AsiaTeak Tropical Plantations
Sri Lanka

Tree Audit Report - 2016

By Forest Works Holdings (Private) Limited

Agro Forestry Division

Sri Lanka.

Word from Certifiers

Forest Works Holdings (Private) Limited; is always dedicated in accurate and precise auditing. This assignment is independently carried out by Forest Works Holdings (Private) Limited on the request of AsiaTeak Tropical Plantations Ltd.

The audit covers Teak plantations established by AsiaTeak Tropical Plantations Ltd., in three locations of Sri Lanka. All the plantations were inspected and evaluated under globally accepted methodologies explained in the report.

Herewith, we further substantiate that the inspected plantations are presently in reported conditions.

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1. INTRODUCTION.

The growth and tree stock evaluation report is an annual report presents by Forest Works Holdings for the purpose of certifying the actual situation in AsiaTeak plantations in Sri Lanka.

Teak (*Tectona grandis*) is a valuable timber wood in the world due to its own characteristics such as durability, hardness and elegance of the hardwood. Timber demand is increasing all over the world very rapidly due to its scarcity with the high demand and supply decreasing in each and every year.

2. PRODUCTIVITY AND VOLUME ESTIMATES

The productivity of Teak plantations has been studied across a broad range of countries through permanent sample plots. The earliest yield table for teak was constructed by von Wulfing (1932) for plantations on Java, Indonesia. Laurie and Ram (1939) constructed a yield table for Teak plantations distributed over present-day India, Myanmar and Bangladesh. More recently, yield tables have been developed using data from permanent and temporary sample plots for plantations of teak established outside its natural range, including provisional yield tables for Trinidad and Tobago (Miller, 1969), Côte d'Ivoire (Maitre, 1983), Nigeria (Abayomi, 1984) and Sri Lanka (Phillips, 1995).

3. ESTABLISHING SAMPLE PLOTS

For forests larger than 3 hectares, the cost involved in measuring every tree becomes prohibitive. By carefully measuring trees within a representative sample of the area it is possible to greatly reduce the time and costs of measuring without losing accuracy. When measuring to assess the volume per hectare, sampling usually involves establishing a number of 'plots' within the forest. Only those trees located within the plots are measured. Based on the size and distribution of trees it is possible to estimate the stocking rates (stems/hectare), species mix, average tree dimensions, stand basal area and timber volumes. Adequate sampling can also provide an indication of the variability of these attributes across the site and can be used to assess the level of precision (the sampling error).

3.1 DETERMINING THE NUMBER, SIZE AND SHAPE OF SAMPLE PLOTS

When assessing timber volumes, the ideal number of trees per plot will usually be between 15 and 25. Where there are a number of species or age classes it may be necessary to increase the size of the plot so as to include a representative sample of each. If the stocking rates are known then the size of the plots can be predetermined. For example, if the

stocking rate was expected to be 500 stems per hectare then a plot of 0.04 hectares would be required to include 20 trees.

But considering the cost factor in commercial forestry plantations, sample plots were established to represent the 10% population of the total tree stock and samples were established by predetermined samples in the grid map of each estate by following the systematic sampling technique.

The best shape for the plots depends on the distribution of the trees and the presence of any gradients, such as slope. In young plantations it is often easier to establish rectangular or quadrangular plots that span a number of planting rows. In native forests or older stands where the trees are more irregularly spaced, large circular plots may be easier to lay out. On steep ground the plot dimensions must take account of slope.

3.2 SAMPLE PLOT ESTABLISHMENT IN ASIATEAK PLANTATIONS

Three plantations are managed by AsiaTeak Plantations in Puttalam and Batticaloa region in Sri Lanka. There are 25 acres land in Puttalam named as Sinnanagavillu estate and 12 acres land in Anamaduwa named as Palugahayaya estate. Other Teak plantation is 120 acres land in Batticaloa named as Kumburuwela estate.

Sample plots have established in all plantations for measuring tree growth rates and volume increments to evaluate the real situation of the plantations for decision making purpose of the management.

4. DIMENSIONS TAKEN FROM SAMPLE PLOTS

4.1 TREE HEIGHT

Tree height is measured by bottom to top of the tree canopy by using a measuring pole that calibrated by standard measuring tapes. Tree height should be recorded to nearest 0.5 m scale.
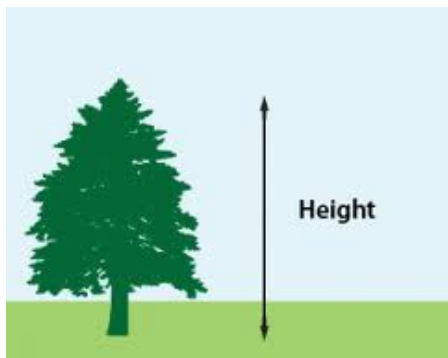

Figure 1: Total Tree Height (m)

4.2 TREE DIAMETER/GIRTH

Tree diameter is the important parameter to evaluate the growth rate of Teak plants. Measuring Diameter at breast height is the standard way to measure the diameter.

Diameter at breast height (DBH) were measured in all sample plots in all plantations. According to the standard way to measure the tree diameter it should be taken at the 1.3 m above from the ground level.
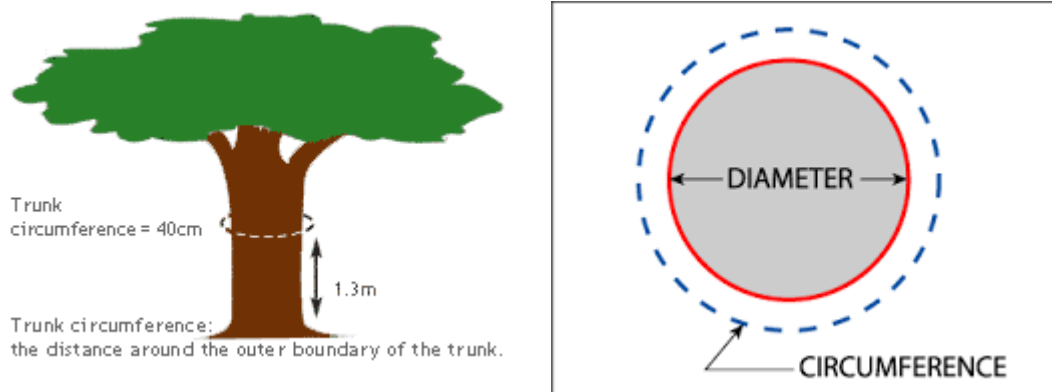
Figure 2: Diameter measurement

