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Development of stem diameter RAP of rubber stand (*Hevea brasiliensis*) in the PBPH-HT area of PT. Sylvaduta Corporation in Kutai Kartanegara District, East Kalimantan Province

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Abstract

The development of industrial plantation forests or timber estates was one way to overcome the imbalance between supply and demand for wood raw materials for the forestry wood industry, namely by developing industrial plantation forests with rubber stands. The research aims to determine the stem diameter and analyze the development of diameter increments (MAI and CAI) in rubber stands in the PT Sylvaduta Corporation area. The research was carried out from March to May 2024 on rubber stands at PT. Sylvaduta Corporation is located in Kembang Janggut District, Kutai Kartanegara Regency, East Kalimantan Province, Indonesia. The research activities carried out include preparation, observation, determining sampling locations, sampling, data collection, data analysis, and reporting. The research results show that (1) the average stem diameter of rubber stands in 2022 will range from 19.37 – 21.14 cm, in 2023 it will range between 21.56 – 23.50 cm, and in 2024 it will range between 23, 83 – 25.95; (2) the average annual diameter increase (MAI) in 2022 ranges from 1.94 – 2.11 cm/year with an average of 2.02 cm/year; MAI in 2023 will range from 1.96 – 2.14 cm/year with an average of 2.05 cm/year; and MAI in 2024 ranges from 1.99 – 2.16 cm/year with an average of 2.07 cm/year; and (3) the average increase in walking diameter (CAI) in 2022 ranges from 1.72 – 1.93 cm/year with an average of 1.81 cm/year; CAI in 2023 ranges from 2.19 – 2.35 cm/year with an average of 2.29 cm/year; and CAI in 2024 will range from 2.27 – 2.46 cm/year with an average of 2.38 cm/year.

Keywords: Stem Diameter Rap, MAI, CAI, Rubber Stand.

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1. INTRODUCTION

The exploitation of natural forest products since the 70s has become a significant source of state income. With the rapid growth of the forestry industry, the wood harvested from natural forests is increasingly massive. As a result, the area of production forests, which are mostly natural forests, is increasingly shrinking. Since the 1990s, it has been felt that natural forests cannot meet the needs of raw materials for the forestry industry and the construction of public housing. The problem of insufficient supply of wood raw materials for housing construction and the woodworking industry has now become a national problem. Therefore, to meet the demand for forest products, the government created an industrial forest plantation or timber eatate program [1].

According to [2] Government Regulation Number 6 of 2007, Industrial Plantation Forests are plantation forests that are managed and cultivated based on the principles of sustainability, benefit principles, and company principles to increase the potential and quality of production forests by implementing intensive silviculture to meet the needs for raw materials for industrial products forest. [3] states that amidst the increasing scarcity of natural production forests, Industrial Plantation Forests or Timber estates are the foundation for future forest product production. Industrial Plantation Forests have several advantages, including they can generate foreign exchange, meet the need for industrial raw materials, and absorb labor; can increase ecological functioning and preserve the environment through forest conservation; and can improve the quality, productivity, and potential of production forest areas that are no longer productive.

The selection of plant types in Industrial Forest Plantation (HTI) activities is also based on the growth characteristics of the plant species themselves, such as the shape of the roots and the shape of the stems, in the hope that the plants will be resistant to natural disturbances such as heavy rain or strong winds. Rubber is a type of woody plant that has a dual function in its use, apart from the wood, rubber also produces latex which is used as raw material for making rubber which has other derivative functions. Rubber grows very well in tropical areas with rainfall between 2,000 - 3,000 mm per year., these conditions are the climatic conditions of most parts of Indonesia [4].

According to [5], the use of rubber as a plant in Industrial Plantation Forests has many advantages, including it can reduce CO_2 gas emissions, increase soil water content, prevent seawater intrusion, absorb neutralizing substances such as gas, solid particles, as well as aerosols from motor vehicles and industry, and maintain nutrients and function for soil and water conservation; can function for the conservation of flora and fauna, rubber wood can be a raw material for the pulp and paper industry, and rubber is an Indonesian export commodity that is important in economic activities. Indonesia is the world's largest rubber producer and exporter.

To realize good forest management, information about tree growth in the form of increments is necessary in preparing a plan for managing results in each forest management unit. [6] stated that tree diameter growth is an important factor in increasing stand productivity, especially wood. Increasing the diameter will have a big influence on increasing tree volume. [7] define increment as the volumetric growth of a tree or standing tree per unit time, apart from that it is also used to describe the increase in the annual value of a tree or the

increase in diameter or height of a tree. Regular measurements are needed to develop a plan for managing results in each forest management unit; schedule and manage forests sustainably, and ensure sustainability of yields by ensuring that harvested yields do not exceed the forest's growth capacity.

PT. Sylvaduta Corporation also has a rubber plantation area of ± 168 hectares with a population of ± 50,000 stands divided into 23 blocks and 312 plots. The rubber stand was planted in 2012 and is now 11 and 12 years old and the stand has not yet been harvested [8].

