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## Estimation of Carbon Stocks from Various Agroforestry Practices in Social Forestry Areas of Dompu Regency

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### ABSTRACT

Forest management in Indonesia is now adopting the Social Forestry approach, a legal scheme that grants management rights to local communities to sustainably manage state forests, customary forests or rights forests. This study aims to identify various agroforestry patterns and analyze the estimation of carbon stocks in these patterns in Dompu District. The data collection method was carried out by census with a sample intensity of 30 plots in all demonstration plots which will then be distributed by random sampling, considering the representation of vegetation conditions and accessibility. Variables studied for pattern identification include plant species, number, wood/non-wood grouping, and dominance of main stand types. For carbon estimation, the variables used include DBH measurement, tree height, volume, BEF, biomass, and live biomass carbon. The results showed two agroforestry patterns: mixed and simple. The estimated carbon stock in the mixed pattern was 16.18 tons/ha, while in the simple pattern it was 27.14 tons/ha

## **INTRODUCTION**

Forests play a vital role in supporting community welfare, both ecologically and economically. In Indonesia, forest management is now directed through a Social Forestry scheme that provides legal management rights to communities around the forest, as stipulated in Permen LHK No. 83/2016. This scheme aims to improve community welfare while preserving forest resources based on local wisdom (Rahayu & Triwanto, 2021). However, population growth and limited agricultural land have led to forest conversion for settlement and agricultural needs (Senoaji, 2010), which has resulted in forest degradation and loss of carbon stocks (Purnobasuki, 2012).

To overcome this pressure, agroforestry systems are an alternative approach that is considered capable of maintaining the ecological function of land while providing economic benefits. Agroforestry integrates woody crops, annual crops, and/or livestock in one field, creating a sustainable production system (Sardjono et al., 2003). This system has been proven to store significant amounts of carbon, reduce erosion, maintain water management, and sustain biodiversity (Hairiah et al., 2011). Carbon stocks in agroforestry is influenced by the species composition, tree diameter and cropping pattern used (Markum et al., 2013).

Dompu District, West Nusa Tenggara, is an area dominated by monoculture maize farming that encourages forest conversion and threatens ecosystem sustainability (Lestari & Widayanti, 2017). As an effort to conserve and increase land productivity, Brawijaya University and Mataram University through the Kedaireka project developed

agroforestry demonstration plots in three Social Forestry locations: BKPH Toffo Pajo Soromandi, BKPH Ampang Riwo, and BKPH Tambora. This research aims to identify various agroforestry patterns and analyze the estimation of carbon stocks in each pattern.

## **METHODS**

### **Time and Place**

The research activities were carried out from October to December 2024, which took place in the Social Forestry Area in three locations, namely BKPH Toffo Pajo Soromandi, BKPH Ampang Riwo and BKPH Tambora in Dompu Regency, West Nusa Tenggara.

### **Sample Determination**

Sampling was conducted to observe various patterns of agroforestry practices and estimate carbon stocks in various agroforestry patterns in the field based on demonstration plot maps in each BKPH. Sampling was done by census. The total number of observation samples was 30 plots in all

BKPHs with 10 sample plots in each classification of vegetation index values. Sampling was conducted using rectangular transects with a size of 20 m x 50 m (Hairiah et al., 2011), and then distributed by random sampling, considering the representation of vegetation conditions and accessibility. Observations of understory plants (shrubs) were carried out in each main plot with an observation plot size of 0.5 x 0.5 m. Record all wet weight and dry weight data of each understory plant (shrubs).

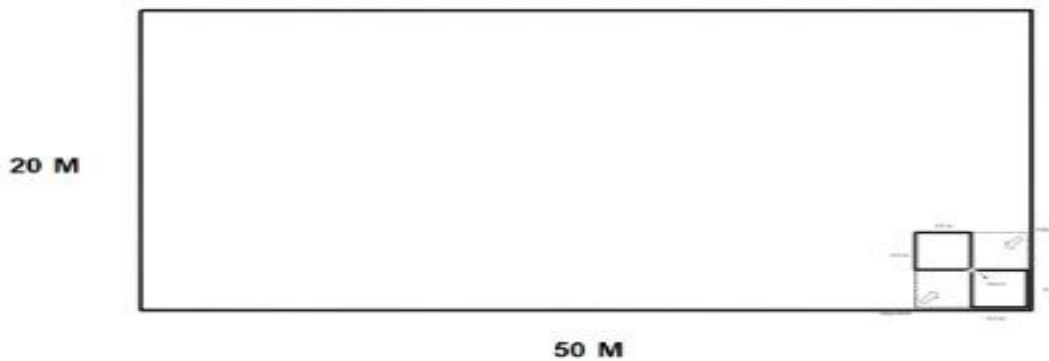


Figure 1. Research Plot

Research Variables

To identify the various patterns of agroforestry practices, the variables studied include, the name of the plant species, the number of plants, grouping plants based on wood and non-wood types and arranging agroforestry patterns based on the dominance of the main stand plant species.

