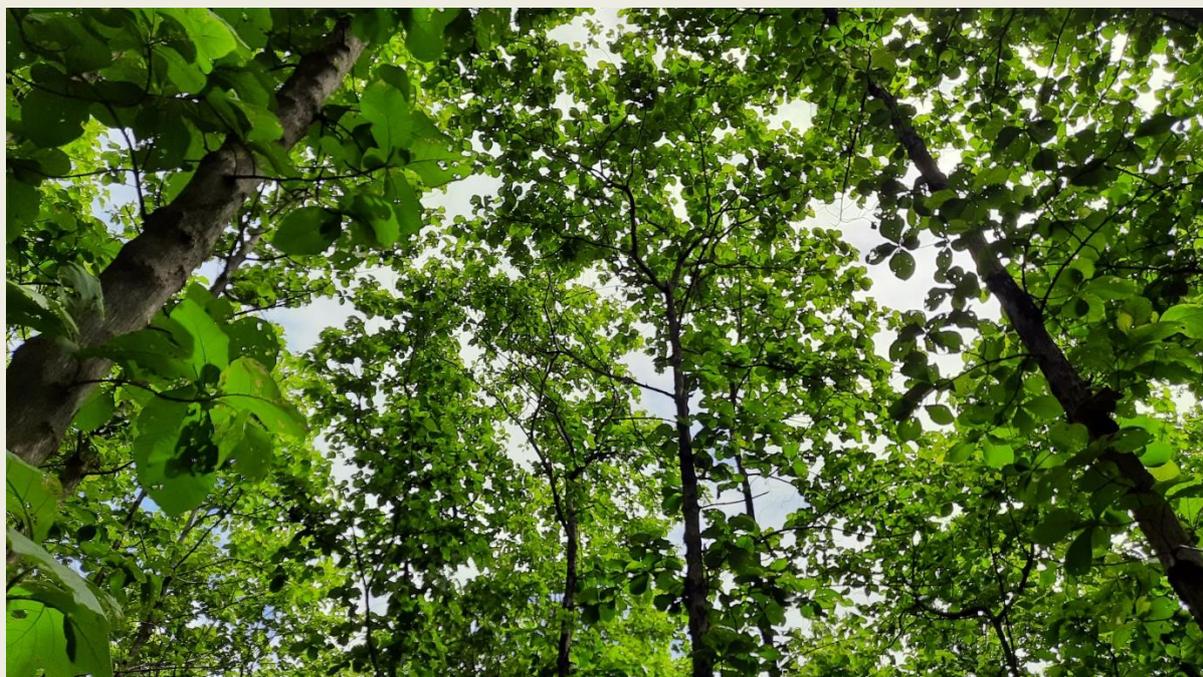


Figure 2.4: Part of canopy of the plantation .It is observed that clean bole height of average tree is around 11.5 and average height is 19-23m

2. Results of inventory of teak plantation-year 2023

2.1. Estate of Chon Dean 01

3. Table 2.1. Number of trees and tree mean GBH values in plots in Chon Dean 1

Plot number (P)	Block 01		Block 02		Block 03		Block 04	
	No. of trees	Mean GBH (cm)	No. of Trees	Mean GBH (cm)	No. of Trees	Mean GBH (cm)	No. of Trees	Mean GBH (cm)
1	47	88.45	28	83.6	58	82.05	56	86.1
2	53	76.23			61	83.7	44	93.2
3	53	80.64					44	88.3
4	46	87					60	82.9
5	53	80.01						
Mean	50.4	82.2	28	83.6	59.5	83.2	51	87.1
TOTAL	252	Min-23.3 Max-134	28	Min-61 Max-137	119	Min-58 Max-122	204	Min-58 Max-138

