Function of tree components in agroforestry forms in Bolaromang Village, Buttono District, Gowa Regency

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Abstract. Agroforestry is one of the fields of science in recognizing and developing agroforestry systems that have been developed by farmers in tropical or subtropical climates for centuries. Agroforestry systems come from the combination of forest science with agronomy. The agroforestry system combines forestry enterprises with rural development to create harmony between agricultural intensification and forest conservation. This research was conducted to determine the structure and composition of plant species, the laying pattern of tree components, and the benefit of tree components in agroforestry systems. The research method is survey method and in-depth interviews at agroforestry cultivators. Data analysis using descriptive and quantitative analysis. Location of the research in Bolaromang Village, Buttono District, Gowa Regency. The result showed a very simple canopy level. The main stratum (tree component) by pine (Pinus merkusii), eucalyptus (Eucalyptus sp.) and suren (Toona sureni). Vegetable plant as agricultural components occupy the bottom stratum. The tree component in an agroforestry system has economic and ecological benefit for the community. From an economic point of view, it can increase income, apart from agriculture. From an ecological perspective, it functions as a windbreak and fertilize the soil.

1. Introduction
Agroforestry is a land management system that functions productively and protectively (maintaining biodiversity, healthy ecosystems, conserving water and soil). Agroforestry is one of the sustainable land management systems [1]. The function of agroforestry at the landscape level (meso scale) has been proven, one of its capabilities is to maintain and preserve natural resources and the environment, especially in land suitability. The positive impacts of agroforestry systems at the meso scale are maintaining physical properties and soil fertility, maintaining the hydrological function of the area, maintaining carbon stocks, reducing greenhouse gas emissions, and maintaining biodiversity. The composition and arrangement of plant and tree species in one land system makes the function of agroforestry highly desirable [2]. Agroforestry systems have different characteristics than monoculture farming systems. Several different components interact with each other in one system (trees, plants, and livestock). Agroforestry systems have unique characteristics in terms of product type, time to obtain products and product use orientation. Products from agroforestry vary widely. commercial products (foodstuffs, fruit, fodder, construction wood, firewood, leaves, skins, latex) and ecosystem services [2]. Principally, agroforestry is developed to solve problems of land use and rural
development, as well as to exploit the potential and opportunities that exist for human welfare with the support of the preservation of resources and the environment [3].

Indonesia with a very large population consisting of various ethnic groups and spread over thousands of islands, so that various choices of farming systems emerge. Agroforestry systems are currently only applied by local farmers. Activities related to agroforestry are mostly found around residential areas. Around the house is a suitable place because it is easy in terms of supervision [1]. One of the areas that applies the agroforestry system in South Sulawesi is the People's Forest area of Gowa Regency, in Bolaromang Village, Buttono Pao District. Approximately 25 ha of forest land that applies agroforestry are managed by the community and are members of farmer groups of 25 people with the aim of improving the welfare of life.

The implementation of agroforestry has proven that agroforestry as a land use system can support an economic orientation, at the semi-commercial to commercial levels [4]. Economically, income in agricultural system is directly proportional to the land of land belonging to the community [5]. In principle, agroforestry is developed to solve problems of land use and rural development, and to take advantage of the potential and opportunities that exist for human welfare with the support of the preservation of resources and their environment [3]. This is why humans are the most important component of an agroforestry system. In managing forests, humans interact with other agroforestry components. This research aims to identify the structure and composition of the agroforestry pattern, the laying pattern of trees in the agroforestry pattern, the functions and benefits of the trees in the agroforestry pattern in Bolaromang Village.

2. Material and methods

2.1. Research location
This research was conducted in Bolaromang Village, Buttono Pao District, Gowa Regency as one of the villages that applies the agroforestry system in South Sulawesi Province.

2.2. Research implementation methods
The methods used in the implementation of this research include:

2.2.1. Observation. Observation is a data collection technique that is carried out by conducting direct observations to obtain data in the form of primary data, including: inventory data on the dimensions of each constituent component, structure and composition, pattern of laying out tree components in agricultural forest mixed.

