The potential of *Curcuma longa*, *Curcuma xanthoriza* and *Centella asiatica* in Silvofarmaka System Based on *Melia azedarach* and *Azadirachta excelsa*

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Abstract. Silvofarmaka system is optimizing land management by combining forestry plants and medicinal plants. The purpose of this research is to study the potential of Turkey (*C. longa*), Curcuma (*C. xanthorrhiza*) and Pegagan (*C. asiatica*) under Mindi (*M. azedarach*) and Sentang (*A. excelsa*) in the silvofarmaka system. There are 60 seedlings for each species planted under Mindi and Sentang under 5 years, and there is no shade tree as a control. We measured the diameter and size of the Turmeric and Curcuma rhizomes, and the number of Pegagan leaves.

The results showed that the average diameter of Turmeric (9.225 cm) and Curcuma (15.125 cm) under the shade of the tree was higher than under the shade of the tree. The difference in growth may be due to the intensity of sunlight. Turmeric, Curcuma, and Pegagan can grow in the shade of light. While the intensity of sunlight in this study is low, namely 304,536 lux (without the shade of a tree), 63.45 (under Mindi), and 47.72 (under Sentang). This lower intensity of sunlight causes lower biomass (diameter and leaves). The medicinal plants need more light intensity to grow optimally so that further activities (e.g. pruning and thinning) are needed.

1. Introduction

Indonesia is a country that has a high level of biodiversity, both flora and fauna. One of the diversity of flora is medicinal plants. Medicinal plants are all plants that some or all parts of the plant can be used as medicine [1]. Recently the local community tends to consume traditional medicine due to back to nature lifestyle and the expensive price to buy modern medicine [2]. More than 20,000 types of medicinal plants that grow and develop in Indonesia. The most popular medicinal plants in Indonesia are Ginger (*Zingiber officinale*), Kencur (*Kaempferia galanga*), Turmeric (*Curcuma longa*), Curcuma (*Curcuma xanthorrhiza*), Pegagan (*Centella asiatica*), Lempuyang (*Zingiber zerumbet*), Temuireng (*Curcuma aeruginosa*) and so on [2].

Those medicinal plants have many advantages, such as Curcuma (*C. xanthorrhiza*) is used for antioxidant, detoxification, preventing cancer cells, preventing acne, anti-inflammatory, reducing cholesterol, and increasing appetite [2]. Turmeric (*C. longa*) can be used for antioxidant, antiaging, detoxification, preventing leukemia disease, diet, and recovering stomach ulcer [2]. Pegagan (*C. asiatica*) is a beneficial medicinal plant in preventing aging. It is ranked high in the top ten herbs known for antiaging properties and this may be in part due to its antioxidative effects [3]. The plant also possesses neuro tonic effects and is known to improve memory and stimulus reflex. It is also supposed to be effective in the treatment of tuberculosis, syphilis, amebic dysentery, and common cold [4].
However, medicinal plants have not been developed well become herbal medicine, and only for *jamu* (traditional medicine in Indonesia). Many species medicinal plants are still lacking on species identification and utilization due to limited knowledge and baseline data regarding the potency of medicinal plants. As a tropical country, Indonesia has a high potency to be the greatest of medicinal plants producer in the world. For plant cultivation, including medicinal plant cultivation, Indonesia is facing many obstacles regarding production aspect such as less on knowledge and skill how to cultivate the medicinal plants, farmers’ capability is still lacking to maintain the quality of medicinal plants and the attention of industries toward the medicinal plant research and products [2], also the limited field for plant cultivation. One of the alternative solutions to overcome the limited field for plant cultivation is through agroforestry system implementation.

Agroforestry is a land-use system that combines forestry plants with agricultural plants. Agroforestry usually applied to forestry plants that intercropped with annual agricultural plants to increase land-use productivity [5]. According to Widianto [6], agroforestry is a form of multipurpose land use consisting of trees, shrubs with or annual crops that are often integrate by livestock in the same land. The scope of agroforestry is not only forestry/woody plants and agricultural plants combination, but also woody plants and fisheries combination or called by silvofishery system, and woody plants and medicinal plants combination or called by the system. Silvofarmaka is an optimization land management by combining forestry plants with medicinal plants in the same land, and specific time to achieve multiple products and benefits.

Implementation of the Silvofarmaka system in this research focused on Turmeric (*Curcuma longa*), Curcuma (*Curcuma xanthorrhiza*), and Pegagan (*Centella asiatica*) as medicinal plants which planted under 5 years old Mindi (*Melia azedarach*) and Sentang (*Azadirachta excelsa*). The objective of this research was to study the potential of Turmeric (*C. longa*), Curcuma (*C. xanthorrhiza*) and Pegagan (*C. asiatica*) under Mindi(*M. azedarach*) and Sentang (*A. excelsa*) in Silvofarmaka system.