5. DATA ANALYSIS
5.1 CURRENT ANNUAL INCREMENT (CAI) AND MEAN ANNUAL INCREMENT (MAI)

CAI and MAI gives us important information about the growth behaviors of plantation. According to this evaluation management plan can be tailor made to achieve the growth targets in each year for

CAI Calculation can be done by reducing the last year average growth by this year average growth. It is the growth performance of current year with the effect of climate conditions, impact of agricultural practices.

MAI is the mean of the growth from first year of the plantation up to now. MAI can be calculated by dividing the current growth by age of trees.

5.2 GROWTH PROJECTIONS OF ASIATEAK PLANTATIONS

Tissue cultured Teak stumps are cultivated by the AsiaTeak plantations for obtaining the best growth rate in the Teak plantations with comparing other general Teak plantations in the world. According to the Thai Orchid Lab company Pvt. Ltd. the proven records are shown that Tissue cultured Teak plants are growing well with short rotation period to achieve the sufficient timber volume in managed Teak plantations.

5.3 TREE STOCK OF ASIATEAK PLANTATIONS IN SRI LANKA IN 2016

Estate	2015			2016			Difference
	No. of Trees Good	No. of Trees Small/Poor	No. of Total Trees	No. of Trees Good	No. of Trees Small/Poor	No. of Total Trees	
Palugahayaya	4459	46	**4505**	4471	43	**4514**	9
Sinnanagavillu	5545	41	**5586**	5558	29	**5587**	1
Kumburuwela Block - 01	2427	0	**2427**	2204	176	**2380**	-47
Kumburuwela Block - 02	4390	0	**4390**	4213	0	**4213**	-177
Kumburuwela Block - 03	4248	0	**4248**	4355	0	**4355**	107
Kumburuwela Block - 04	3102	0	**3102**	3322	0	**3322**	220
Kumburuwela Block - 05	5926	0	**5926**	6760	0	**6760**	834
Total Kumburuwela	20093	0	20093			21030	937
Grand Total	**30097**	**87**	**30184**	**10029**	**72**	**31131**	**947**

Table 1: Tree Stock Comparison of 2016 with 2015

5.4 GROWTH ANALYSIS OF EACH PLANTATION

5.4.1 PALUGAHAYAYA ESTATE - ANAMADUWA

	Tree Ht (m)				Tree DBH (cm)			
Year	2013	2014	2015	2016	2013	2014	2015	2016
Plot 01	5.5	6.2	6.8	8.7	6.1	7.5	9.0	10.2
Plot 02	5.5	6.3	6.7	9.0	6.1	7.5	9.3	10.2
Plot 03	5.9	6.9	7.4	11.2	6.6	8.0	9.8	11.1
Plot 04	7.0	9.1	8.9	12.3	7.6	9.7	12.0	13.1
Average	**6.0**	**7.1**	**7.5**	**10.3**	**6.6**	**8.2**	**10.0**	**11.2**

Table 2: Growth comparison of Palugahayaya estate

$$\text{Average timber volume} = 219.1 \text{ m}^3$$

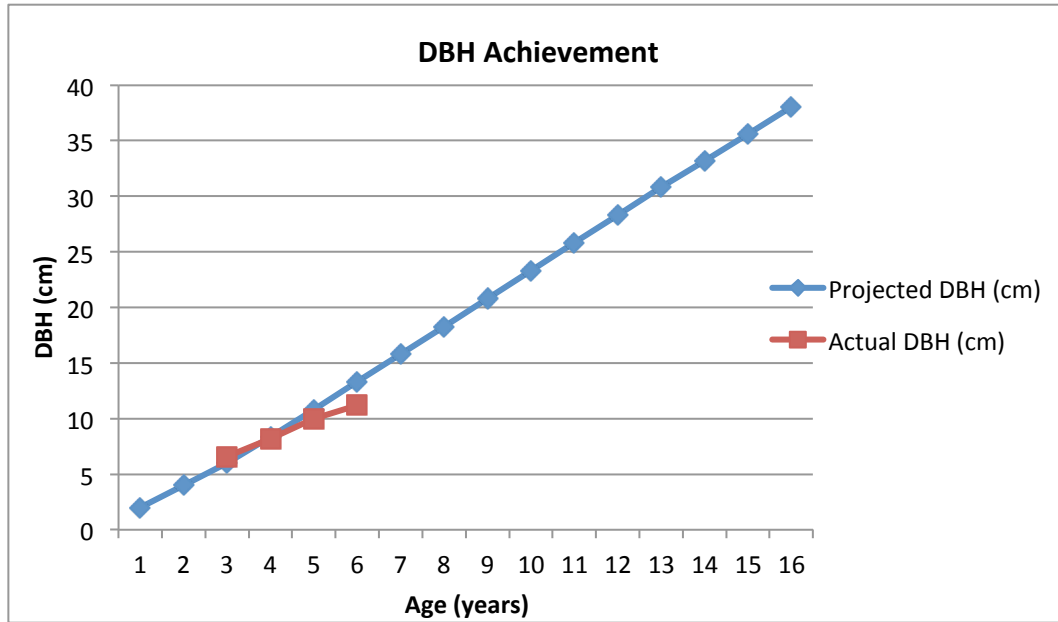## DBH Analysis of Palugahayaya estate-Anamaduwa

