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# Development of Agroforestry to Support Food Security of Farmers in Bangko Hamlet, West Halmahera

**Mahdi Tamrin[1*], Abdul Kadir Kamaluddin[2], Sabaruddin B.[3]**

[1] *Departemen of Forestry, Universitas Khairun, Indonesia, mahdi.tamrin@unkhair.ac.id*
[2] *Departemen of Forestry, Universitas Khairun, Indonesia, dul_alzi@yahoo.com*
[3] *Departemen of Forestry, Universitas Khairun, Indonesia, adhisabar@gmail.com*

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## ABSTRACT

Good forest management practices will certainly have an impact on the economic condition of the community around the forest. One form developed in Indonesia is the agroforestry pattern. Agroforestry is a form of land management system that functions to increase productivity and species diversity, so it is often used as an example of a sustainable land management system. This research aims to obtain information on the types of plants that have been planted to determine the potential for the development of agroforestry systems in an effort to improve the economic and ecological functions of the land. The research modality with a field observation approach is direct observation and careful recording of the studied study of the agroforestry system developed. The results of the study show that the development of agroforestry in Bangko Hamlet, West Halmahera with an alley cropping system. Farmers take advantage of the space under the stand by planting various types of agricultural crops with high economic value for sale or household consumption. This can be seen from the crop patterns used by farmers and the production products produced. There are several types of forest and agricultural plants, including white teak, motoa, linggua and types of agricultural plants, namely cassava, bananas, dragon fruit and mangoes.

Keywords: Agroforestry, Food security, Production diversity

## ABSTRAK

Praktek pengelolaan hutan yang baik tentunya akan berdampak terhadap kondisi ekonomi masyarakat sekitar hutan. Salah satu bentuk yang dikembangkan di Indonesia adalah pola agroforestri. Agroforestri merupakan satu bentuk sistem pengelolaan lahan yang berfungsi untuk meningkatkan produktifitas dan keragaman jenis sehingga seringkali dipakai sebagai salah satu contoh sistem pengelolaan lahan yang berkelanjutan. Penelitian ini bertujuan untuk mendapatkan informasi jenis-jenis tanaman yang telah ditanam untuk mengetahui potensi pengembangan sistem agroforestri dalam upaya peningkatan fungsi ekonomi dan ekologi lahan. Medode penelitian dengan pendekatan observasi lapang yakni pengamatan langsung dan pencatatan secara teliti terhadap kajian yang diteliti dari sistem agroforestry yang dikembangkan. Hasil penelitian menunjukkan bahwa pengembangan agroforestri di Dusun Bangko, Halmahera Barat dengan sistem alley cropping. Petani memanfaatkan ruang dibawah tegakan dengan menanam berbagai jenis tanaman pertanian bernilai ekonomi tinggi untuk dijual atau konsumsi rumah tangga. Ini terlihat dari pola tanaman yan digunakan petani serta hasil produksi yang dihasilkan. Terdapat beberapa jenis tanaman hutan dan pertanian, diantaranya jati putih, motoa, linggua dan jenis tamanan pertanian yakni ubi kayu, pisang, buah naga dan mangga.

Kata kunci: Agroforestri, Ketahanan pangan, Keragaman produksi

## INTRODUCTION

The research explores how agroforestry can function as a nature-based solution for climate-sensitive communities such as drought, landslides and erosion amid the degradation of forest and agricultural lands. This will have a direct impact on farmers who have been optimizing land use with agroforestry systems. Because this is expected to optimize the results of its use in a sustainable manner to guarantee and improve people's living needs and increase the carrying capacity of human ecology, especially in rural areas. Agroforestry systems can also increase the income of communities around forests and meet household food needs **(**Mayrowani, 2011; Wulandari *et al*., 2020). Good management will ensure that the necessary food needs will be met, including; (1) the availability of food and the improvement of nutritional quality; (2) variety of food products; and (3) farmers always have food security.

Indonesia's population growth rate averaged 1.27 percent per year from 2010 to 2023 (BPS, 2023). This figure shows how much food must be prepared. Data shows that per capita rice consumption in Indonesia, both local and imported, reached 6.81 kg per month in September 2023, up 0.87% from 6.75 kg per month in September 2021 (BPS, 2023). In 2022, per capita rice consumption in Indonesia reached 81,044 kg per year (Kompas, 2023). If the increase in alternative food production is not balanced by the great need for food, there will be major problems in the future.

