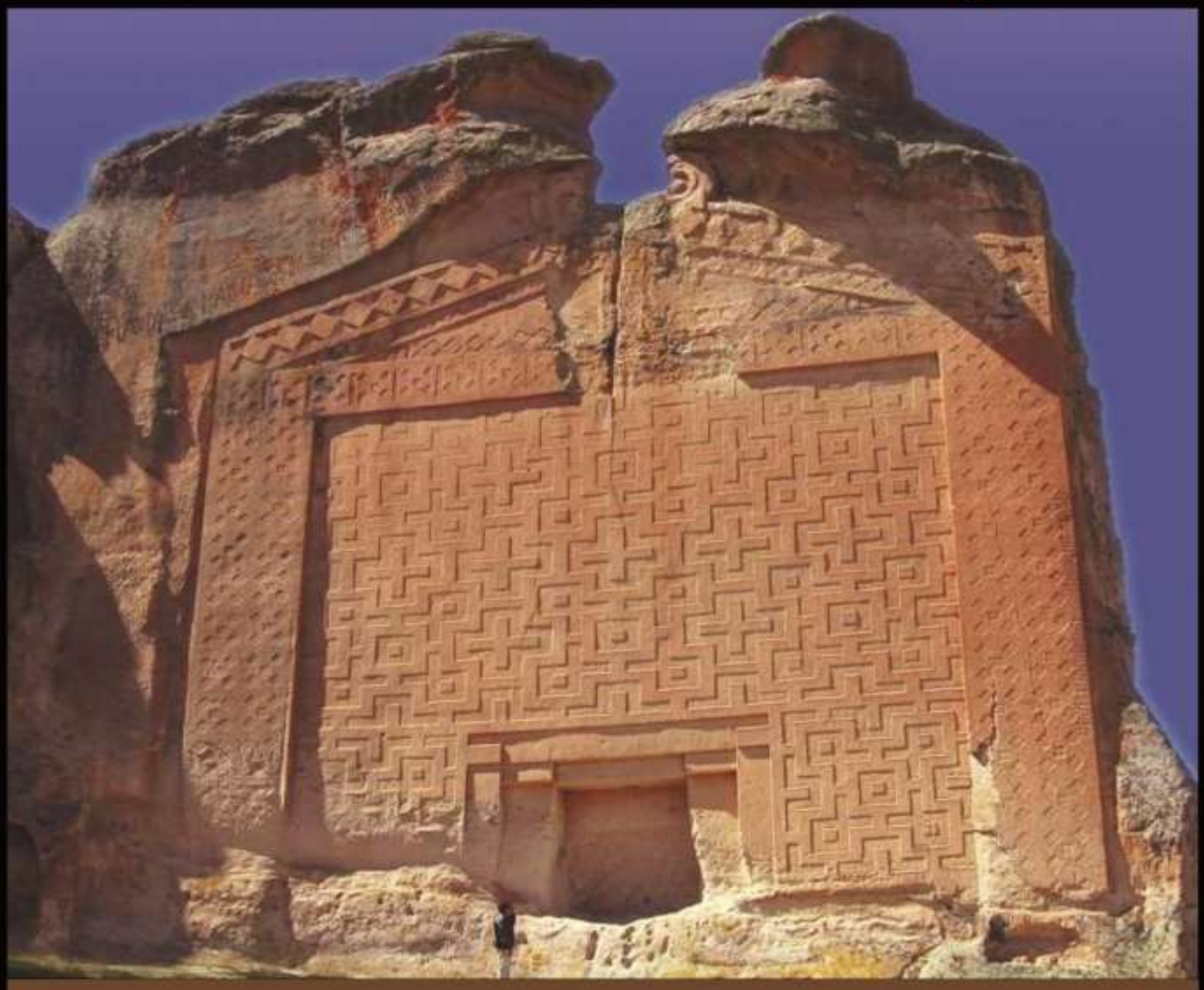
I.BİLSEL ULUSLARARASI MİDAS BİLİMSEL ARAŞTIRMALAR KONGRESİ

KONGRE KİTABI

08-09-MART 2025 ESKİŞEHİR



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1. BİLSEL INTERNATIONAL MIDAS SCIENTIFIC RESEARCHES CONGRESS BOOK
08/09 March, 2025
ESKİŞEHİR /TÜRKİYE