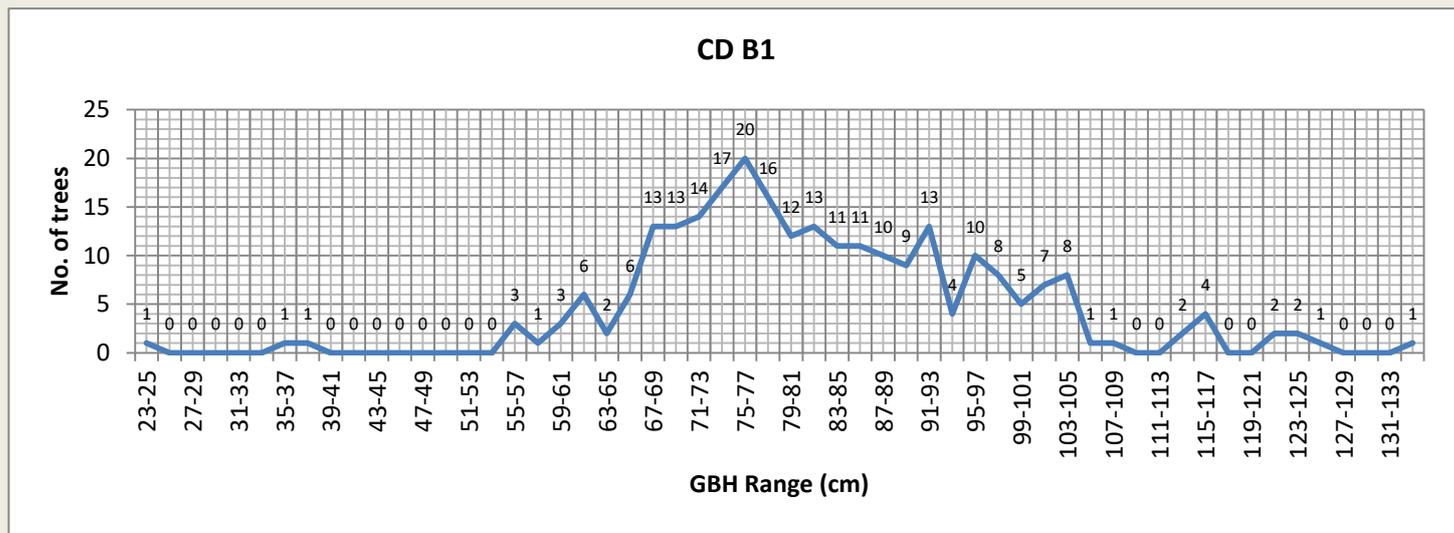
4.

Plot number (P)	Block 05		Block 06		Block 07		Block 08	
	No.of trees	Mean GBH (cm)	No.of Trees	Mean GBH (cm)	No. of Trees	Mean GBH (cm)	No.of Trees	Mean GBH (cm)
1	30	80.7	49	88.5	59	79.37	55	93.58
2			49	84.43	45	85.4	38	105.24
3					49	88.63		
Mean	30	80.7	49	86.47	51	84.11	46.5	98.34
TOTAL	30	Min-63 Max-105	98	Min-57 Max-116	153	Min-57 Max-117	93	Min-55 Max-151