To meet the growing need for food, increasing food production and land availability is essential, especially in Indonesia, which has a very large population that requires a wide variety of food alternatives. One alternative is to develop an agroforestry system that utilizes land around forests to increase food crop production through an extensification pattern. Regulation of the Minister of Environment and Forestry Number 24 of 2020 concerning the Provision of Forest Areas for Food *Estate* Development clearly shows the efforts of the Ministry of Forestry in improving Indonesia's food security over the past few years. In addition, efforts to increase the food contribution of the forestry sector are both through increasing food crop programs in forest areas such as social forestry and by providing forest areas for food development (Montagnini & Metzel, 2024).

Due to the increasing population and the increasingly fierce competition in the use of land resources, food products from forests are generally in the form of non-rice food and have not been widely used by the community. As a result, the dominance of rice in the population consumption map is increasingly burdensome for the government in meeting people's food needs. With food diversification in corrections, dependence on rice can be reduced, and the forestry sector can help provide non-rice food (Panda *et al*., 2024). In response to these conditions, policies and programs to diversify food consumption have been in place for a long time, but have not resulted in a significant increase in local food consumption. To increase food security and independence, diversification of local food consumption is very important (Widowati, 2023).

People's access to food sources caused by poverty is strongly linked to poor consumption patterns. Field realities show that poor and food-insecure people are around and within the forest. About 48.8 million people, or 12% of the total population, lived in and around forest areas in 2017. About 10.2 million people, or 25% of the total population, live in and around these forest areas, and they fall into the poor category. Empowering communities around forests can increase income so that people can get more food (Dushkova & Ivlieva, 2024; Ullah, 2024). This study investigates how farmers in Bangko Hamlet, West Halmahera, can support their food security through land use in their agroforestry activities.

## METHODOLOGY

This research was carried out at Campus IV of Khairun University, Bangko Hamlet, West Halmahera Regency. This location was chosen because it is an educational forest and forest and land rehabilitation area (RHL) in collaboration with Khairun University and the Akemalamo Watershed Management Center (BPDAS). This area has been planted with several types of forestry plants with a third year maintenance status (P3) with a plant life of more than 7 years. Also currently various commodities are being developed, both agricultural commodities and fruits. The research will be carried out from April to September 2024.

Primary data is data obtained directly from the research subject as a source of information. The following are the primary data collection techniques: field observation, structured interviews and plant inventory. Secondary Data by conducting a document assessment as supporting data in this study such as land area, campus cooperation with the community around the campus, be it the document of agricultural and forestry crop development blocks on campus IV and management plans and other relevant data to help data analysis, as well as research that has been carried out on Campus IV, West Bangko Hamlet.

Figure 1. Map of the research location

### Field Observation

Field observation is direct observation and careful recording of the studies that are being researched. Field observations were carried out to determine the location of data collection and obtain actual data on agroforestry development in Campus IV, Bangko Hamlet by looking at the types of plants, planting patterns developed and their contribution to farmers' income.

**Structured Interviews**

Interviews were conducted with respondents, namely farmers around campus IV, Bangko Hamlet to find out what things have been done in agroforestry development so far.

**Plant Inventory**

The inventory is carried out directly by calculating the number of types and the number of individual plants per hectare according to the area of land developed. Sample tile sampling was taken using the systematic sampling method with random start. The measuring plot is circular with an area of 0.1 ha (radius 17.85 m).

**Data Analysis**

Data analysis was carried out to determine the development of agroforestry that has been carried out by farmers in Bangko Hamlet, West Halmahera. The descriptive analysis of agroforestry development includes the number of types and the number of individual plants per hectare. Revenue analysis that the calculation of farmers' income estimates is calculated by formula (Hernanto 1988 in Qurniati *et al*., 2013).

## RESULTS AND DISCUSSION

**Agrofotesri in Bangko Hamlet, West Halmahera**

Agroforestry integrates various types of plants and trees, which allows communities to obtain various food sources and also forms of land use. This helps reduce dependence on one type of plant, thereby increasing food security. In addition, the use of agroforestry systems contributes to improving soil quality. Tree roots help prevent erosion and improve soil fertility through the addition of organic matter, which in turn supports the growth of food crops.

Efforts to use land to improve welfare are carried out by farmers/landowners by applying several patterns that already exist in Indonesia. In North Maluku, in particular, planting various types of spice crops and plantation crops that have high economic value so that they can provide great benefits to land owners and managers. Over time, the idea arose to create a new breakthrough by planting MPTS forestry plants (Andriansyah *et al*., 2021).