Figure 3: DBH achievement of Palugahayaya estate, Anamaduwa DBH Comparison with Projected growth level

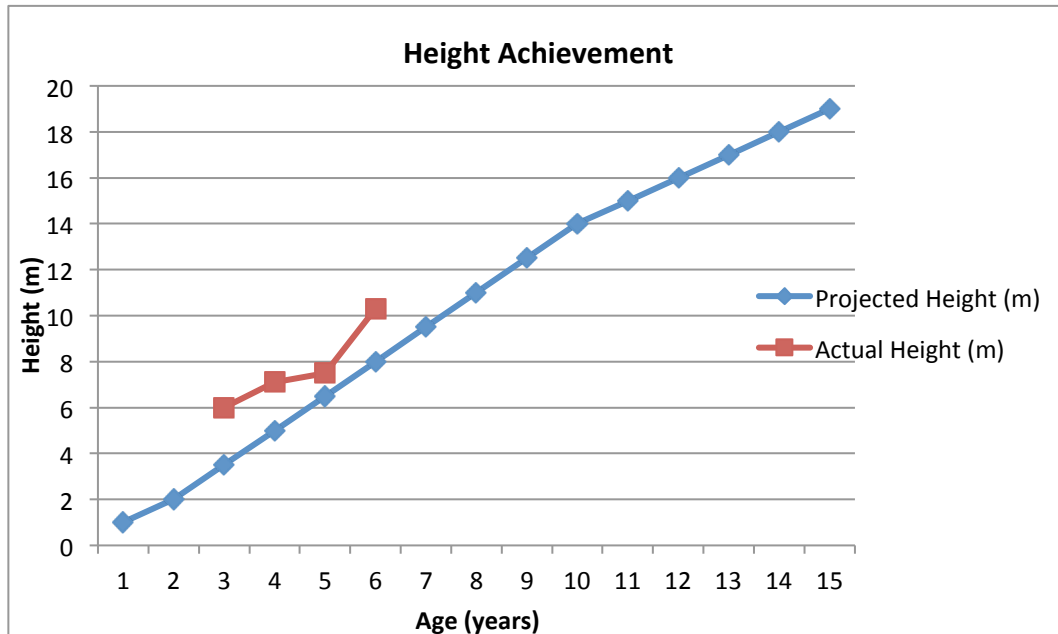## Height Analysis of Palugahayaya estate-Anamaduwa

Figure 4: Height achievement of Palugahayaya estate, Anamaduwa (Height Comparison with Projected growth level

MAI & CAI Analysis

Year	Tree Ht (m)				Tree DBH (cm)			
	Year 2013	Year 2014	Year 2015	Year 2016	Year 2013	Year 2014	Year 2015	Year 2016
MAI	2.0	1.8	1.5	1.7	2.2	2.0	2.0	1.9
CAI	-	1.1	0.3	2.9	-	1.6	1.9	1.1

Table 3: Annual CAI and MAI Changes - Palugahayaya estate
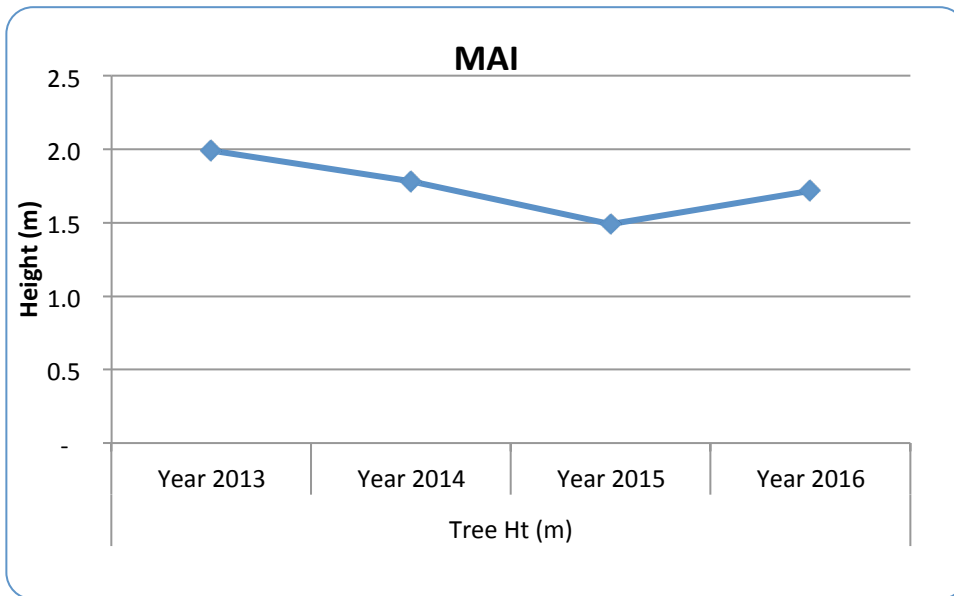
MAI