EDITOR
Prof. Dr. Gülsüm YALDIZ

ISBN: '978-625-97254-8-2'

https://bilselkongreleri.com/

21.03.2025
by BILSEL PUBLISHING

CONGRESS ID
CONGRESS TITLE

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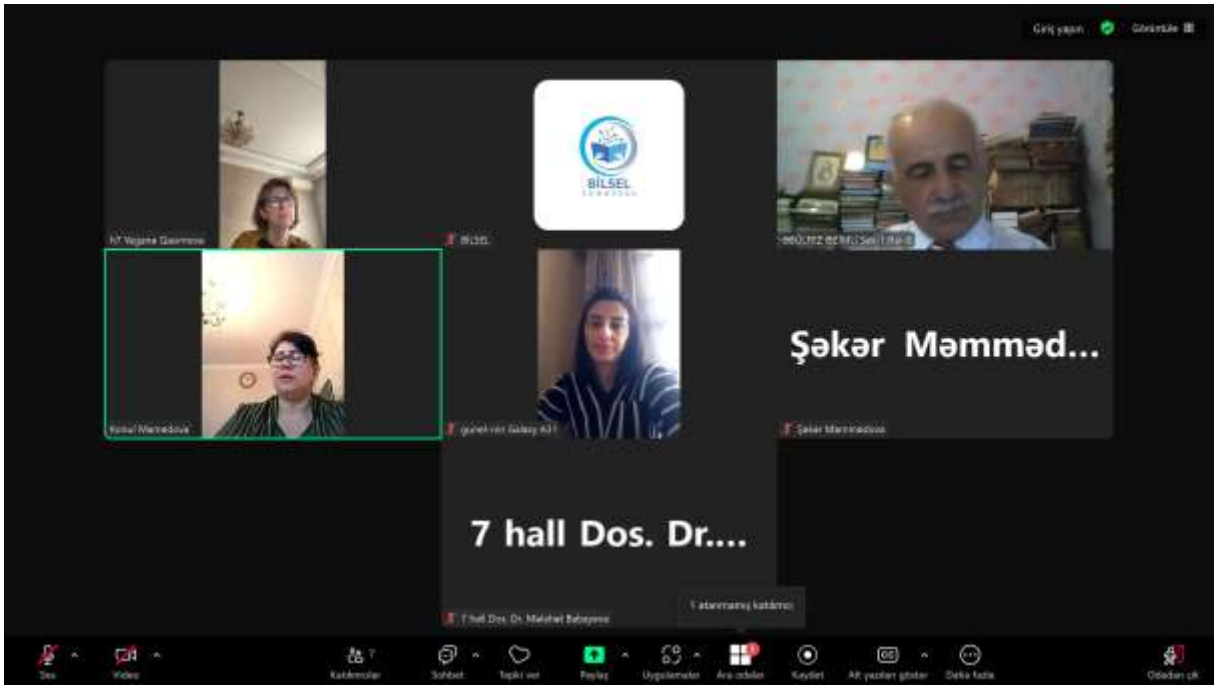
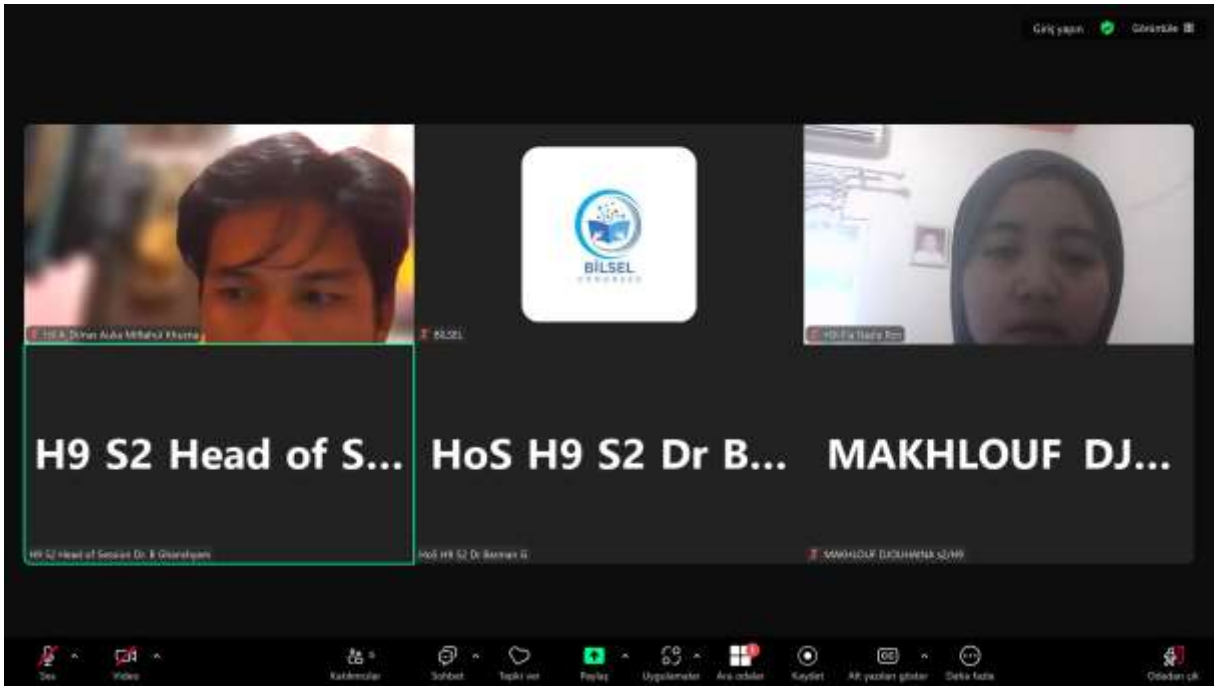
Pia Nazla Pon *Rommy Qurniati* *Septi Nurul Aini* *Slamet Budi Yuwono*	*University of Lampung*	*ECOLOGICAL CONDITIONS IN THE IMPLEMENTATION OF AGROFORESTRY PATTERNS IN THE SEKAMPUNG RIVER FLOW AREA*