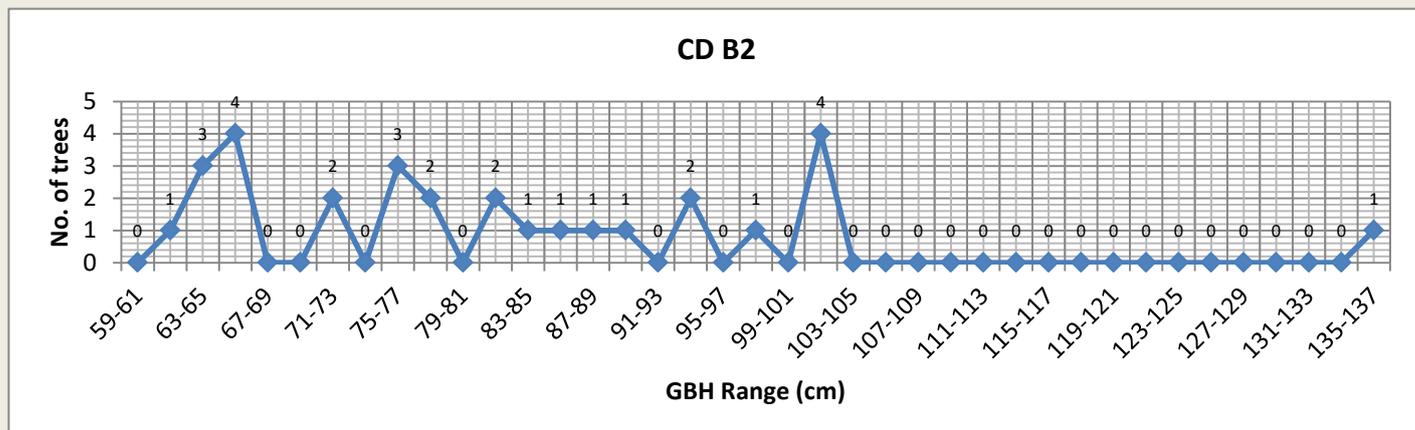
Figure 2.5: GBH measurement of teak tree is being taken by Mr. Paul Rockwood who always visits the plantation with Audit and management team.

Graph 3.1 Number of trees against to average GBH range values in Blocks in Chon Dean 1



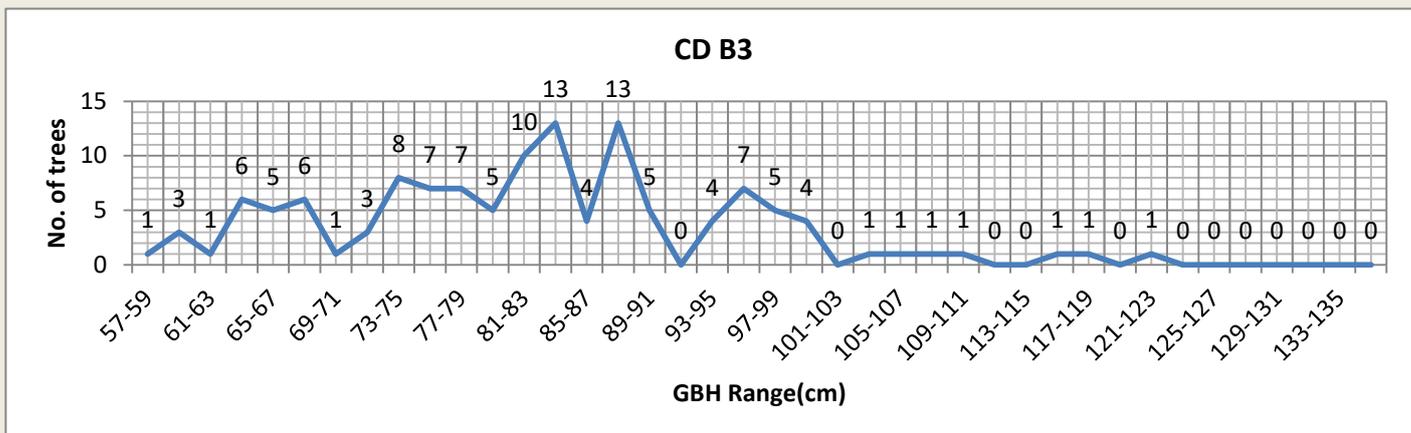
Out of 252 of trees, 99 trees are having more than 86 cm GBH.

It can be assumed that in block no.1. Out of 2670 trees, There are 1048(39%) trees having more than 86cm cm GBH category