Land use with an agroforestry system at Campus IV Bangko Hamlet is not new, as long as farmers around the campus know agroforestry as *Dobo* in Bahasa Makian which means garden or *kobong* , which is farming and planting various types of plants on the land they manage. Tamrin *et al*., (2015) in their research on Bacan Island stated that *Doro* in the Galela language is a form of local knowledge of the community that is applied in farming activities in mixed gardens for generations.

The research conducted at Campus IV of Khairun University, Bangko Hamlet, West Halmahera, was carried out with an alley cropping agroforestry system under white teak stands (*Gmelina arborea*) and several other forestry plants, namely motoa (*Pometia pinnata*), gofasa (*Vitex cofasuss*) and linggua (*Petrocarpus indicus*) with agricultural crops cultivated by farmers, including cassava (*Manihot esculenta*), bananas (*Musa paradisiaca*), peanuts (*Arachis hypogaea*), and fruit plants such as dragon fruit (*Selenicereus undatus*), mango (*Mangifera indica*) and durian (*Durio zibethinus*) with a land area of more than 12 hectares.

Table 1 shows that forestry plants found on agroforestry land as many as 4 types of plants consist of 300 individuals, including white teak, motoa, linggua and gofasa. This type of plant

is a cultivated plant planted by farmers in collaboration with Khairun University and BPDAS Akemalamo, North Maluku.

Table 1. Composition of forestry crops

| No. | Kind | Latin Names | Number of Individuals | Percentage (%) |
|---|---|---|---|---|
| 1 | Jati Putih | *Gmelina arborea* | 100 | 33.33 |
| 2 | Mota | *Pometia pinnata* | 65 | 21.67 |
| 3 | Linggua | *Petrocarpus Indicus* | 80 | 26.67 |
| 4 | Gofasa | *Vitex cofasuss* | 55 | 18.33 |

The types of forest plants developed above are types of plants that can interact positively with agricultural crops, for example, through more efficient absorption of nutrients or by providing shade that reduces heat stress. Overall, forest plant types are key components in agroforestry systems that support ecological balance, sustainability, and agricultural productivity. Hamid *et al*, (2023) set up agroforestry ecologically and environmentally, land that implements agroforestry will provide benefits such as maintaining the physical quality of the soil, increasing soil fertility, maintaining a role in supporting watersheds, reducing greenhouse gas levels in the air, and preserving biodiversity. The benefits of agroforestry from the economic aspect can increase household income both in the short and long term.

Land use with this agroforestry system is carried out from generation to generation by utilizing land owned by farmers. Of course, the use is done wisely and wisely by paying attention to environmental aspects so that sustainability in land use can be achieved without damaging the ecosystem. Tamrin *et al*., (2023) in their research said that the process of land use for agroforestry activities is carried out in a sustainable manner by using technology that is suitable for natural resources and used wisely by farmers. This is a savings for farmers because the utilization is not excessive by farmers so that it is maintained and sustainable.

Table 2. Composition of agricultural crops and fruits

| No. | Kind | Latin Names | Number of Individuals | Percentage (%) |
|---|---|---|---|---|
| 1 | Ubi Kayu | *Manihot esculenta* | 230 | 51.69 |
| 2 | Pisang | *Musa paradisiaca* | 98 | 22.02 |
| 3 | Buah Naga | *Selenicereus undatus* | 102 | 22.92 |
| 4 | Mangga | *Mangifera indica* | 10 | 2.25 |
| 5 | Durian | *Durio zibethinus* | 5 | 1.12 |

In Table 2 there are 5 types of agricultural crops and fruits consisting of 445 individuals including cassava (*Manihot esculenta*), banana (*Musa paradisiaca*), dragon fruit (Selenicereus undatus), mango (*Mangifera indica*) and durian (*Durio zibethinus*). These plants are planted by farmers on available land by utilizing space in forestry plants with an agroforestry system. The plant was chosen because it has high economic value and has a large market in Bangko Hamlet, West Halmahera. Farmers' activities around campus IV of Khairun University, especially Bangko Hamlet, have been active in planting agricultural crops on campus land or around campus, one of the types is cassava. The plant is planted and the results are processed into kasbi sago food with a fairly high production.