The research aimed to determine the growth of stem diameter and analyze the development of diameter increments (MAI and CAI) in rubber stands in the PT Sylvaduta Corporation area.

2. RESEARCH METHODS

2.1. Time and Place

The research was carried out from March to May 2024 on rubber tree stands at PT. Sylvaduta Corporation is located in Kembang Janggut sub-district, Kutai Kartanegara district, East Kalimantan Province, Indonesia.

2.2. Objects, Materials and Tools

The research objects were a 12-year-old rubber tree stand, measuring tape, compass, marker, stationery, camera, and calculator.

2.3. Research Activities

The research activities carried out include preparation, observation, determining sampling locations, sampling, data collection, data analysis, and reporting.

2.4. Sampling

Determination of rubber tree stands plots as sampling locations using purposive sampling techniques, namely blocks A1, E1, and G3. Each block took 100 rubber plants that were 12 years old, so the total sample was 300 plants.

2.5. Data Collection

The data collected consists of:

1. Primary data collected was the diameter of the rubber plant at a height of 1.30 m or the diameter at chest height of an adult. The diameter is calculated based on the results of measuring the circumference of the tree at breast height divided by 3.142 cm, using the formula (Forestry Department, 1992) quoted in [9], namely: $D = K/\pi$

Information: D = tree diameter(cm); K = tree circumference (cm); and π = (phi constant) = 3.142

2. Secondary data collected was:
   a. Planting distances are measured directly in the field using a roller meter.
   b. Planting year or plant age was obtained from information from PT's stem girth book. Sylvaduta Corporation.
   c. The general condition of the planting location was obtained from direct observations in the field and company documents

2.6. Data analysis

1. To calculate the Mean Annual Incrementor MAI [10] with the formula: MAI = Dt/t
   Information: Dt = tree diameter at age 1 (cm); and t = age (years).
2. To calculate the Current Annual Increment or CAI [10] with the formula:
   CAI = (Dt - Dt-1) / T
   Information: Dt = tree diameter at age t (cm); Dt-1 = tree diameter of previous year (cm); and T = distance between measurements (years)

3. RESULTS AND DISCUSSION

3.1. General Description of PT Sylvaduta Corporatioan

Based on the East Kalimantan Provincial Government Administration, the area of PT. Sylvaduta Corporation is included in the Government Administration area of Kutai Kartanegara Regency, East Kalimantan Province. Based on the Forestry Administration, the PT. Sylvaduta Corporation is included in the Belayan DAS KPHP Administrative area. The physiography of the research location is based on direct observations in the field, namely wavy topography, land slope of 8-25%, and altitude of 1,200 m above sea level.

PT. Sylvaduta Corporation is a national private company that operates in the field of Forest Utilization Business Licensing or PBPH-HT which is located in Kembang Janggut sub-district, Kutai Kartanegara district and Muara Ancalong sub-district, East Kutai district, East Kalimantan Province. Initially PT. Sylvaduta Corporation is an IUPHHK-HA forest management permit company that has received an extension by the decision of the Minister of Forestry number 205/Menhut-IV/1997, but based on the letter of the Director General of Forestry Production Development number S.163/VI-BRPHP/2007 dated March 6 2007 This area is technically not suitable for use as a Natural Forest IUPHHK area, but it is possible to use it as an IUPHHK in Plantation Forests. And the area of PT. Sylvaduta Corporation ± 47,025 Ha. PT. Sylvaduta Corporation has an area/rubber land of ± 168 Ha, with a plant population of ± 50,000 plants that are 11 and 12 years old withstanding conditions that have not yet been harvested, starting from 2012 at the start of planting, divided into 23 blocks and 312 plots [7].

3.2. Number of Plants and Plant Spacing

The research results show that the number of trees, planting distance, clone type, and plant age from each plot are presented in Table 1.

Table 1. Rubber Stand Data PT. Sylvaduta Corporation in Blocks A, E, and G

Block	Stand Type	Clone Type	Plant Spacing (m)	Age (Year)	Amount
A	Rubber	IRR 118 dan PB 260	3 x 6	12	100
E	Rubber	IRR 118 dan PB 260	3 x 6	12	100
G	Rubber	IRR 118 dan PB 260	3 x6	12	100

Source: Secondary Data from PT Sylvaduta Corporation

3.3. Measurement Results of Stem Diameter

The results of stem diameter measurements in rubber stands in 2022, 2023, and 2024 in block A, block E, and block G are presented in Table 2.