Figure 5: Mean annual increment of tree height at Palugahayaya estate
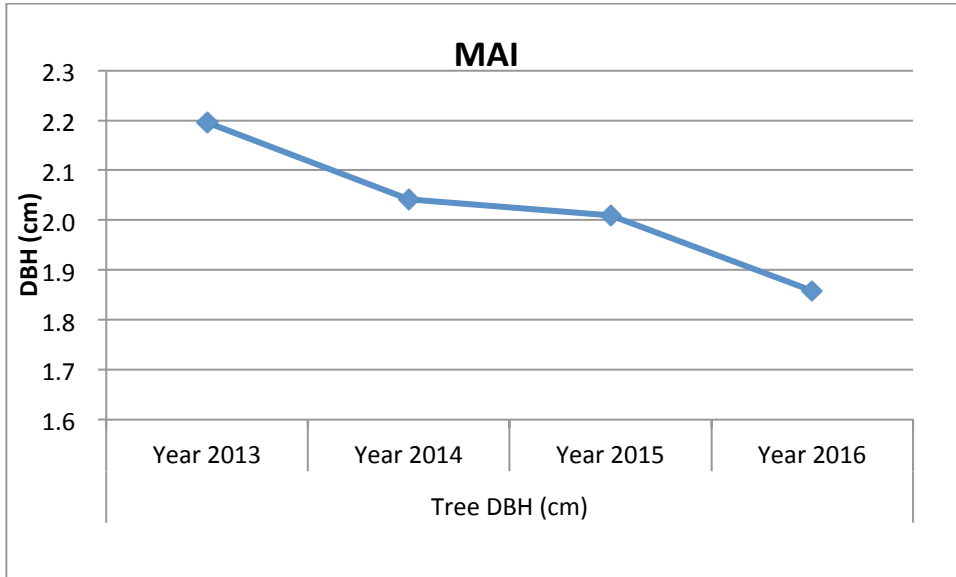
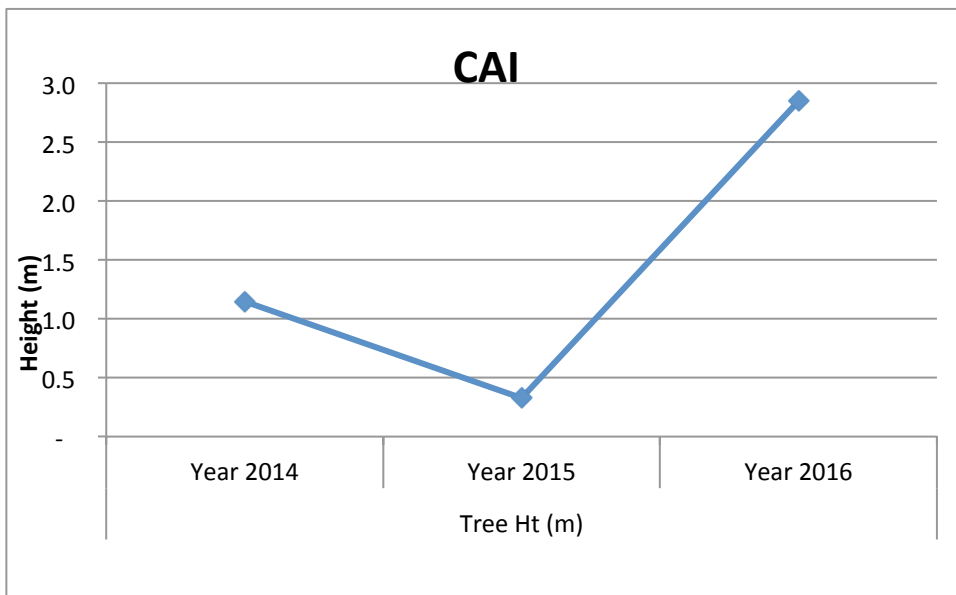Figure 6: Mean annual increment of tree DBH at Palugahayaya estate

CAI

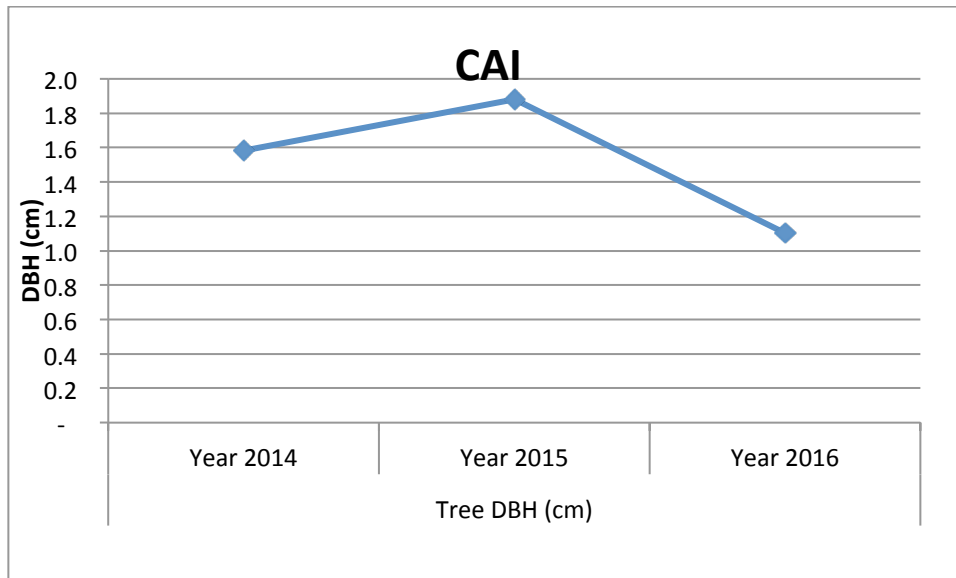Figure 7: Current annual increment of tree Height in Palugahayaya estate

Figure 8: Current annual increment of tree DBH in Palugahayaya estate

5.4.2 GROWTH ANALYSIS OF SINNANAGAVILLU ESTATE-PUTTALAM

Year	Tree Ht (m)			Tree DBH (cm)		
	2014	2015	2016	2014	2015	2016
Plot No. 01	4.7	5.3	7.6	5.3	7.1	9.6
Plot No. 02	5.7	6.2	7.4	4.1	8.9	10.5
Plot No. 03	5.1	6.1	8.1	4.4	7.5	10
Plot No. 04	5.4	6.4	8.2	4.1	8.7	10.9
Plot No. 05	4.8	6.4	8.7	3.9	8.4	11.4
Average	**5.1**	**6.1**	**8.0**	**4.4**	**8.1**	**10.5**