**Agroforestry Planting Patterns Developed**

Based on the results of the study, there is a planting pattern developed at Campus IV of Bangko Hamlet is the agroforestry planting pattern of Alley cropping, which is a technique of planting annuals or food crops between the corridors of forest plants or tree plants. Alley cropping is

also an agroforestry model that has been used as a solution to various global problems to improve the efficiency of land use in order to reduce environmental risks (Haerani, 2017).

The alley cropping planting pattern is chosen by farmers because it is considered easier to maintain and a guarantee of success in growing until the harvest is larger. This can be seen in the gardens owned by local farmers and on Campus IV of Khairun University, Banko Hamlet in utilizing their land with an agroforestry alley cropping system. Here is a diagram of the planting pattern of alley cropping that can be depicted.

Figure 2. Planting pattern diagram of alley cropping

Figure 1 above shows the alley cropping planting system between white teak plants and cassava and motoa and several types of agricultural crops and fruits. The planting distance of white teak is 10x10 meters as well as the motoa plant, under the stand are planted cassava with a planting distance of 1x1 meter. The number of white teak plants is 100 trees with an average diameter of 27 cm and an average tree height of 12 m.

(a) (b)

Figure 3. Planting pattern alley cropping

A good planting system arrangement will facilitate more flexible management options to reduce nutrient competition and complement the space between trees and plants (Haerani, 2017). Of course, routine maintenance is carried out, both pruning of teak plants and cleaning weeds during the growing period to reduce the shade of inserted plants. When there are no plants on the land, hedges are allowed to grow freely to cover the soil (Barreto *et al*., 2012).

Agroforestry plants are thought to increase soil fertility levels through the absorption of nutrients from humus in the surrounding environment and then concentrate them into perennial biomass and the upper soil layer (Quinkenstein *et al*., 2009). The application of agroforestry systems has the potential to remain productive while supporting various ecosystem services. Alley cropping is believed to be one of the best land use strategies to contribute to food security while limiting environmental damage.

**Estimated Revenue**

Agroforestry development activities at Campus IV of Khairun University, West Bangko Halmagera Hamlet In financing their needs, farmers sell their agroforestry products from several types of agricultural commodities. The estimated income of farmers can be calculated from several agroforestry products that will be sold based on the amount of production produced, especially agricultural crops and fruits such as cassava, bananas, dragon fruit, mangoes and durians. The following is the calculation of estimated revenue in table 3.

Table 3. Estimated income of farmers

| No. | Kind | Latin Names | Production (kg) | Estimation Income (Rs) | Percentage (%) |
|---|---|---|---|---|---|
| 1 | Ubi Kayu | *Manihot esculenta* | 600 | 36.000.000 | 65.08 |
| 2 | Pisang | *Musa paradisiaca* | 178 | 15.130.000 | 27.35 |
| 3 | Buah Naga | *Selenicereus undatua* | 306 | 3.060.000 | 5.53 |
| 4 | Mangga | *Mangifera indica* | 45 | 1.125.000 | 2.03 |
| 5 | Durian | *Durio zibethinus* | - | - | |
| Total | | | 1129 | 55.315.000 | 100 |

Estimated income is calculated in a period of one year based on the calculation of the harvest period from each source of income from the components of agricultural crops and fruits. The estimated income is calculated from the estimated crop production produced by the agroforestry system by farmers.

Based on Table 3 above, it is known that the estimated income from the agroforestry system developed in the components of agricultural crops and fruits. The type of ubi kayu plant has an estimated revenue of IDR 36,000,000 with a percentage of 65.08%. Then pisang plants with an estimated income of IDR 15,130,000 or 27.35%, then buah naga plants with an estimated income of IDR 3,060,000 with a percentage of 5.53, types of mangga plants with an estimated income of IDR 1,125,000 with a percentage of 2.03% and Janis durian plants whose estimated income cannot be calculated.

## CONCLUSION

Based on research carried out at Campus IV of Bangko Hamlet, there is a planting pattern developed, namely *the Alley cropping* agroforestry planting pattern. In utilizing their land, farmers plant various types of forest plants and agricultural crops, including jati putih (*Gmelina arborea*), motoa (*Pometia pinnata*), linggua (*Petrocarpus indicus*), gofasa (*Vitex cofasuss*), and other MPTS crops, namely mangga (*Mangifera indica*), durian (*Durio*), buah naga (*Selenisereus udatus*),

and pisang agricultural crops (*Musa Paradisiac*) and several other types of horticultural crops. All of these types of plants are types of plants that have high economic value.

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