2. Method

2.1. Location and Time Research

This research conducted at the Cikabayan experimental station, Dramaga IPB campus, Bogor. The location of research shaded by Mindi trees (N1) and Sentang trees (N2), and without shading (N0).

![Figure 1. The red mark shows the location of the study](image)
2.2. Tools and Research Object

The tools used in this study were phiband, SAS 9.0 software, cameras, hoes, lux meter, tally sheet, and ruler. The object of this study is Mindi, Sentang, and medicinal herbal such as Turmeric.

2.3. Procedures of Research

2.3.1. Preparation of Medicinal Plants
Station, Dramaga, Bogor.

2.3.2. Land Preparation and Planting
Land preparation was done a week before planting begins with the clearing of weeds, herbicide spraying, and clearing land from weeds.

2.3.3. Application Maintenance
Fertilizer applied to each planting hole as much as 1 kilogram/hole before medicinal plants are grown. Weeding was done twice during the study.

2.4. Data Collection Methods
The data collection technique performed in this study was the observation techniques and literature. The research location was at the Cikabayan experimental station IPB. Types of data collected in this study are:

- Primary data, consisting of information on the age of Curcuma, Turmeric, and Pegagan. This research observed diameter, height, and the leaves number of Curcuma and Turmeric, as well as branches.

Figure 2. Open land conditions
Figure 3. Conditions under the Mindi and Sentang stands

Figure 4. Layout of planting herbal plants
Figure 5. Information of planting herbal plant
number, tendrils length, and tendrils number. We measured light intensity every two weeks. The measurement of light intensity is done every two weeks. Each measurement is carried out in the morning, afternoon, evening, and repeated 3 times a day.

2.5. Data Analysis
Analysis of variance of data using ANOVA at 5% level to see the differences between treatments. Duncan advanced test at 5% occurs if there is a significantly different effect on the observed variables. The data was processed using the SAS 9.0 program.

3. Result and discussion
Agroforestry is a form of multiple land use consisting of a mixture of trees, shrubs with or annual crops that are often accompanied by livestock in one plot of land [6]. Researchers examine the combination of forestry plants with herbal plants. Forestry plants used are Mindi (*Melia azedarach*) and Sentang (*Azadirachta exelsa*), for herbal plants used are Temulawak (*Curcuma Longa*), Turmeric (*Curcuma xanthorrhiza*) and Pegagan (*Centella asiatica*).

Mindi tree (*Melia azedarach*) is a fast-growing and multipurpose tree species. The use of wood for furniture, parquet, plywood, and veneers is an export product of high economic value. Mindi leaves, and seeds can be used as plant-based pesticides. Mindi wood can be used in the form of solid wood. For example, as a component of a house, a component of furniture or crafts, it can also be used in the form of panels such as beautiful plywood and beautiful veneer lamina [7]. Mindi tree or geringging (*Melia azedarach*) is a type of fast-growing tree that is always green in the tropics, shedding leaves during winter, likes light, fertile below freezing, is somewhat resistant to drought and tolerant of saline soils. The mindi tree is a fast-growing, with straight stems, light-like umbrella-like, deeply rooted, deeply rooted, and has broad branches. Mindi tree height can reach 45 m, with a free height of branches 8-20 m and a diameter of up to 60 cm [8].

Sentang is one type of forestry plant that has the potential to be developed on agroforestry land. Sentang is a type of fast-growing, has beautiful wood, and is easy to do. The wood commonly used for building materials, furniture, plywood, floors, and pianos. In Malaysia, the leaves and flowers are eaten as vegetables. Leaves and flowers contain azadirachtin which can be used as an insecticide, besides twigs, leaves, and green fruits can be used to fertilize the soil [9]. Sentang is a superior crop in Malaysia but has not been widely developed in Indonesia. Sentang growth is well developed in agroforestry land because of the conical shape of the canopy, thus allowing the sentang and crops to get good sunlight. Regulatory properties are essential to avoid competition between forestry and crops. The deep root system is overlapped with shallow-rooted plants. Based on the description above, it is crucial to research the dimensions and root systems of the sentang plants on agroforestry land.