Table 4: Tree growth comparison of Sinnanagavillu estate - Puttalam

Average timber volume = 188.4 m^3

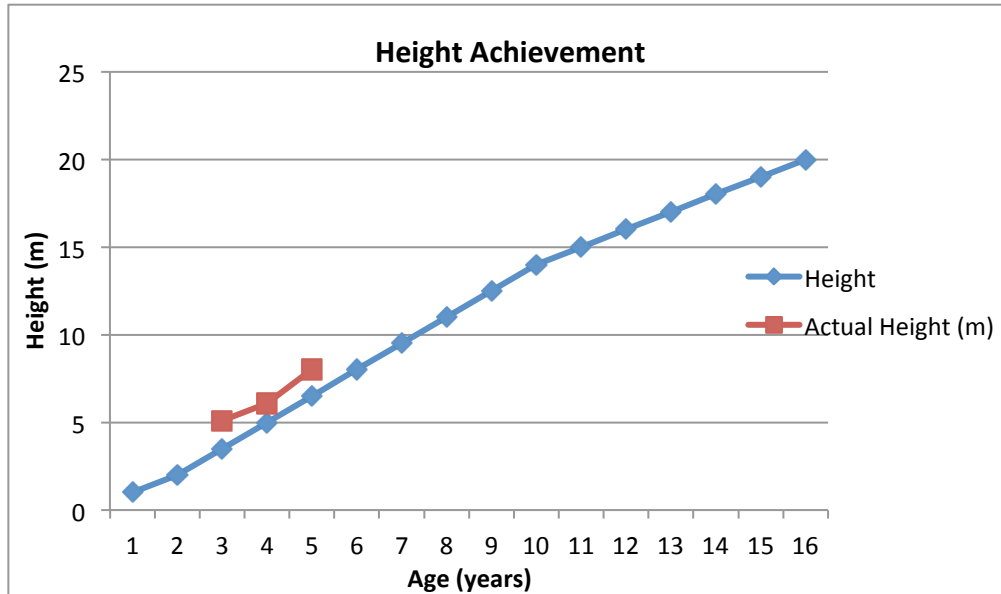## Height Analysis of Sinnanagavillu estate - Puttalam

Figure 9: Height achievement of Palugahayaya estate, Anamaduwa (Height Comparison with Projected growth level)

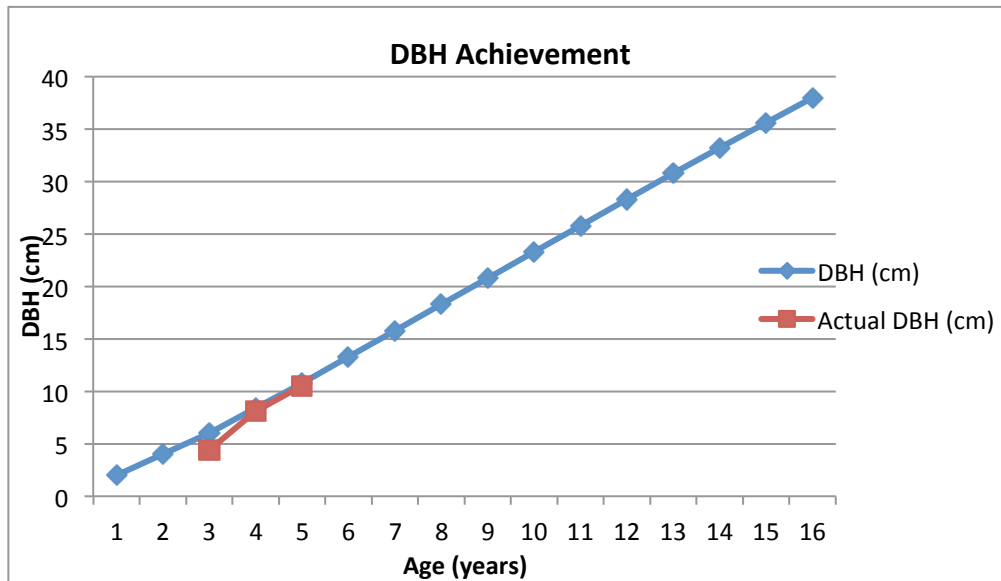## DBH Analysis of Sinnanagavillu estate - Puttalam

Figure 10: DBH achievement of Palugahayaya estate, Anamaduwa DBH Comparison with Projected growth level

MAI & CAI Analysis

Year	Tree Ht (m)			Tree DBH (cm)		
	year 2014	Year 2015	Year 2016	year 2014	Year 2015	Year 2016
MAI	1.7	1.5	1.6	1.5	2.0	2.1
CAI	-	0.9	1.9	-	3.8	2.4

Table 5: Annual CAI and MAI Changes - Sinnanagavillu estate
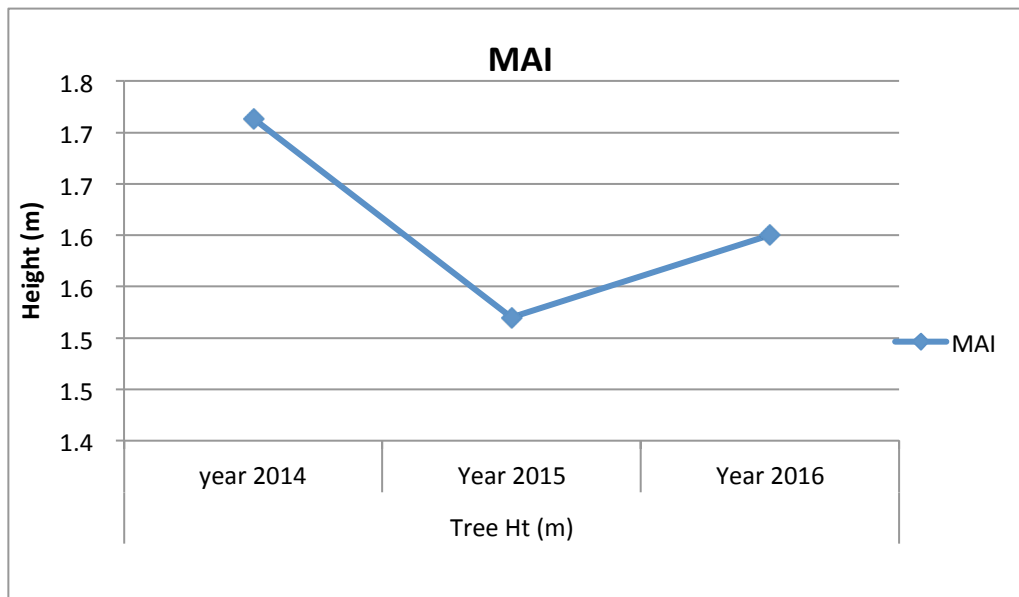
Mean Annual Increment (MAI)