To analyze the estimation of carbon stocks in various agroforestry patterns, the variables studied were measuring all types of plants that have DBH (Diameter Brest High), measuring plant height, calculating geometric tree volume, calculating BEF

(Biomass Extention Factor) values, calculating tree biomass, calculating live biomass carbon.

Data Analysis

To estimate the biomass of agroforestry plants and understorey plants (shrubs), the following allometric formula was used:

1. Allometric Formula

The allometric formula for estimating the biomass of several types of plants commonly grown on agroforestry land in social forestry in Dompu district can be seen in Table 1

Table 1. Allometric Formula for Agroforestry Plants (Hairiah et al., 2011; Arifin, 2001)

Types of Trees	Estimation	Source
	Tree biomass (Kg/tree)	
Coffee trimmed	$(AGB)_{est} = 0.281 D^{2.06}$	Arifin, 2001
Banana	$(AGB)_{est} = 0.030 D^{2.13}$	Arifin, 2001

2. Biomass Formula of Understorey

Sampling of understory plant biomass must be done using destructive methods (taking plant parts as samples). Lower plants taken as examples are all living plants in the form of trees with a diameter of <5 cm, herbs and grasses (Hairiah et al., 2011). The following formula calculates the biomass of understorey (shrubs).

$$BKT(gr) = \frac{DW \text{ of Sample}}{WW \text{ of Sample}} \times WW_{total}$$

Description:  
 TDW-Biomass: Total Dry Weight  
 DW: Dry Weight  
 WW: Wet Weight

Sampling of understory biomass (shrubs) should be done using the destructive method (taking plant parts as samples). The understory taken as samples are all living plants in the form of trees < 5 cm in diameter, herbs and grasses. First cut all lower plants (trees < 5 cm in diameter, herbs and grasses) contained in the quadrant, separate the leaves and stems, then put them in paper bags, label them according to the sub plot code, tie all paper bags containing lower plants (shrubs) taken from one plot, put them in a large sack, weigh the wet weight of the leaves or stems, record the weight in the observation sheet, take plant samples from each leaf and stem biomass of about 2 ounces. If only a small sample of

biomass is obtained (< 2 ounces), then weigh everything and make it a sub-sample, dry the sub-sample of plant biomass that has been taken in an oven at 80 ° C for 48 hours, then weigh the dry weight and record it in the observation sheet.

## RESULTS AND DISCUSSION

### Agroforestry Pattern

Grouping agroforestry patterns based on the combination of crop varieties in social forestry in Dompu district. Based on the combination of crop varieties, two agroforestry patterns were found: mixed agroforestry and simple agroforestry. Both patterns can be described as follows (Table 2).

Table 2. Agroforestry Patterns and Plots

Patterns	Description	Demonstration Plots	Plot Quantity	Plot No.	Land area (Ha)
1.Mixed	Mixed Agroforestry is a land use system that combines different types of agricultural crops, woody trees, and/or livestock on the same land. This pattern aims to increase land productivity in a sustainable manner by utilizing positive interactions between planted components.	Karamabura, Madaprama, Oi Kampasi.	6	1,2,19,20,21,22	0,6
2.Simple	Simple Agroforestry pattern is an agroforestry system that combines a few types of plants or trees in one field with a simpler	Karamabura, Madaprama, Oi Kampasi,	24	3,4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18,23,24,25,26,27,28,29,30	2,4

Patterns	Description	Demonstration Plots	Plot Quantity	Plot No.	Land area (Ha)
	structure than mixed agroforestry. Usually, this pattern consists of only one or two types of woody trees combined with agricultural crops.	Karamabura, Madaprama, Oi Kampasi,			

Source: Primary Data 2025

Based on the results of research in three BKPH areas in Dompu Regency in Table 2, the patterns and plots of agroforestry in social forestry in Dompu Regency are that most farmers still plant with a simple agroforestry pattern, namely 24 plots. This is because most of the land is used to grow seasonal crops such as corn and only a few forestry crops (annual) and MPTS (Multi Purposive Tree Species) for side income and personal consumption. According to, good maize prices, government seed and fertilizer assistance, and government maize planting programs have encouraged communities to increase maize productivity, motivating farmers to expand production areas.

