Study of agroforestry mindi planting pattern
(Melia dubia cavanilles) in Selaawi Village, Garut District, West Java Province

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Abstract. Melia dubia Cavanilles (big mindi) is one of the fast-growing species which is potential to be developed in community forests. This species is found to occupy most agroforestry lands in Selaawi village (Garut, West Java). The research was conducted in three stand types, namely: (i) pine stand (as reference), (ii) old mindi stand, (iii) young mindi stand with objectives to identify the pattern of planting of mindi agroforestry in Selaawi Village, to analyze the condition of growing places, and to measure the productivity of each stand. This research was conducted 2011 in Selaawi Village, Talegong Subdistrict, Garut District, West Java Province. There are several tree species dominating the sites, namely Melia dubia Cavanilles (43.37%), Paraserianthes falcataria (23.20%), Maesopsis eminii (15.35%), Manglieta glauca (9.83%), Eucalyptus spp. (4.68%), Anthocephalus cadamba (1.62%) and other wood species (1.96%).

1. Introduction

Agroforestry is a land-use system and technology where long-lived trees (including shrubs, palms, bamboo, wood) and short-lived crops or fodder are cultivated on the same plot in time and space setting [1]. As a carefully managed artificial forest to also produce timber such as natural forests, agroforestry is a place to harvest forest products for daily needs. In this way agroforestry can replace the function of natural forest. With the development of agroforestry, the role of natural forests as a source of vegetable materials increasingly disappears. If other demands on natural forests, ie as land reserves for agricultural expansion, are also reduced, the protection of natural forests can be more efficient [1]. Agroforestry patterns are commonly found in Indonesia, which can be grouped into two main categories, namely simple agroforestry systems and complex agroforestry systems.

In Selaawi, Garut, West Java, there is an agroforestry mindi that has the potential to be developed because it has ecological and economic functions that support the lives of local people. Mindi is one type of fast wood growing or fast-growing species that are potential to be developed. There are two types of mindi that are potentially developed, namely big mindi (Melia dubia Cavanilles) and small mindi (Melia azedarach). Big mindi (Meliaceae) is a multipurpose tree of tropical and subtropical regions mainly cultivated for its medicinal and industrial importance [2]. Mindi trees can be harvested...
at the age of five years and new shoots from the former felled can be harvested again after four years later.

The selection of plant species is not limited to the types that are already on the market today. Species selection can be done by observing local species that have the potential to be expanded [3]. It can be done by selecting the type-potential types naturally grown in Indonesia or by developing species of exotic type that has long grown in Indonesia like Melia dubia cavanilles. Data and information about the condition of the stand and growing place in each stand is expected to be make references in determining the best patterns in Selaawi Village. The purposes of this research are to identify the pattern of planting of mindi agroforestry in Selaawi Village, to analyze the condition of growing places and to measure the productivity of each stand.

2. Methodology

This research was conducted on three stands representing the condition of forest stands in Selaawi Village namely young mindi stand (mindi of age three years), old mindi stand (mindi of age fourteen years), and forest stand pine Perhutani (pine age twenty five years). These three plots are located in Selaawi village which is administratively located in Talegong Subdistrict, Garut Regency, West Java. The village is located at an altitude of 750 - 1,400 meters above the sea level. Data retrieval done was: (a). Determination of research plot, making a circle plot with an area of 0.01 ha in young mindi stands, old mindi and pine forest. The measurement of stands in the plot includes the measurement of the diameter and height of the tree as a whole, and (b) soil sampling using soil ring or soil drill.

2.1. Analysis of growing places

To obtain data on the physical properties and soil chemistry. Soil samples were taken from three different stands. Physical and soil chemical properties were taken three replications of each land cover at a depth of 0-20 cm. The method of land sampling is as follows:

2.1.1. Example of intact soil (undisturbed soil sample). Intensive soil sampling for analysis of soil physical properties were such as bulk density, porosity, permeability. Sampling intact soil was only at one depth of 0-20 cm. The soil sampling activity was begun by cleansing the body part of the soil to be taken from the litter and stone cover, then flattened. The sample ring was laid perpendicular to the surface of the soil, and only three-quarters of the part entered the soil. Next, the second sample ring was put on the first ring, then pressed again until the first ring and the second ring got into the ground. Ring was dug by using a shovel/hoe. The two rings were separated with caution, then the excess of soil that the top and bottom of the ring was sliced up flat. Ring was closed by using plastic bag [4]. Then the soil was analyzed in the laboratory.