Figure 11: Mean annual increment of tree height in Sinnanagavillu estate
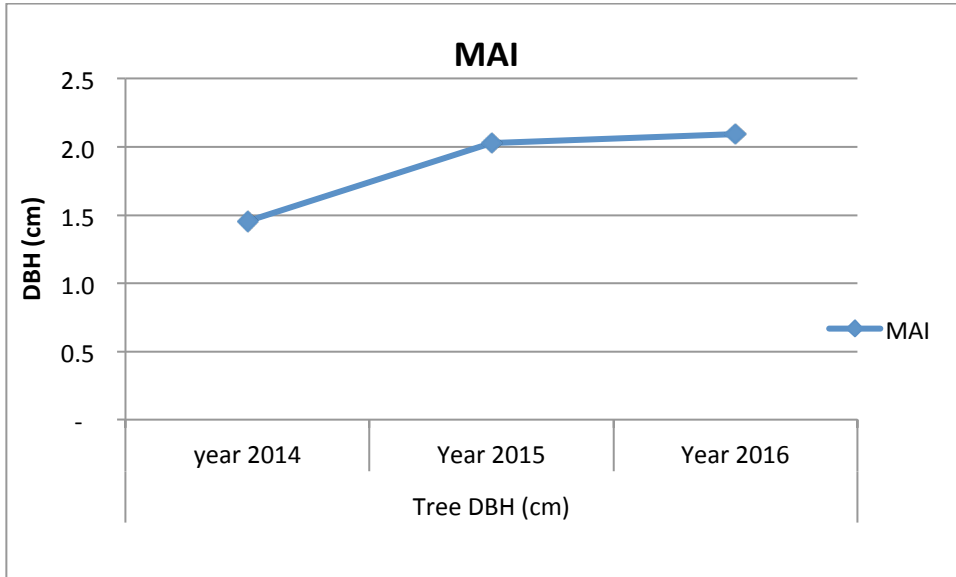
Figure 12: Mean annual increment of tree DBH in Sinnanagavillu estate
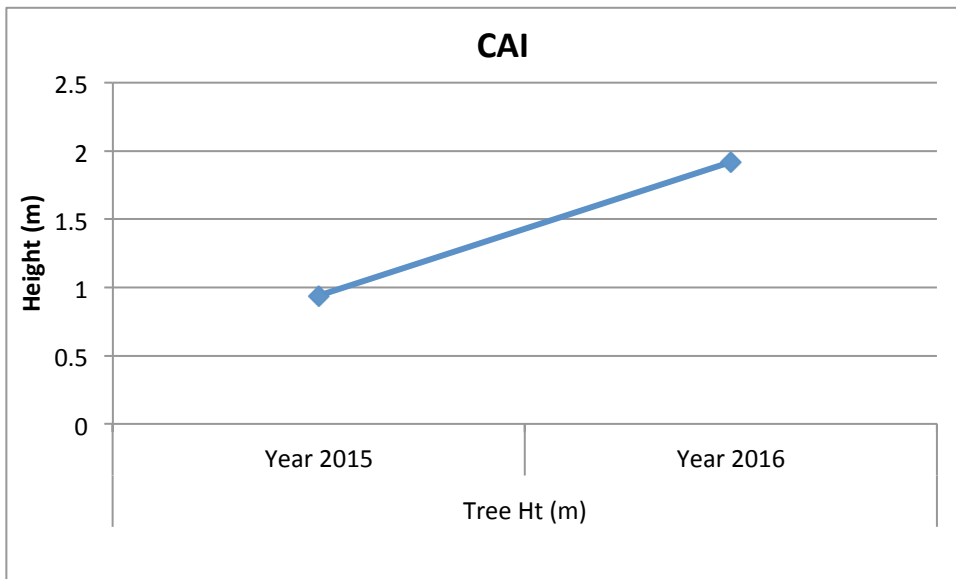
Current Annual Increment (CAI)

Figure 13: Current annual increment of tree Height in Sinnanagavillu estate.
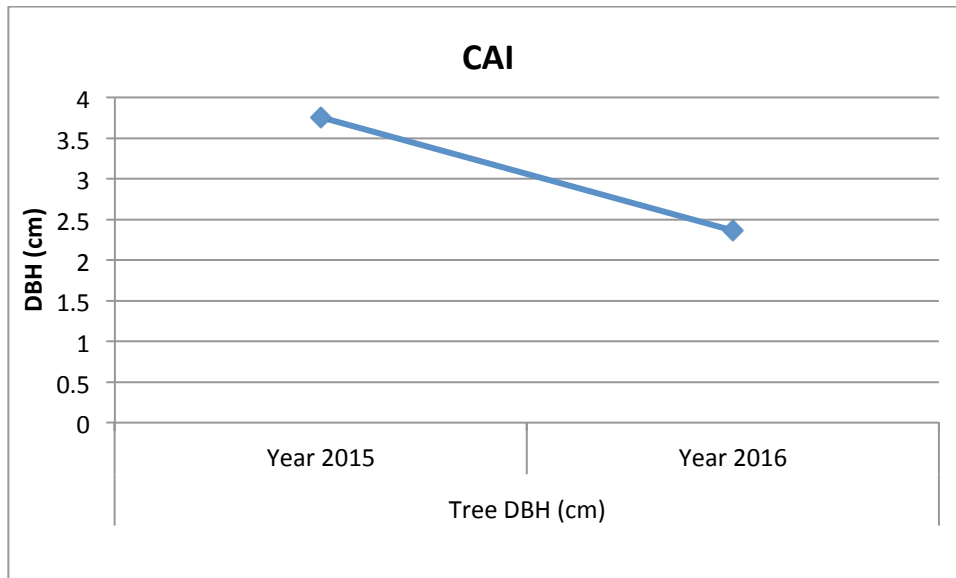
Figure 14: Current annual increment of DBH in Sinnanagavillu estate.