Table 2. Data on Average Stem Diameter of Rubber Stands PT. Sylvaduta Corporation in Blocks A, E, and G in 2022, 2023 and 2024

Block	Number of Stands per Block	Average Stand Diameter (cm) in the year of		
		2022	2023	2024
A	100	20,13	22,46	24,86
E	100	21,14	23,50	25,95
B	100	19,37	21,56	23,83

Source: Secondary Data Processing Results from PT Sylvaduta Corporation (2022 and 2023) and Primary Data Processing Results (2024)

The research results in Table 2 show that the average stem diameter of rubber stands in 2022 ranges from 19.37 – 21.14 cm, in 2023 it ranges from 21.56 – 23.50 cm, and in 2024 it ranges from 23, 83 – 25.95. This situation shows that the increase in stand age is followed by an increase in diameter resulting from stand growth. The growth in stem diameter is the result of secondary growth, namely the division of cells in the cambium area and the formation of xylem and phloem tissue. As stated by [11] the diameter of a tree is influenced by the quality of the place where it grows and the age of the tree. The more fertile the growing area, the better the tree growth will be, this is indicated by the large diameter of the tree. Likewise, the effect of tree age on the diameter of the tree, the older the tree, the larger the diameter. When referring to the standards for rubber plant stem girth according to age published by [12] that during normal growth, rubber that is 12 years old has a stem girth of 38 – 44 cm or a stem diameter between 12.09 – 14.00 cm, then the rubber stands at the research location have very good growth because they have a stem diameter of > 38 – 44 cm.

3.4. Increase in Stem Diameter

The results of data analysis regarding the average mean annual increment of stem diameter (MAI) the average current annual increment (CAI) and the average diameter of rubber standing stems are presented in Table 3.

Table 3. Results of Analysis of Average Mean Annual Increment (MAI) and Average Current Annual Increment (CAI) of Stem Diameter Rubber Stands

Annual Average	Block			Average (cm)
	A	E	G	
Average of MAI				
Tahun 2022	2.01	2.11	1.94	2.02
Tahun 2023	2.04	2.14	1.96	2.05
Tahun 2024	2.07	2.16	1.99	2.07
Average of CAI				
Tahun 2022	1.72	1.77	1.93	1.81
Tahun 2023	2.34	2.35	2.19	2.29
Tahun 2024	2.41	2.46	2.27	2.38

Source: Secondary Data Processing Results from PT Sylvaduta Corporation (2022 and 2023) and 2024 Primary Data Processing Results

The research results in Table 3 show that the average MAI in 2022 ranges from 1.94 – 2.11 cm/year with an average of 2.02 cm/year; MAI in 2023 will range from 1.96 – 2.14 cm/year with an average of 2.05 cm/year; and MAI in 2024 will range from 1.99 – 2.16 cm/year with an average of 2.07 cm/year. This shows that the MAI between 2022-2023 is 0.03 cm/year, and the increase in MAI between 2023-2024 is 0.02 cm/year. The research results also show that the average CAI in 2022 ranges from 1.72 – 1.93 cm/year with an average of 1.81 cm/year; CAI in 2023 ranges from 2.19 – 2.35 cm/year with an average of 2.29 cm/year; and CAI in 2024 will range from 2.27 – 2.46 cm/year with an average of 2.38 cm/year. This shows that the incremental CAI between 2022 - 2023 is 0.48 cm/year, and the increase in CAI from 2023-2024 is 0.09 cm/year. As explained by Husch et al., (1982) as quoted by [6] growth speed is a change in the dimensions (height, diameter, volume) of growth over each time interval. Instantaneous speed and average speed to express growth speed or growth point rate. The measurement of the average growth speed is called Mean Annual Increase (MAI) and the instantaneous speed is called Current Annual Increase (CAI). The results of the research above show that the increase in MAI and CAI of rubber stands each year is not always constant. This situation was explained by [13] that the increase in stand volume depends on the density (number) of trees that make up the stand (degree of stocking), type, and fertility of the soil. The increase in volume of a tree can be seen from the speed of growth in diameter, each type has a different rate. In plantation forests, the graph of diameter growth is usually S-shaped (sigmoid) because at first, it grows rather slowly, then quickly, and then decreases.

Based on the research results above, it also shows that from 2022 to 2024 the MAI and CAI values will continue to increase. The MAI and CAI values are still showing an increase and have not shown any signs of decreasing or converging. This means that the rubber stand is up to 12 years old and for the next few years the rubber stand will still be in a good growth period.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusion

Based on the results of the research and discussion, conclusions are drawn, namely as follows:

1. The average stem diameter of rubber stands in 2022 will range from 19.37 – 21.14 cm, in 2023 it will range from 21.56 – 23.50 cm, and in 2024 it will range from 23.83 – 25.95 cm.
2. The average annual diameter increase (MAI) in 2022 ranges from 1.94 – 2.11 cm/year with an average of 2.02 cm/year; MAI in 2023 will range from 1.96 – 2.14 cm/year with an average of 2.05 cm/year; and MAI in 2024 will range from 1.99 – 2.16 cm/year with an average of 2.07 cm/year.
3. The average increase in walking diameter (CAI) in 2022 ranges from 1.72 – 1.93 cm/year with an average of 1.81 cm/year; CAI in 2023 ranges from 2.19 – 2.35 cm/year with an average of 2.29 cm/year; and CAI in 2024 will range from 2.27 – 2.46 cm/year with an average of 2.38 cm/year.

4.2. Suggestion

1. Based on the results of field observations, weed control should be carried out periodically so that the growth of rubber stands is not disturbed.
2. Further research is needed regarding determining the correct cutting time for rubber stands in Industrial Plantation Forests.

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