1. BİLSEL INTERNATIONAL MIDAS SCIENTIFIC RESEARCHES CONGRESS, 08/09 March, 2025 ESKİŞEHİR /TÜRKİYE





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SEKAMPUNG NEHRİ AKIŞ ALANINDA TARIMSAL ORMANCILIK MODELLERİNİN UYGULANMASINDA EKOLOJİK KOŞULLAR

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Özet

Sekampung Havzası, Lampung Eyaleti'nde su yönetimi ve arazi kullanımı kalitesinde dikkat edilmesi ve iyileştirilmesi gereken havzalardan biridir. Sekampung su havzasının 484.191,80 hektarlık alanının %49'u bozulmuştur. Bu durum Sekampung su havzası çevresindeki çevre ve topluluklar üzerinde olumsuz bir etkiye sahiptir. Bu çalışma, geliştirilen tarımsal ormancılık modelinin sürdürülebilir olması ve arazi kullanım koşullarının iyileştirilmesi için Sekampung havzasındaki ekolojik koşulları analiz etmeyi amaçlamaktadır. Veri toplama Kasım-Aralık 2024'te Tanggamus Regency, Air Bakoman Köyü'nde bir vaka çalışması ile gerçekleştirilmiştir. Veriler, 50 katılımcı ile yapılandırılmış görüşmeler ve çiftçilerin arazilerinde yapılan gözlemler yoluyla toplanmıştır. Veri analizi betimsel olarak yapılmıştır. Sonuçlar, Air Bakoman Köyü'ndeki tarımsal ormancılık sistemindeki ekolojik koşulların, meyve ağaçları ve kereste ağaçlarının bir kombinasyonu ile arazi başına 4-6 tür bitki çeşitliliği sergilediğini ve hem gıda hem de gıda dışı işlevler olmak üzere arazi başına 4-5 bitki türü işlevine sahip olduğunu göstermiştir. Ortalama arazi alanı 1,6 hektardır veya 0,04 hektar ile 14 hektar arasında değişmektedir. Buna karşılık, polikültür deseninde 2-3 bitki türü ve 3 bitki işlevi tespit edilirken, pirinç ve kahve plantasyonlarından oluşan monokültür deseninde yalnızca 1 tür ve 1 bitki işlevi bulunmaktadır. Tüm desenlerde arazi verimliliği iki büyüme sezonu boyunca dalgalanmıştır, ancak tarımsal ormancılık diğer desenlere göre daha değişken toprak örtüsüne sahiptir.

