



Research report

Carbon sequestration in rubber plantations in Phak Mai
Subdistrict, Huai Thap Than District, Si Sa Ket Province

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Research title : Carbon sequestration in rubber plantations in Phak Mai, Huai Thap Than District, Si Sa Ket Province.

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Abstract

This research aims to compare carbon sequestration and ecological characteristics of rubber plantations. This study investigated two influencing factors: 1) differences in the age of rubber trees and 2) management styles (monoculture and integrated management). The study was conducted in rubber plantations in Phak Mai Subdistrict, Huai Thap Than District, Si Sa Ket Province.

Sample plots of 30 × 30 meters were established. Two sample plots of 30 × 30 meters were surveyed at a height of 1.35 meters to collect data on the circumference of the rubber trees and their height. This data was then used to calculate above-ground biomass using allometric equations. $WT = 0.0798 (D^{2H})^{0.8706}$ The canopy cover was assessed using light metering equipment, and the types of ground cover plants in the area were surveyed. The total biomass was then used to calculate carbon sequestration using a coefficient of 0.47.

The study found that mature rubber plantations managed using integrated management systems stored up to 16.74 tons of carbon per rai (rai ≈ 1,600 sq.m.) and had a canopy cover of 96.25%. This carbon sequestration rate is approximately 6.7 times higher than that of young, monoculture rubber plantations, which stored only 2.51 tons of carbon per rai. Furthermore, the integrated plantations showed greater diversity of intercrops such as *Dipterocarpus alatus*, coconut palm, and fodder grasses, indicating that mature rubber plantations with integrated management are significantly more effective in mitigating global warming and maintaining a healthier ecosystem.

Keywords: Rubber, Carbon sequestration, Biomass

Introduction

1. Background and Significance

Currently, global warming and climate change are increasingly severe environmental problems affecting the entire world. A major cause is the increase in greenhouse gases in the atmosphere, especially carbon dioxide, resulting from various human activities. One internationally accepted approach to mitigating this problem is increasing green spaces to act as carbon sinks. Plants utilize the natural process of photosynthesis to absorb carbon dioxide and store it as biomass.

Rubber is one of the most important cash crops in Thailand, especially in the northeastern region where planting areas have been continuously expanding, including in Huai Thap Than District, Si Sa Ket Province. Besides providing latex for income, rubber plantations also function as planted forests with high potential for carbon sequestration due to their fast-growing, long-harvesting lifespan. However, carbon sequestration in rubber plantations can vary depending on several factors, particularly the age of the trees and the plantation management style, which currently includes both monoculture and mixed planting.

A survey conducted in Phak Mai Subdistrict, Huai Thap Than District, revealed that rubber plantation farmers employ varying management practices in terms of age and intercropping methods. However, a lack of empirical data comparing the efficiency of these methods is a significant concern. Therefore, this study aims to compare carbon sequestration in rubber plantations, selecting two representative areas with different management practices: young rubber plantations (monoculture management) and mature rubber plantations (integrated management). The study will compare biomass, canopy cover, and the diversity of cover crops.

The findings from this project will help determine the actual amount of carbon sequestration in the study area and provide crucial information to promote awareness among farmers about the role of rubber plantations in mitigating global warming. It will also serve as a guideline for sustainable rubber plantation management, aiming to create added value through carbon credit assessment in the future.

2. Research Questions

1. How does the age of rubber trees affect carbon sequestration and canopy cover?
2. How do management practices affect the diversity of ground cover plants in terms of carbon sequestration?

3. Research hypothesis

1. Different ages of rubber trees affect carbon sequestration and canopy cover.
2. Different management practices affect crop diversity, ground cover, and carbon sequestration.

4. Objectives of the research

1. To study and compare the carbon sequestration potential in above-ground biomass of rubber plantations.
2. To study and compare the canopy cover and diversity. Ground cover plants in rubber plantation ecosystems with different management practices.
3. To study the relationship between rubber plantation management styles and carbon sequestration efficiency.

5. Results obtained from the research

1. This study provides empirical data at the local level on the actual amount of carbon

stored in rubber plantations in Phak Mai Subdistrict, Huai Thap Than District, Si Sa Ket Province.

2. It reveals the ecological differences between monoculture rubber plantations and conventional rubber plantations. a mixed approach, especially in terms of canopy density and ground cover plant.

3. It provides guidelines for promoting and managing rubber plantations sustainably by encouraging farmers to adopt intercropping systems in rubber plantations can improve carbon absorption efficiency and help retain soil moisture.

6. Scope of Study

1. Scope of content.

This study compares rubber plantation ecosystems by examining two factors:

1.1 Age factor: Comparing rubber trees of different ages.

1.2 Management Factors: A comparison between monoculture rubber plantations and integrated management rubber plantations.