2.1.2. Ordinary soil samples (disturbed soil sample). Soil sampling is commonly used for the analysis of chemical properties such as pH, CEC, moisture content, and nutrient content. Soil sampling activity was begun by cleaning the soil surface from plants, leaves, and residual dirt. Then, the soil was taken composite from 3 points by using hoe and knife at depth 0 - 20 cm, then mixed into 1 kg composite soil. The soil sample was loaded into a plastic bag and labeled and inserted into the cool box to keep it moist. The study was analyzed in the laboratory [4].

2.1.3. Physical properties of soil. The soil sample used was a whole soil sample of 100 grams taken at a depth of 0-20 cm. Physical properties of soil analyzed included texture, bulk density, porosity, depth of soil solum, water availability and permeability.

2.1.4. Soil chemical properties. Analysis of soil samples in the laboratory was performed for the determination of N-total by Kjeldahl method, Nitrate, by titration method, P which was available, by Bray method, K exchanged, NH₄OAc extract which was measured with a flametometor, C-organic with Walkley & Black method, pH H₂O with pH stick, texture with the method of granular analysis of how to pipette, weight volume with ring sampler method, porosity with the calculation according to the
formula \( n: l \cdot (BV / BJ) \), and aggregate stability [4]. The physical properties parameters and soil chemical properties are presented in Table 1.

**Table 1.** Physical properties parameters and soil chemical properties.

| No | Parameter                        | Method                               |
|----|----------------------------------|--------------------------------------|
| 1  | Climate (Temperature, Humidity, and Rainfall) | Field measurements and secondary data |
| 2  | Physical properties               |                                      |
|    | a. Bulk density                  | Ratio of ground weight               |
|    | b. Porosity                      | Volumeter                            |
|    | c. Water available               | Gravimetry                           |
|    | d. Water content                 | Gravimetry                           |
|    | e. Soil texture                  | Pipette method                       |
|    | f. Soil structure                | Field observation                    |
|    | g. Depth of roots                | Field observation                    |
| 3  | Chemical properties              |                                      |
|    | a. C-Organic                     | Kjehdahl                             |
|    | b. N total                       | Kjehdahl                             |
|    | c. P                             | P-bray II                            |
|    | d. K                             | \( \text{NH}_4\text{Oac pH 7, AAS} \) |
|    | e. CEC                           | \( \text{NH}_4\text{Oac pH 7, Titration} \) |
|    | f. pH                            | \( \text{pH meter (potentiometer)} \) |

2.2. *Analysis data of vegetation*

Vegetation analysis was performed to obtain important value index (INP) data of vegetation type both forest and plant plants at the study site. To obtain forest plantation vegetation data, the sampling of land cover was taken. In this study, nine sample plots were made by circular plot method [5].

2.3. *Analysis data of site condition*

To analyze the data quality of site condition on various stands used computer program with software Microsoft Excel 2007, Minitab 15 was used.

3. Results and discussion

The planting of mindi trees in Selaawi Village is generally combined with seasonal crops. Selaawi Village has different mindi tree planting patterns, among others are:

3.1. *Young mindi stand*

Mindi agroforestry is combined with coffee and cardamom. Mindi was planted in 2007 and is now tree years old. In this stand plot, originally mindi was planted with palawija (turmeric, ginger, eggplant and chilli) and then in the third year it was replaced with cardamom and coffee plants. This planting pattern is the pattern of planting which is mostly done by agroforestry farmers in Selaawi Village. Substitution of shade under the shade is in accordance with canopy plant conditions. Crops such as palawija cannot grow optimally in low sunlight conditions. Land conditions are tilted so that terracing is made. The distance of planting young mindi have regularly started that is with distance of 3 m x 3 m.