The gathering includes annual plants that grow clumps. This plant is trunked, and its habitus can reach a height of 2-2.5 meters. Each plant family consists of several plants (tillers), and each plant has 2 - 9 leaves. The leaves of Temulawak plant have a length of about 50 -55 cm and a width of about 18 cm. The Curcuma seedlings are round shaped like eggs, while the branch rhizomes are on the side of the elongated shape. Rhizome skin color, when young or old, is a dirty yellow color. Yellow rhizome flesh color with a bitter taste, pungent, and medium fragrance. The use of Intersection Lawak are many and varied as a treatment for various diseases. Among obas pain liver disorders, fever, jaundice, aches, constipation, potent drugs, stimulants of milk, and menstrual laxatives. The use of rhizomes of curcuma as a medicine turned out to be pharmacologically a positive influence on the content of bile, liver, and pancreas [10].

Turmeric is one of the tribe-finding plants (Zingiberaceae), which widely planted in yards, gardens, and around teak forests. Turmeric is a perennial plant that has the characteristic of growing in groups to form clumps. Plant height between 40-100 cm. Turmeric widely used by the food, beverage, pharmaceutical, cosmetic, and textile industries. Turmeric is known as a flavoring, neutralizing rancid odor in cooking; and coloring. The coloring in turmeric is known as curcumin as an alternative because it is a natural coloring agent that is harmless. In Indonesia, turmeric often used in making coconut oil-
wet. In addition to the oil's color becoming more attractive, turmeric can also preserve coconut oil. Turmeric is also often used as a mixture of traditional medicine to cure various diseases, such as fever, runny nose, nasal congestion, rheumatism, diarrhea, dysentery, itching on the skin, swelling, body odor, malaria, heartburn or intestinal ulcers, and mouth ulcers. Besides that, turmeric also lowers high-fat levels, cures chest pain, asthma, discomfort in the stomach, aches in the shoulder, irregular menstruation, hepatitis, high blood pressure, and so on [11].

Pegagan (*Centella asiatica*) is a cosmopolitan plant that has a wide distribution area, both tropical and subtropical. Pegagan spreading wild and can flourish on the ground with an altitude of 1-2500 m above sea level. This plant originates from the Asian region and is often found abundantly in open places, such as dry fields and areas that are somewhat protected. This plant likes wet environments such as gutters, paddy fields, road edges, grasslands, even the edges of walls or fences. Pegagan grows creeping cover the soil, not trunked, plant height between 10-25 cm, has a single strand of leaves arranged in root noon, and consists of 2-10 leaves. Green leaves; shaped like a fan, kidneys, or kidneys; the surface and back are slippery. In various countries, Pegagan has been passed down from generation to generation as a traditional medicine for various types of diseases. Pegagan has pharmacological effects that are very beneficial for maintaining a healthy body. Pegagan is known as a medicine for revitalizing the body and blood vessels and can strengthen the structure of tissues. Pegagan can be consumed as a brain tonic or anti-forgetful for adults and seniors. In other words, Pegagan can improve the workings of the brain, sharpen memory, and heal people with a mental health condition [12].

**Table 1.** Recapitulation Results of Analysis of Variance in Shade Effect on Growth of Curcuma and Turmeric.

| Variable                  | Plants Species | Turmeric | Curcuma |
|---------------------------|----------------|----------|---------|
| Height                    | 0.8677<sup>tn</sup> | 0.6491<sup>tn</sup> |
| Diameter                  | 0.9717<sup>tn</sup> | 0.0006*  |
| The Number of Leaves      | 0.8701<sup>tn</sup> | 0.9314<sup>tn</sup> |

*: Significant effect at the 5% level, tn: No significant effect at the 5% level.

**Table 2.** Duncan Test Results The Effect of Shade on Curcuma Growth.

| Shade | Height (cm) | Diameter (cm) | Number of Leaves |
|-------|-------------|---------------|------------------|
| N0    | 1<sup>a</sup> | 1.004<sup>a</sup> | 5.875<sup>a</sup> |
| N1    | 3.625<sup>a</sup> | 1.435<sup>a</sup> | 3.75<sup>a</sup>  |
| N2    | 5.438<sup>a</sup> | 1.75<sup>a</sup>  | 2.5<sup>a</sup>   |