The following variables were studied:

Independent variable: Age of rubber trees and management practices.

Dependent variable: Biomass, carbon sequestration, percentage of canopy cover and type of ground cover crop.

2. Scope of the location.

Sample plot 1: Young rubber plantation (Coordinates :14°57'23.5"N 103°58'58.1"E)

Sample plot 2: Mature rubber plantation (Coordinates :14°57'23.4"N 103°58'48.7"E)

3. Time scope.

The study was conducted from January 10, 2026 to January 24, 2026.

7. Materials and equipment used in conducting the research

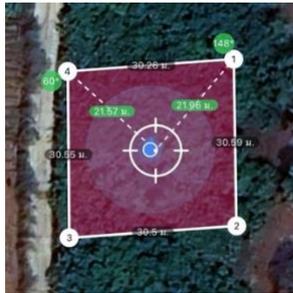
1. Measuring tape and body measuring tape.
2. Canopy cover measuring device, made from PVC pipe.
3. Altimeters and altimeter applications.
4. Notebook and pen.
5. Camera
6. Spreadsheet program (Microsoft Excel)

Research methodology

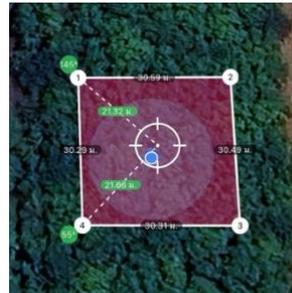
1. Setting up sample plots.

Set up a sample plot of 30 x 30 meters in the two representative rubber plantations

Plot 1: Young Plot



Plot 2: Mature Plot



The plot size is set at 30 × 30 meters.



Plot 1: Young Plot (Monoculture) Plot 2: Mature Plot (Integrated Management)

2. Data collection on rubber trees.

2.1 Measure the trunk circumference at a height of 1.35 meters for each tree.

2.2 Measure the height of each rubber tree using a height measurement application.



Measure the circumference at a height of 1.35 meters.

3. Collection of ecological data.

3.1 Measure the percentage of canopy cover using a canopy cover measuring device. Shine a light up. Record the shading values vertically at the center of the plot and at the four corners of the plot.



Measure canopy cover.

3.2 Survey and record the types of ground cover plants found within the sample plots.



Explore the types of ground cover plants.

4. Data analysis.

4.1 Calculate the diameter (D) from the measured circumference ($D = \text{Circumference} / \pi$). Then, estimate biomass using the allometry equation $WT = 0.0798 (D^2H)^{0.8706}$. Substitute the diameter (D) and height (H) values, then multiply by 0.47 to find the amount of carbon.

4.2 Assess canopy cover. Calculate the percentage using a measuring device by comparing the proportion of shading.

4.3 Comparing Results : Compare the data obtained between the two rubber plantations to draw conclusions.

Research results

In a comparative study of carbon sequestration, canopy cover, and ground cover vegetation in rubber plantations of different ages and management practices, the researchers present the data analysis results in three parts as follows:

1. Information on the growth of rubber trees.

Based on surveys and measurements of rubber trees in two sample plots, namely, a plot with young trees (Monoculture management) and older age plots (integrated management) yielded the study results shown in Table 1.

Table 1 Compare the average growth rates of rubber trees.

List of plots	Plot 1 (Young - Monoculture)	Plot 2 (Mature - Integrated Management)
Number of trees surveyed (trees)	76	83
Average height (meters)	11.39	16.40
Minimum - Maximum height (meters)	8.95 - 14.06	14.00 - 18.70
Average trunk circumference (cm)	38.41	53.64
Minimum - Maximum Circumference (cm)	21 - 58	17 - 105

From Table 1 it was found that:

Rubber trees in Mature have a significantly better growth rate than those in younger plots, exhibiting greater average trunk diameter and height, which is consistent with the age of the trees.

2. Ecological data: Canopy cover and ground cover.

From the environmental survey within the sample plots to assess the completeness of the ecosystem, using equipment and surveying undergrowth, the results are shown in Table 2.

Table 2 Ecological data, canopy cover, and plant species in the plot.

Parameter	Plot 1 (Young - Monoculture)	Plot 2 (Mature - Integrated Management)
1. Canopy covering.		
- Number of spots where leaves were found (spots)	74 / 80	77/80
- Percentage of coverage (%)	92.50	96.25
- Density level	Dense	Very dense.
2. Cover crops and companion crops.		
- Key features	Common weeds were found covering the ground at only one level.	Other cash crops are planted between the rows of rubber trees.
- Types of plants found.	Common natural grass	Additional trees planted: <i>Dipterocarpus alatus</i> .