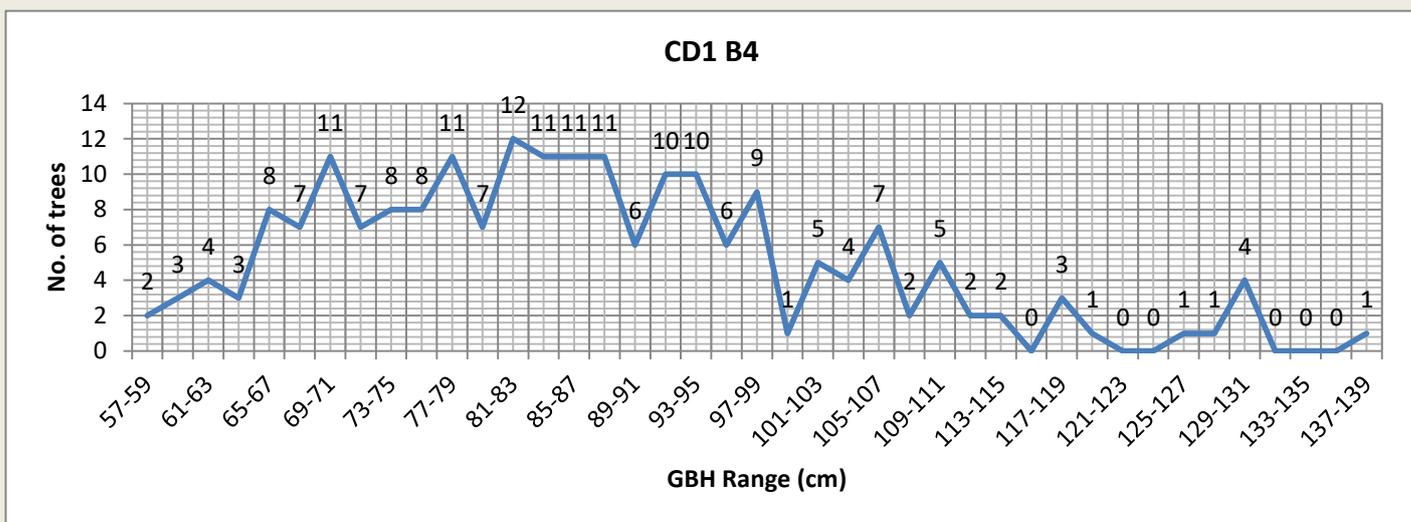
Out of 28 of trees, 11 trees are having more than 86 cm GBH.

It can be assumed that in block no.2. Out of 204 trees, There are 80 (39%) trees having more than 86 cm GBH category



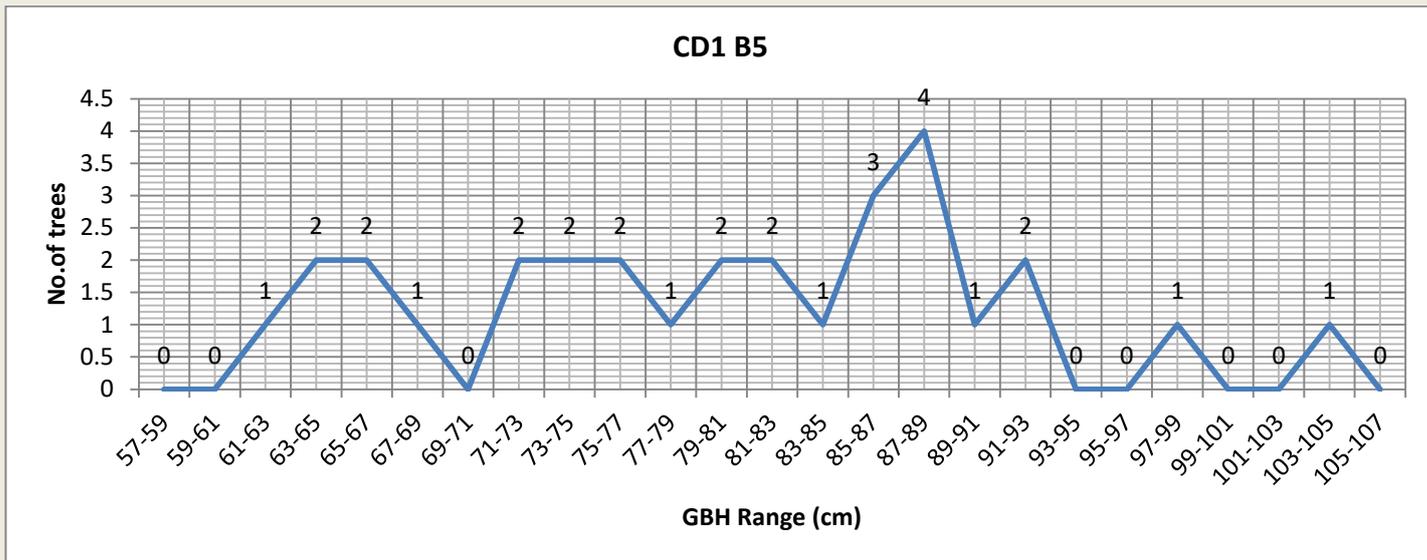
Out of 120 of trees, 48 trees are having more than 86 cm GBH.