Farmers who planted with mixed agroforestry patterns were 6 plots. This is because farmers have switched to making agroforestry products as the main income and began to leave planting monoculture crops such as corn. Agroforestry has ecological and economic benefits. One of the

ecological benefits of agroforestry is that it can absorb and store carbon. According to (Permana et al., 2024), agroforestry is considered a practical form of agroecology because it is designed and managed based on ecological principles. The system includes interactions between trees and crops and is a potential pathway to make agriculture more sustainable. Because it mimics the composition and function of natural forest ecosystems, agroforestry has great potential to achieve agricultural sustainability. Agroforestry contributes to restoring soil health by stabilizing soil, forming soil aggregates, storing carbon, increasing nutrient availability, and supporting soil biota. Agroforestry is also recognized as an approach to achieve carbon neutrality. According to (Fardiansyah et al., 2022), the economic aspect is indicated by increased production and income, which can be daily, weekly, seasonal, and annual.

#### **Estimation of Carbon Stocks**

Table 3. Estimated Carbon Stocks for Each Agroforestry Pattern

No	Agroforestry Pattern	Plot Quantity	Total Carbon Stocks (Tons)	Average Amount of Carbon Stocks (tons/ha)
1	Mixed	6	97,11	16,18
2	Simple	24	651,56	27,14
<b>Quantity</b>		30	748,7	24,96

Source: Primary Data 2025

Based on the results of research in three BKPH areas in Dompu District in Table 3, the estimated carbon stock for each agroforestry pattern found that the amount of carbon stock in the mixed agroforestry pattern and simple agroforestry pattern was 24.96 tons/ha. In mixed agroforestry pattern, the estimated carbon stock is 16.18 tons/ha. In simple agroforestry pattern, the estimated carbon stock is 27.14 tons/ha.

Based on the results of this study, there are significant variations in the amount of carbon stocks in different types of agroforestry patterns applied in the social forestry area of Dompu District. This difference is strongly suspected to be influenced by several factors, such as plant species composition, vegetation density, plant age, and different land management practices in each location. In comparison, a similar study conducted by (Markum et al., 2021) on social forestry in Sesaot Village, West Lombok District, found that the main factors determining carbon stocks were tree diameter and wood specific gravity. This is in line with the findings in Dompu district, where mixed agroforestry and simple agroforestry patterns are mostly dominated by plants with a diameter of less than 10 cm. This is because social forestry in Dompu district has only started since 2021. Therefore, if observed from the age of the plants, they are in the range of 3-4 years, which allows the diameter of the plants to be <10 cm.

This revealed that there is significant variation in carbon stocks across different agroforestry

patterns in Dompu district, influenced by factors such as vegetation composition, plant density, plant age and land management. Tree diameter was the main determining factor, contributing up to 75% of the total carbon stock, while sapling-sized vegetation only contributed around 6%. These results are in line with previous research in West Lombok, which emphasized the importance of tree diameter and wood specific gravity in carbon stocks. Thus, agroforestry management that encourages the growth of large trees can be an effective strategy to increase carbon stocks in social forestry systems.

## CONCLUSION

Based on research results on social forestry in Dompu district

1. Variety of agroforestry practice patterns in Social Forestry in Dompu District with a total of 30 plots using mixed agroforestry patterns and simple agroforestry patterns. In the mixed agroforestry pattern, 6 plots were found and in the simple agroforestry pattern, 24 plots were found. This is because most of the land is used to grow seasonal crops, namely corn, and only a few forestry crops (annual) and MPTS (Multi Purpose Tree Species) for side income and personal consumption.

2. Estimated carbon stocks in various agroforestry patterns in Social Forestry in Dompu District with 30 plots amounted to 24.96 tons/ha. In the mixed agroforestry pattern, the estimated carbon stock is 16.18 tons/ha, while in the simple

agroforestry pattern the estimated carbon stock is 27.14tons/ha

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