Young mindi stand planted from 2007 to 2009 amounted to 65,000 trees in the farmers’ gardens in Selaawi and surrounding villages. This data shows that the community is very interested in mindi plants. Mindi planting by farmers was combined with other types of wood plants such as *tissuk* and *africa*. According to Kulkarni [6] planting *Melia dubia* with agroforestry system along with cotton, papaya, pomegranate, sweet lime crops was intercropped in North K North Karnataka, India.
3.2. Old mindi stands

This pattern combines mindi with tea, where mindi is fourteen years old while tea is eight years old. Tea is a plant that can grow under the stand of mindi. The average diameter is 38 cm and 24 meters high. In addition to tea, mindi combined with African wood, avocado and sengon. The distance of planting tea is 100 cm x 70 cm and the distance of planting mindi with other trees is irregularly. The average of plant spacing is 5 m x 5 m. This mindi stand is the mother tree used by the Selaawi villagers for the propagation of plants with a land area of 1.2 ha and there are about 60 parent trees.

3.3 Pine stands

Pine stands are plants planted by Perhutani with an area of 75 ha which is included in the area of Selaawi Village. This stand is a pure pine stand, no other tree species. But under the stands there are several types of grasses such as babadotan and others.

Selaawi Village has a high rainfall of 2,224 mm/year and an average temperature of 19.9 °C and humidity of 83.8%. Types of trees that dominate in farmers’ garden are mindi (Melia dubia Cavanilles) (43.37%), sengon (Paraserianthes falcatoria) (23.20%), Africa tree (Maesopsis eminii) (15.35%), manglid (9.68%), jabon (Anzocephalus cadamba) (1.62%) and other tree species such as mahoni (Swietenia mahagoni), tissue (Hibiscus cannabinus), suren (Toona sureni), puspa (Schima wallichii), pala (Myristica fragrans) and rasamala (Altingia excelsa) (1.96%). Types of non-timber plants owned by the community that contributes to farmer income include aren (Arenga pinnata), kapulaga (Amomum compactum), coffee (Coffea arabica), tea (Camellia sinensis).

The stand of mindi is generally planted at a distance of 3 m x 3 m and other trees are planted between the mindi tree. Seed sources are usually obtained by purchasing or bartering with the seller of seeds. Seed extraction of mindi is very difficult to do, until now only a few people who can do it until now. A complete description of the standing site and stand productivity is presented in table 2.

The increase of plant age caused the productivity of stands to increase. The highest tree volume is in the plot of old mindi stands (187.8 m$^3$/ha), pine stands (122.54 m$^3$/ha) and young mindi (82.49 m$^3$/ha). The results showed that regarding the cation exchange capacity (CEC), the highest CEC was in young mindi stands (32.81 me/100 g), pine stand (22.01 me/100 g), and then the lowest CEC was old mindi forests (20.37 me/100 g). CEC at young mindi has bigger value than the other two stands because this young mindi stand, fertilization activity and soil processing were done intensively. According to Patil et al. [8] the variation in the productivity of tree species is mainly depends on the genotype and climatic conditions which ultimately reflect on species performance; hence, environment also has a significant influence on the productivity.

According to Hardjowigeno [9], CEC shows the ability to absorb and exchange cations with plant roots. CEC is a chemical nature that is closely related to soil fertility. Hardjowigeno [9] states that CEC.
is the number of cations (in milliequivalents) that can be absorbed by soil union weight (usually per 100 g). CEC is a chemical nature that is closely related to soil fertility. Land with high CEC can absorb and provide better nutrients than land with low CEC. The relationship factors of growth mindi can be seen in figure 2.