It can be assumed that in block no.3. Out of 951 trees, There are 380 (40%) trees having more than 86 cm GBH category



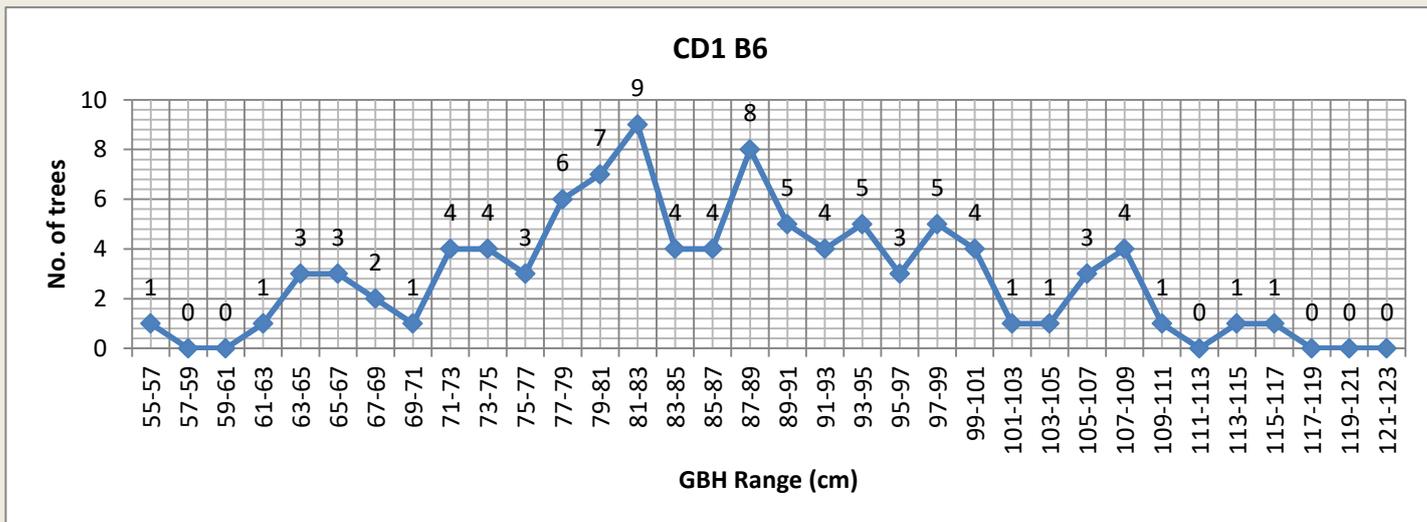
Out of 204 of trees, 117 trees are having more than 86 cm GBH.