2.2.2. In-depth interview. The interview method used in this study was direct question and answer with respondents using a list of questions that had been prepared previously as an interview guide.

2.2.3. Documentation
The documentation method is used to obtain data such as the profile of the research location and pictures of the research location that can support the compiler data and analysis of research data.

2.3. Research procedure
Research procedures carried out include:

a. Determination of the research plot by means of purposive sampling based on the constituent components in the garden so that 5 point observation plots were determined with a plot size of 20 m x 20 m.

b. Recording all plant species, measuring the circumference of the tree trunk and the height of the plants that are in the observation plot.

c. Observe and measure the canopy cover area using a roll meter, by pulling the roll meter until the outer canopy of the tree corresponds to each cardinal direction.
d. Draw the canopy projection on graph paper.
e. Conduct surveys and observations regarding the placement of patterns, functions and benefits of
   trees in the agroforestry area

2.4. Data analysis
The data that has been collected in this study were analysed using quantitative descriptive data
analysis.
a. The data obtained were plant species, height, and diameter. The data is tabulated to obtain
   information on the horizontal and vertical structure in agroforestry area.
b. The data from the survey, namely the information on tree laying patterns, the functions and
   benefits of trees in the garden and the results of the interviews were analysed descriptively to
   obtain observations which were used as the basis for making conclusions.

3. Result and discussion

3.1. Plant types composition
Bolaromang Village is included in a protected area with an area of 100 ha and a private forest
covering an area of 60 ha. Forest is a main source of water and plantation areas cloves (Syzygium
aromaticum), coffee (Coffea), jackfruit (Artocarpus heterophyllus) and other timber crops). Bolaromang Village has a loose and fertile soil type, so plants can grow well [6]. Coffee and cacao
is the one of popular trees for agroforestry conceptual [7–9].

The results showed the composition of the types of plants contained in the study area was not
much different between one farmer to another in terms of plant types. The difference is in terms of the
number of plants in the area. The total number of individual plants divided into 5 observation plots
was 29 individuals with 3 types of plants. The composition of the plants in the research location is
presented in Table 1.

| Table 1. Plant type composition |
|--------------------------------|
| No. | Plant Type | Plot | Amount (tree/plot) | Average (tree/plot) |
|-----|------------|------|-------------------|---------------------|
|     |            | 1    | 2    | 3    | 4    | 5    |                   |
| 1   | Pine (Pinus merkusii) | 8    | 4    | 0    | 3    | 5    | 20                | 4.00               |
| 2   | Eucalyptus (Eucalyptus sp.) | 0    | 0    | 5    | 0    | 0    | 5                 | 1.00               |
| 3   | Suren (Toona sureni) | 0    | 0    | 0    | 3    | 1    | 4                 | 0.80               |
|     | Total      | 8    | 4    | 5    | 6    | 6    | 29                | 5.80               |
|     | Average    | 2.66 | 1.33 | 1.66 | 2    | 2    | 9.67              | 1.93               |

3.2. Horizontal and vertical structure of agroforestry

Colour Description:
- Pine (Pinus merkusii)
- Eucalyptus (Eucalyptus sp.)
- Suren (Toona sureni)
Figure 1. Plot 1, (a) Horizontal Structure, (b) Vertical Structure

Figure 2. Plot 2, (c) Horizontal Structure, (d) Vertical Structure

Figure 3. Plot 3, (e) Horizontal Structure, (f) Vertical Structure
Plots 1-5 are included in Stratum A with a height of 13-41 meters. The tree functions in this stratum as shade for the plants that grow under it. Another function is to protect the damaged plants from the influence of the wind and as a barrier for rainwater so that it does not fall directly on the lower plants. And can minimize soil erosion so that it is sufficient for plant water needs.

The results showed plots 1-5 were dominated by pine (*Pinus merkusii*). Except for plot three which only consists of eucalyptus (*Eucalyptus sp.*). The canopy size on plot 1 averages 3.5 m in the west and 1.6 m in the east. In plot 2 the average canopy width is 3.5 m in the west and 0.7 m in the east. Plot 3 of the average canopy in the west is 3.2 m and the east is 1.4 m. The horizontal closure of the canopy of plot three mostly leads to the west. In plot 4, the average towards the west is 3.8 m and the average towards the east is 2 m. whereas in plot 5, the average canopy width is 3 m in the west direction and 2.7 in the east.