**Table 2. Conditions of growing places and stand productivity.**

| Location                        | Pinus stand (reference) | Old Mindi Stand (mindi+afrika tree+avocado+tea) | Young Mindi Stand (mindi+kapulaga+Coffea) | p<0.05 |
|---------------------------------|-------------------------|------------------------------------------------|---------------------------------------|--------|
| **Geographical location**       |                         |                                                |                                       |        |
| Latitude                        | S: 07°18’08,3”          | S: 07°18’46,0”                                 | S: 07°18’53,2”                        |        |
|                                 | E: 107°30’17,7”         | E:107°28’41,0”                                 | E : 107°29’19,4”                      |        |
| Altitude (mdpl)                 | 1158                    | 925                                            | 862                                   |        |
| Slope (%)                       | 103                     | 63                                             | 19,1                                  |        |
| **Soil conditions**             |                         |                                                |                                       |        |
| C-org (%)                       | 1.55±0.17e(L)           | 1.35±0.08 (R)                                  | 2.01±2.01b(T)                        | 0.003  |
| N-Total (%)                     | 0.13±0.0155 (S)         | 0.11±0.005 (R)                                 | 0.15±0.005 (T)                       | 0.018  |
| P available (ppm)              | 6.97±1.22 (R)           | 5.77±1.15 (R)                                  | 8.17±1.65 (R)                        | 0.178  |
| K (me/100 g)                    | 0.83±0.1 (T)            | 0.85±0.04 (T)                                  | 0.72±0.035 (T)                       | 0.113  |
| CEC (me/100 g)                  | 22.01±4.07 (T)          | 20.37±1.96 (S)                                 | 32.81±5.5 (T)                        | 0.020  |
| Sand (%)                        | 20.93±2.84a             | 24.63±1.33b                                    | 16.13±2.02b                          | 0.008  |
| Dust (%)                        | 30.10±1.8a              | 31.60±1.4a                                     | 30.10±1.0a                           | 0.406  |
| Clay (%)                        | 48.97±1.4a              | 43.77±2.4b                                     | 53.77±2.9c                           | 0.006  |
| Porosity (%)                    | 68.27±1.49 (T)          | 67.02±12.6 (T)                                 | 57.16±1.81 (T)                       | 0.217  |
| Permeability (%)                | 1.53±1.94 (AL)          | 5.85±3.74(S)                                   | 0.61±0.61 (SL)                       | 0.085  |
| pH                              | 5.40±0.1 (M)            | 5.07±0.05b(M)                                  | 4.66±0.2 (M)                         | 0.002  |

**Condition of stand**

| Age (Year) | 20 | 14 | 3 |
| Density (tree/ha) | 110±88a | 300±121a | 1066±258b | 0.001 |
| LBDS(m²/ha)   | 9.47±8.60a | 17.61±5.38a | 13.05±1.04a | 0.309 |
| Volume(m³/ha) | 122.54±97.67a | 187.80±61.18a | 82.49±10.68a | 0.230 |
| Index Diversity (H’) | 0(R) | 1.5(S) | 1.78(S) |

Note. Numbers on the same line followed by the letters are not significantly different from the Duncan test (p<0.05). Criteria for assessment of soil chemistry and physical properties are: R = low, S = medium, T = high, M = acid, AL = slightly slow, SL = very slow [7]. Diversity Index are: S = medium, R= low.

**Figure 2.** The relationship factors of growth mindi.
Number 1, 2 and 3 in figure 2 are pine stand plots (references), numbers 4, 5 and 6 are plots of old-minded stands, whereas number 7, 8 and 9 are young mindi stands. Each stand has its own group, indicating that there is a difference in the condition of the growing place between the stands. This study shows that soil chemical properties affect more stand productivity. It is because the mindi plant is a fast-growing species. According to Wasis [10], fast-growing plants require many nutrients in their growth causing soil nutrients much depleted.

Differences in age, density and growth-factors greatly affect the productivity of the mindi stand. The productivity of the mindi stands viewed from the volume is more influenced by the physical and chemical properties of the soil. Based on the figure above, the positive correlated physical properties include dust content, soil permeability, sand and porosity of the soil. Soil chemistry that is positively correlated with productivity, among others are CEC, N, P, and C. According to Hardjowigeno [9], the elements of C, N, P, and K are elements of macro-nutrients that are essential for the plant and their function in the plant cannot be replaced by another element. Therefore, when they are not enough in the soil, the plant cannot grow normally. According to research by Bramasto and Restu [3], the results of the analysis show that the most influential soil factors in fruit production are K, % Clay, P, and CEC. It is indicated by a p-value of less than 5% alpha. From the equation, it is known that the elements that have a positive coefficient of fruit production are elements of K (potassium) and P (phosphorus). It means that the greater the value of K and P the more the production of the mindi plant will be. Elements of K and P indeed have role in the formation of flowers and fruits in plants.

4. Conclusions
The planting of mindi trees in Selaawi village is generally combined with seasonal crops. Selaawi village has different mindi tree planting patterns, among others young mindi stand, old mindi stand, pine stand. Types of trees that dominate in farmers’ garden are mindi (Melia dubia Cavanniels and Melia azedarach) (43.37%). Capacity Exchange Cation (CEC) at young mindi has bigger value than the other two stands because this is in the young mindi stand fertilization activity and soil processing is still done intensively.

5. References
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