It can be assumed that in block no.4. Out of 2010 trees, there are 1152 (57%) trees having more than 86 cm GBH category



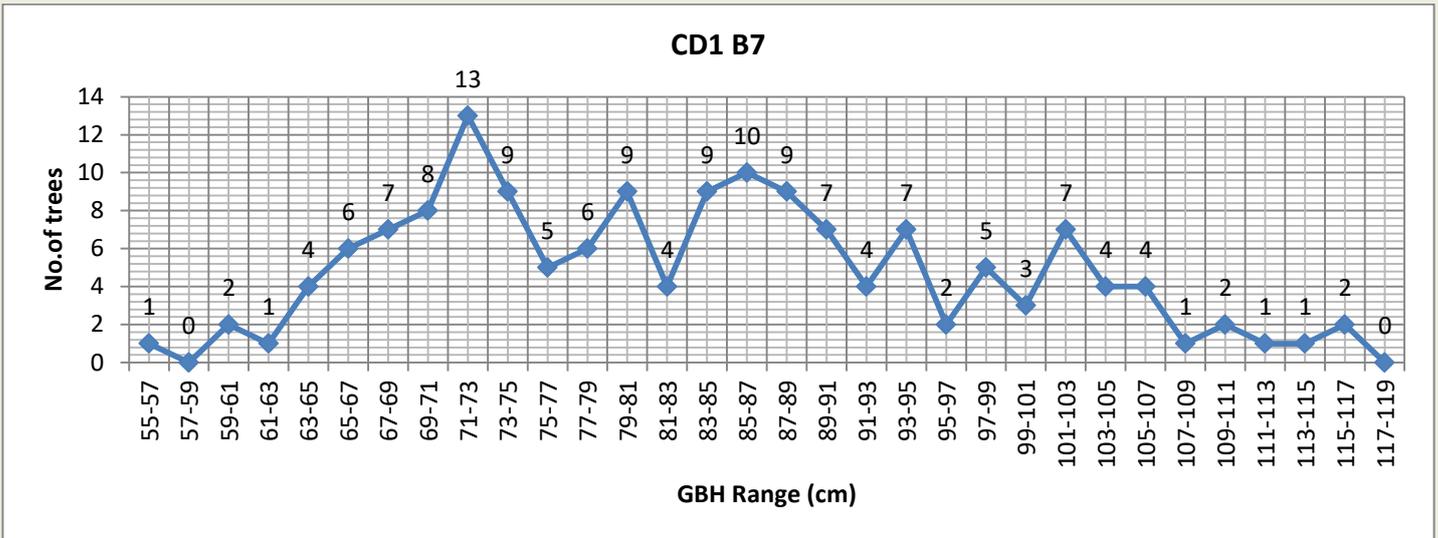
Out of 30 trees, 10 trees are having more than 86 cm GBH.

It can be assumed that in block no.5. Out of 243 trees, there are 80 (33%) trees having more than 86 cm GBH category



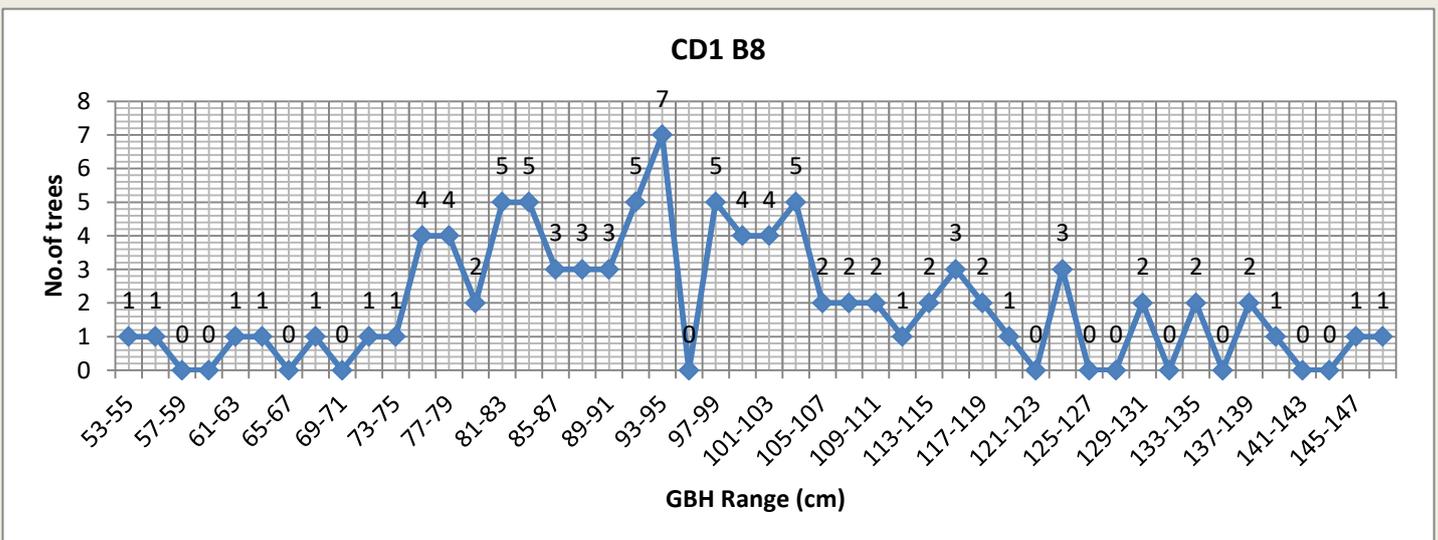
Out of 98 of trees, 45 trees are having more than 86 cm GBH.