Canopy size is one of the features that most influences tree growth in a radial direction because canopy describes stand density and individual tree competition [10]. Canopy width and growing space requirements can be used to determine the number of reference trees per hectare according to the tree spacing scheme [11,12]. Based on the canopy projection, it can be seen that there are plot spaces 1-5. This occurs because the spaces are optimized for vegetable crops such as carrots, cabbage, and mustard greens compared to trees. Thus, this agroforestry system makes the existing trees shade the plants underneath [13].

### 3.3. Function of trees in agroforestry patterns

In fact, the function of trees in agroforestry is as protection, wind control, litter emitter, soil fertilizer, and shade for the plant underneath. In a different case, the respondent's agroforestry area was previously an area without trees. Regulation from the government that requires them to plant trees, so the respondents planted trees. This is the impact of the management and use of land in protected areas.
The pattern of laying trees in the agroforestry pattern in Bolaromang Village was randomly planted because many of them did not grow properly when planted as a barrier between land ownership or farming roads. The ecological functions obtained from planting pine (*Pinus merkusii*) [14], eucalyptus (*Eucalyptus sp.*) [15–17] and suren (*Toona sureni*) [18,19] can be seen in Table 2.

Table 2. Ecological functions obtained from planting pine (*Pinus merkusii*), eucalyptus (*Eucalyptus sp.*), and suren (*Toona sureni*).

| Tree Types          | Ecological Functions                                      |
|---------------------|-----------------------------------------------------------|
| Pine (*Pinus merkusii*) | 1. As a pioneer tree                                      |
|                     | 2. Water storage                                           |
|                     | 3. Landslide control plants (deep roots, high interception and evapotranspiration) |
| Eucalyptus (*Eucalyptus sp.*) | 1. Able to prevent landslides (reduce the amount of water rising to the ground) |
|                     | 2. Strong root system, gripping the soil and reducing soil movement |
| Suren (*Toona sureni*) | 1. Suren leaves contain chemical compounds that are bioactive |
|                     | 2. Serves in absorbing carbon                             |

3.4. **Direct benefit of tree in an agroforestry system**

The conversion of forest land into agricultural land causes many problems such as decreased soil fertility, erosion, extinction of flora and fauna, floods, drought and even changes in the global environment. This is due to the increasing forest area that has been converted into agricultural land. Agroforestry is present as a land management system to overcome problems caused by land use change and at the same time to overcome problems of food availability [20,21].

Based on the results of interviews with respondents, the benefits of having trees are they can be used as firewood, but in very limited quantities (there is a binding law that cannot harvesting wood in forbidden areas). The people of Bolaromang Village assume that with the agroforestry pattern there are many benefits to be obtained, one of which is from an environmental perspective. The shade trees in their garden serve as windbreaks, can also be used as shelter and also help fertilize the soil. Agroforestry systems are able to play a role in maintaining the physical properties of the soil by producing litter so that they can add soil organic matter, increase soil and root biology activities [22], maintain and increase water availability in the root layer [2].

3.5. **Economic Benefits**

The economic benefit by farmers is crops can increase income. Some of people make agricultural products as a main income. This is because they have is quite large of area. Income will be directly proportional to the arable area [5,23].

4. **Conclusions**

Composition of plant species in Bolaromang Village, Buttono Pao District, Gowa Regency is pine (*Pinus merkusii*) and suren (*Toona sureni*). In the vertical structure of the plants contained therein reach an average height of > 15 meters. Therefore, plants fall into stratum A. The laying pattern used by farmers in Bolaromang Village is a random mixture. Trees are planted irregularly (not following lines or lines) between food plants.

There are two benefits to the community by applying agroforestry patterns, namely the ecological benefits of being a shade tree that functions as a windbreak and fertilizes the soil. The economic function is to increase income, it is very helpful for those who do not have other jobs besides farming.
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