5.4.3 GROWTH ANALYSIS OF KUMBURUWELA ESTATE-BATTICALOA

Block Number 01

Year	Tree Ht (m)		Tree DBH (cm)	
	2015	**2016**	**2015**	**2016**
Plot No. 01	8.3	9.3	10.6	13.0
Plot No. 02	3.3	4.1	4.2	5.4
Plot No. 03	3.5	4.5	4.3	6.0
Average	**5.0**	**6.0**	**6.3**	**8.1**
MAI	**1.7**	**1.5**	**2.1**	**2.0**
CAI		**0.9**		**1.8**

Table 6: Tree growth comparison 2015 with 2016 of Kumburuwela Estate-Block number 01

Average timber volume = 37.5 m^3

Height Analysis of Block 01, Kumburuwela estate - Batticaloa

Figure 15: Height achievement of Block 01,Kumburuwela estate, Batticaloa (Height Comparison with Projected growth level)

DBH Analysis of Block 01, Kumburuwela estate - Batticaloa

Figure 16: DBH achievement of Block 01,Kumburuwela estate, Batticaloa (DBH Comparison with Projected growth level)

Block Number 02

Year	Tree Ht (m)		Tree DBH (cm)	
	2015	**2016**	**2015**	**2016**
Plot No. 01	2.1	3.9	2.5	5.3
Plot No. 02	3.0	5.6	3.6	6.5
Plot No. 03	1.8	2.6	1.9	3.2
Plot No. 04	3.7	3.0	3.7	3.0
Average	**2.3**	**4.0**	**2.7**	**5.0**
MAI	**0.8**	**1.0**	**0.9**	**1.3**
CAI		**1.7**		**2.4**

Table 7: Tree growth comparison of Kumburuwela Estate-Block number 02

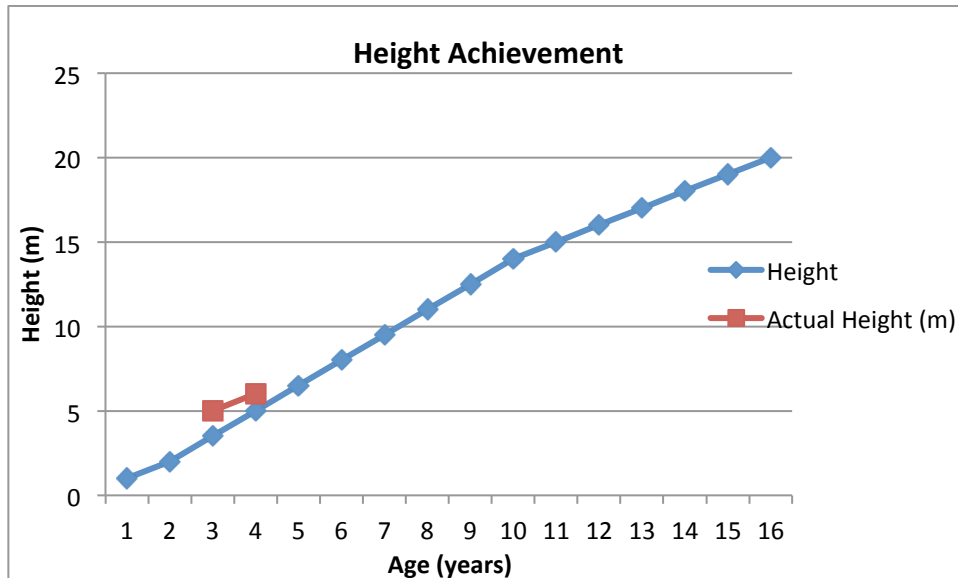**Height Analysis of Block 02, Kumburuwela estate - Batticaloa**

Figure 17: Height achievement of Block 02,Kumburuwela estate, Batticaloa (Height Comparison with Projected growth level)