It can be assumed that in block no.6. Out of 910 trees, There are 417 trees (45%) having more than 86 cm GBH category



Out of 154 of trees, 66 trees are having more than 86 cm GBH.

It can be assumed that in block no.7. out of 1270 trees, There are 544 (42%) trees having more than 86 cm GBH category



Out of 93 of trees, 65 trees are having more than 86 cm GBH.

It can be assumed that in block no.8. out of 699 trees, There are 488 (69%) trees having more than 86 cm GBH category

Table 2.2. Estimated number of trees having more than 85cm GBH in Chon Dean 01 teak Plantation

Estate	Block no.	Tree no. more than 66cm GBH in Blocks and its % in 2022	Ranking of bigger trees in 2022	Tree no. more than 85cm GBH in Blocks and its % in 2023	Ranking of bigger trees in 2023	No of trees for ha.
Chon Dean 01	1	1052 (38%)	5	1048(39%)	6	315
	2	74 (35%)	6	80(39%)	6	357
	3	351 (35%)	6	380(40%)	5	375
	4	938 (46%)	2	1152(57%)	2	318
	5	85 (33%)	7	80(33%)	7	382
	6	431 (45%)	3	417(45%)	3	306
	7	541 (42%)	4	544(42%)	4	320
	8	460 (66%)	1	488(69%)	1	322
	Estate total	3932 (43%) from 9136 trees		4189 (46%) from 8957 trees		366 (average)

It seems that when no.of trees for ha is higher, the tree growth rate has slowdown in Block 5 and Block 3. This observation is correct when other factors in all the Blocks are constant.

Table 2.3. Comparison of tree parameters between year 2022 and 2023 in Chon Dean 1

Estate	Block no.	No. of Plots	Year 2022			Year 2023				
			No. of trees measured for GBH	No of trees for ha.	Average GBH (cm)	No.of trees measured for GBH	No of trees for ha.	Average GBH (cm)	Average Height (m)	Variance in GBH (cm) vs 2022
Chon Dean 01	1	5	252	315	82.08	252	315	82.2		0.12
	2	1	28	357	82.25	28	357	83.6		1.35
	3	2	120	375	81.37	119	375	83.2		1.83
	4	4	204	318	86.41	204	318	87.1		0.69
	5	1	30	382	79.83	30	382	80.7		0.87
	6	2	98	306	84.93	98	306	86.5		1.57
	7	3	154	320	84.03	153	320	84.1		0.07
	8	2	93	322	98.16	93	322	98.3		0.14
Estate average			336	84.88		336	85.71		0.83	
Total	20	985			(27 DBH)	977				

Table 2.4. Sample plots information, planted area and tree inventory data in year 2023 of Chon Dean 1
Total trees in blocks were counted in this year .