		Coconut trees and fodder grass.
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Table 2 shows that: Mature rubber plantations are more fertile than younger ones due to better management practices. integrated management, where farmers have implemented Plant supplementary crops. These include Dipterocarpus alatus and coconut trees interspersed in vacant spaces, creating a more complex ecosystem structure. This provides a larger leaf area for carbon absorption and helps retain soil moisture better than young plots where only weeds are allowed to grow naturally.

3. Biomass and carbon sequestration.

Based on calculations using allometric equations. To determine the amount of carbon stored in above-ground biomass, the results are summarized in Table 3.

Table 3 Compare carbon sequestration.

Carbon data	Plot 1 (Young - Monoculture)	Plot 2 (Mature - Integrated Management)
Total biomass including the plot (kg)	3,008.66	20,030.53
Total carbon content of the plot (kg carbon)	1,414.07	9,414.35
Carbon sequestration (tons/rai) rai \approx (1,600 sq.m.)	2.51	16.74

Table 3 shows that: Mature rubber plantations managed using integrated management practices store approximately 6.7 times more carbon than younger, monoculture rubber plantations (16.74 tons per 2.51 tons/rai). This is due to two main factors:

1. Age of the rubber tree: Mature rubber trees have large trunks and accumulate a large amount of biomass.
2. Integrated Management: Intercropping (using Dipterocarpus alatus and coconut trees) helps increase the total biomass of the area and promotes better carbon sequestration in the overall ecosystem.

Conclusion and Discussion

Based on a comparative study of carbon sequestration in rubber plantations of different ages and management practices, between young plots (monoculture management) and Mature Plots (integrated management), the research findings can be summarized and discussed as follows:

Surveys and data analysis revealed that mature rubber plantations store up to 16.74 tons of carbon per rai (rai \approx 1,600 sq.m.) above ground, significantly higher than younger rubber plantations which only stored 2.51 tons of carbon per rai—a difference of approximately 6.7 times. This difference is influenced by two distinct factors: Age is the primary driver of total biomass accumulation and carbon storage, while Management Style plays a crucial role in enhancing biodiversity and soil ecosystem health through intercropping.

In terms of age and growth, rubber trees in Mature Plots have a longer biomass accumulation period, resulting in larger trunks and a higher average height than those in younger plots. This aligns with the principle of tree growth where wood yield is directly proportional to carbon storage.

Furthermore, in terms of ecology and management, it was found that Mature Plots were managed using integrated management practices, involving the intercropping of cash crops with rubber trees, including: *Dipterocarpus alatus* and coconut trees. This resulted in a more complex ecosystem with a higher canopy density (96.25%) compared to young plots planted solely with rubber trees and only covered by weeds (92.50%). Having multiple plant layers in this mixed plot not only increases the leaf area for photosynthesis and carbon absorption but also helps maintain moisture and ecosystem integrity more effectively.

Therefore, it can be concluded that planting rubber trees in an integrated management system, combined with allowing the trees to grow to their appropriate age, is the most effective approach to increasing carbon sequestration and helping to mitigate global warming.

Suggestions

1. Applications: Farmers should be encouraged to switch from monoculture rubber plantations to intercropping (such as perennial trees or other cash crops) to increase their income and enhance carbon sequestration in the area.

2. Further Studies: In the future, further studies are needed on the amount of carbon stored in the soil to obtain a comprehensive understanding of carbon sequestration in rubber plantations.

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(Coefficient 0.47)

Optional Badges

1) I AM A DATA SCIENTIST



We collected field data on rubber trees (circumference and height) and used it for calculations. Allometric equations were used to compare carbon sequestration between single rubber plantations and mixed plantations. The results were analyzed and presented through graphs and tables to clearly show the differences in carbon quantities. This empirical data was used to draw conclusions based on scientific principles, and is therefore believed to meet the criteria of the "I AM A DATA SCIENTIST" award.

2) I AM A COLLABORATOR



The team of five had clearly defined roles to ensure the project was completed successfully. Miss Kanokporn Wongpakdee: Planned and defined the direction of the project. Miss Kantisa Jentookjai analyzed and verified the accuracy of the information provided by Miss Siriwimon Sombatwong. Miss Siraphat Noradee Participated in field data collection. Miss Phitchaya Malison Compiled and formatted the report. with excellent teamwork from everyone involved, leading us to believe that it meets the criteria for the "I AM A COLLABORATOR" award.

3) I MAKE AN IMPACT



This research aims to study carbon sequestration in rubber plantations to help mitigate global warming. The study results show that: Integrated rubber farming It helps maintain ecological balance better than monoculture rubber plantations. We aim to promote this knowledge to farmers in the community, encouraging them to adapt their farming methods for sustainability, raising environmental awareness, and increasing the value of local land use. We believe this meets the criteria of the "I MAKE AN IMPACT" mark.