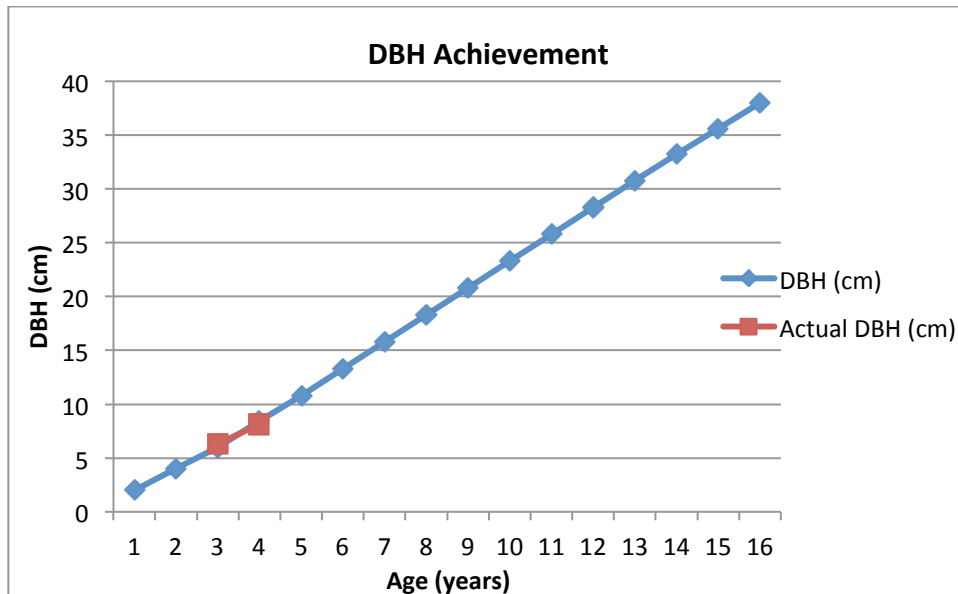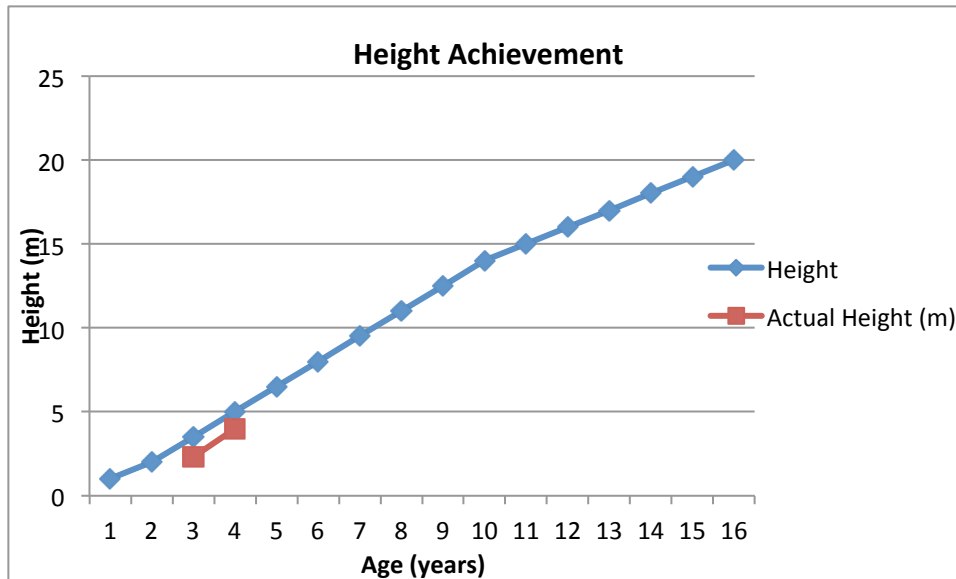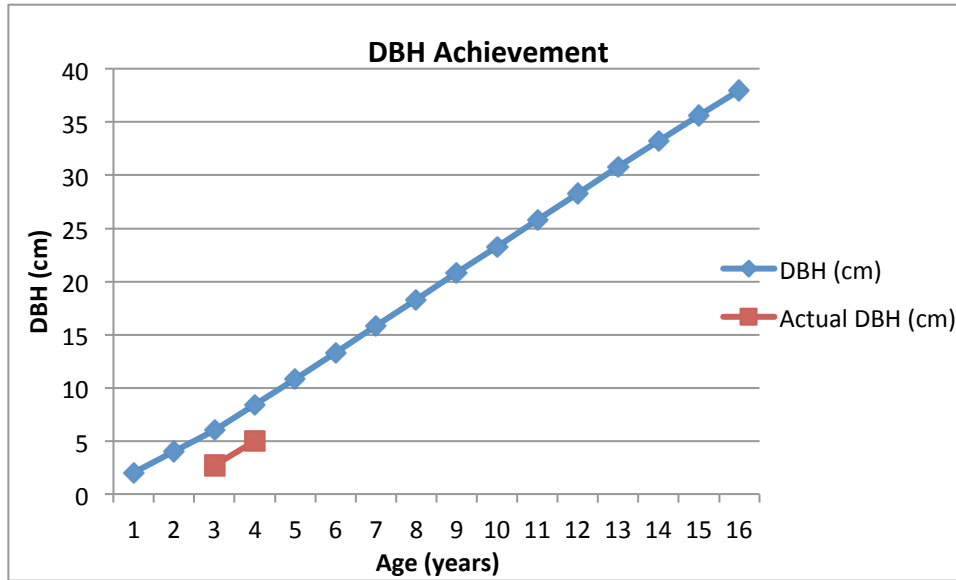## DBH Analysis of Block 02, Kumburuwela estate - Batticaloa

Figure 18: DBH achievement of Block 02,Kumburuwela estate, Batticaloa (DBH Comparison with Projected growth level)

Block Number 03

Year	Tree Ht (m)	Tree DBH (cm)
	2016	2016
Plot No. 01	1.8	2.2
Plot No. 02	3.7	4.8
Plot No. 03	3.9	5.0
Plot No. 04	3.9	3.9
Average	**3.2**	**4.0**
MAI	**1.1**	**1.3**
CAI	-	-

Table 8: Tree growth comparison of Kumburuwela Estate-Block number 03

Block Number 04

Year	Tree Ht (m)	Tree DBH (cm)
	2016	2016
Plot No. 01	1.6	1.8
Plot No. 02	4.3	5.0
Plot No. 03	4.6	5.6
Average	**3.5**	**4.2**
MAI	**0.9**	**1.0**
CAI	-	-

Table 9: Tree growth comparison of Kumburuwela Estate-Block number 04

6. DISCUSSION AND RECOMMENDATIONS

Current annual increment and mean annual increment of height in Palugahayaya estate show some incremental growth according to the analyzed data. Reason could be the competition of trees for sunlight. This is a result of delaying the thinning programme in Palugahayaya estate. With the rapid incremental growth of height, DBH increment is slow.

It is recommended to keep the same situation for more two or three years to get a satisfactory height of trees and after that silvicultural operations can be adjusted to increase the DBH.

Trees in Sinnanagavillu estate show satisfactory growth rate of both height and DBH. Height and DBH are in line with projected growth rates and the plantation condition should be maintained further for achievement of positive growth rates.

Trees in block 01 of Kumburuwela estate growing well but the growth rate of block 02 is better than block 01.

It is recommendable to apply organic and compost for the poor grown areas in all three plantations to uplift the soil condition and growth conditions.

7. REFERENCE

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