ECstate	Estate	Block no.	Estimated Total trees in block	Estimated planted area (ha)	No. of Plots	Plots area in block (m ²)	No. of trees measured for DBH in Block	No of trees for ha.	Average GBH (cm)	Average height (m)	Variance in GBH (cm) 2023 vs 2022
CCChon Dean 1	Chon Dean 01	1	2668	8.47	5	8000 (40x40mx5)	252	315	82.2		0.12
		2	210	0.59	1	784 (28x29m)	28	357	83.6		1.35
		3	985	2.65	2	3200 (40x40mx2)	119	372	83.2		1.83
		4	2032	6.39	4	6400 (40x40mx4)	204	318	87.1		0.69
		5	259	0.68	1	784 (28x28m)	30	382	80.7		0.87
		6	896	2.93	2	3200 (40x40mx2)	98	306	86.47		1.57
		7	1288	4.05	3	4800 (40x40mx3)	153	318	84.11		0.07
		8	698	2.17	2	2880 (40x40+40x32)	93	322	98.34		0.14
		Total	9036	27.93	20	30048	977				
						Average	336	85.71 (DBH)		0.83	

Table 2.5. Thailand Teak Plantation tree count.
Comparison Tree Audit 2020-2023

some data (good/reserved trees) were not counted in this year)

Estate Name	Block number	Geophysics count trees 2020				Geophysics count trees 2023				
		Total good trees	Marked for thinning	Reserved trees	Total trees	Total good trees	Marked for thinning	Reserved trees	Total were Counted this year.	trees this
Chon Daen 1	B1				2735				2670	
	B2				209				204	
	B3				982				951	
	B4				2026				2010	
	B5				258				243	
	B6				939				910	
	B7				1289				1270	
	B8				698				699	
	Total all blocks				9136				8957	

**Table 2.6. Determination of site index based on growth parameters of past years of Chon Dean 1
Chon Dean 1 plantation age is assumed as 23 years**

Estate	Block no.	No. of Plots	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	DBH differences from 2013 to 2022 and (Mean Increment of DBH) (cm) and periodic increment of DBH{}
			Ave. DBH (cm)											
Chon Dean 01	1	5	19.4	19.8	20.6	20.7	22.2	23.5	23.9	23.8	24.3	26.1	26.2	6.8 (1.14){0.68}
	2	1	17.7	18.1	19.0	18.9	21.1	22.6	23.4	23.3	23.9	26.2	26.6	8.9 (1.16){0.89}
	3	2	18.3	19.2	19.5	19.5	21.2	22.5	23.4	23.5	23.9	25.9	26.5	8.2 (1.15){0.82}
	4	4	19.4	19.5	21.3	21.5	23.3	24.7	25.3	25.5	25.5	27.5	27.7	8.3 (1.2){0.83}
	5	1	19.9	19.8	21.2	21.5	22.7	23.3	23.7	23.4	23.9	25.4	25.7	5.8 (1.11){0.58}
	6	2	19.4	18.9	20.4	20.5	22.6	23.9	24.6	24.5	25.3	27	27.5	8.1 (1.19){0.81}
	7	3	18.9	18.6	20.8	21.1	22.8	23.8	24.3	24.6	24.5	26.7	26.8	7.9 (1.16){0.99}
	8	2	19.9	22.2	24.4	24.7	27.2	28.8	29.2	29.3	29.4	31.3	31.3	11.4 (1.36){1.14}
	Estate average		19.1	19.5	20.9	21.05	23.2	24.1	24.7	24.7	25	27	27.3	8.2(1.18){0.82}

Recommendation

- (1) It is recommended to prune the adventitious shoots only after required training given under close supervision.
- (2) Root system of uprooted trees should be closely monitored at regular basis if termite causes for decaying of roots.
- (3) Control fire or fire lines must be properly maintained.
- (4) Average GBH increment in last two year is 0.83cm.
- (5) More finding of this inventory and Audit findings are explained in executive summary.

Finally it can be concluded this teak plantation is healthy and good condition. Plantation is much more potential to get more growth increment particularly for diameter growth for next 5 years if the plantation is maintained and managed scientifically. The decrease of GBH increments may be due to tree density of plantation which needs to be reduced.

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