**Table 3.** Duncan's Test Results The Effect of Shade on Turmeric Growth.

| Shade | Height (cm) | Diameter (cm) | Number of Leaves |
|-------|-------------|---------------|------------------|
| N0    | 0<sup>a</sup> | 3.62<sup>a</sup> | 3.5<sup>a</sup>  |
| N1    | 5.375<sup>a</sup> | 0.1563<sup>b</sup> | 3.125<sup>a</sup> |
| N2    | 5.688<sup>a</sup> | 0.1788<sup>b</sup> | 2.375<sup>a</sup> |
Based on the results of data collection in the field and ANOVA tested it can be seen that the diameter variable has a significant effect on turmeric based on (table 1). ANOVA test results on Turmeric showed that Turmeric had a significant effect on the diameter variable, while the height and number of leaves had no significant effect. Turmeric on the diameter variable has an average value of 3.62 cm in open land, while the diameter variable under the Mindi and Sentang stands no significant effect with an average value of 0.1563 cm and 0.1788 cm, respectively. The Curcuma plant does not have a significant effect on the height, diameter, and number of leaves. According to Musyarofah [13], The low growth of plants under the shade caused by the low intensity of sunlight and high soil moisture due to high rainfall. The low light intensity causes plants to grow slowly compared to plants that have a higher light intensity, so plants on open land grow faster. The magnitude of the measured light intensity in the treatment of medicinal plants without shade reached 304,536 Lux, while under the Mindi and Sentang stands respectively 63.45 Lux and 47.72 Lux.

Data of light intensity in each field show that high light intensity values found in open land. While on land under the mindi and sentang stands have low light intensity values. This shows that the higher the intensity of light, the faster the rate of photosynthesis and cause photosynthesis results to increase so that the dry weight of the rhizome would increase [14]. High light intensity influences plant photosynthesis so that the diameter of turmeric plants tends to increase.

ANOVA test results on Gotu kola plants show that Gotu kola plants have a significant effect on the variable number of branches in open land, and also Gotu kola plants have a significant effect on the vine length variable under sentang stands. This is shown in (table 4)

**Table 4. Recapitulation Results of Analysis of the Variance of Shade's Effect on Pegagan Growth.**

| Variable          | Effect of Shade |
|-------------------|-----------------|
| Number of Tendrils| 0.7999<sub>n</sub> |
| Number of Branches| 0.0021<sup>*</sup> |
| Tendril Length    | 0.0158<sup>*</sup> |

*: Significant effect at the 5% level
<sub>n</sub>: No significant effect at the 5% level

**Table 5. Duncan Test Results The Effect of Shade on Pegagan Growth.**

| Variable       | Peubah            |
|----------------|-------------------|
|                | Number of tendrils| Number of Branches | Length of Tendril (cm) |
| N0             | 4.5<sup>a</sup>   | 5<sup>a</sup>      | 24.25<sup>b</sup>     |
| N1             | 4.25<sup>a</sup>  | 0.5<sup>b</sup>    | 7.25<sup>b</sup>      |
| N2             | 5<sup>a</sup>     | 0<sup>b</sup>      | 54.7<sup>a</sup>      |

ANOVA test results on Pegagan plants have a significant effect on the number of variables with no shade treatment and the length of tendrils with planting treatment under sentang stands, while for the variable number of tendrils on all kinds of shade treatment has no significant effect. Pegagan plants have a significant effect on the variable number of branches in open land with an average value of up to 5 branches, while on the Mindi and sentang land do not have a significant effect with each value of 0.5 branches and 0 branches. Regarding the vine length variable, it has a significant effect on the contiguous land with an average value of 54.7 cm, while open land and Mindi have no significant effect with values of 24.25 cm and 7.25 cm.
The longest tendrils are found on the contiguous land due to Pegagan plant under pressure due to the lack of incoming light compared to the land under Mindi stands and open land. The pressure that occurs causes Pegagan plants to look for incoming sunlight, so the tendrils on the land under the Sentang stands tend to belong. This is in accordance with Salisbury's research that the parameter of the longest leaf stalk in the shade treatment produces the longest stalk length compared to the treatment without shade, this is because the intensity of sunlight received by the plant is less than optimal, because of the shade that holds some of the sunlight that should be received by plants, so that the plants undergo etiolation so that plants adapt to lengthen the petiole to capture sunlight so that the resulting photosynthate is sufficient for making food reserves. Shaded plants have leaf stems that are responsive to the direction of light and the intensity of light. This is indicated by bending the stem so that the leaf strands move to a less shaded place [15].

According to Hamid [16] the results of pruning in the form of leaves and various types of woody tissue in the agroforestry system, in addition to being useful for enriching nitrogen, also increase light intensity so that microorganism activity increases, decomposition is faster and soil fertility would be better. Pruning is highly recommended to be done on agroforestry systems because it can increase the entry of light intensity in plants under the shade to increase the growth of plants under the shade.

4. Conclusion

Turmeric (C. longa), Curcuma (C. xanthorrhiza), and Pegagan (C. asiatica) showed that sunlight intensity might cause different growths. Turmeric, Curcuma, and Pegagan can grow up under light shading. However, sunlight intensity in this research was low. This lower sunlight intensity caused lower biomass (diameter and leaves). Those medicinal plants require more light intensity to grow optimally, so further activities (e.g. pruning and thinning) are necessary. This combination of the plantation is very recommended for the silvofarmaka system.

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