Anahtar Kelimeler: Ürün Deseni, Monokültür, Bitki Çeşitliliği, Plantasyon, Polikültür

ECOLOGICAL CONDITIONS IN THE IMPLEMENTATION OF AGROFORESTRY PATTERNS IN THE SEKAMPUNG RIVER FLOW AREA

Abstract.

The Sekampung Watershed is one of the watersheds in Lampung Province that needs attention and improvement in the quality of water management and land use. The Sekampung watershed has degraded 49% of its 484,191.80 ha area. This condition has a negative impact on the environment and communities around the Sekampung watershed. The study aims to analyze the ecological conditions in the Sekampung watershed so that the developed agroforestry pattern can be sustainable and improve land use conditions. Data collection was conducted in November-December 2024 with a case study in Air Bakoman Village, Tanggamus Regency. Data were collected through structured interviews with 50 respondents and observations of farmers' land. Data analysis was done descriptively. The results showed that the ecological conditions in the agroforestry system in Air Bakoman Village displayed plant diversity of 4-6 species per plot of land with a combination of fruit trees and timber trees and had 4-5 functions of plant species per plot of land, both food and non-food functions. The average land area is 1.6 ha or ranges from 0.04 ha to 14 ha. In comparison, the polyculture pattern identified 2-3 types of plants with 3 plant functions, while the monoculture pattern of rice and coffee plantations only had 1 type and 1 plant function. Land productivity in all patterns fluctuated over two growing seasons, but agroforestry had more variable soil cover than other patterns.

Keywords: Cropping Pattern, Monoculture, Plant Diversity, Plantation, Polyculture

INTRODUCTION

Sekampung Watershed is the main watershed in Lampung Province, which has a very important role because it has a guarding and protection function for all parts of the watershed to maintain the sustainability and balance of the existing ecosystem (Ridhayana *et al*., 2022). The Sekampung watershed is one of the important areas to pay attention to and improve the quality of water management and land use. The Sekampung watershed is one of 15 national priority watersheds, 108 out of critical in Indonesia. The watershed is a national priority due to the frequent floods and landslides and the declining water quality in various rivers (Apriadi *et al*., 2023). With the Sekampung watershed area of 484,191.80 Ha, about 49% is degraded (Arifin *et al*., 2018). Degraded ecological conditions have a negative impact on the environment and communities around the Sekampung watershed area, such as soil erosion, which causes a decrease in land productivity and affects the income of the people who manage the land (Agustina and Dewi, 2020).

Agroforestry is one of the favored solutions to promote land improvement through dynamic ecologically based natural resource management by integrating trees, shrubs, and or annual crops often accompanied by livestock in a single field (Olivi *et al*., 2015). Agroforestry systems provide important economic and ecological benefits to farmers with great potential to maintain watershed functions while maintaining crop production with high economic value. Agroforestry patterns benefit the community economically and contribute to ecological sustainability by maintaining environmental conditions (Qurniati *et al*., 2017). Agroforestry provides ecological benefits, meaning that the pattern can maintain ecosystem integration, maintain soil and water quality, reduce erosion and land degradation, and increase biodiversity (Wattimena *et al*., 2024).

The application of ecology plays an important role in creating a harmonious relationship between the various components that make up the ecosystem, including humans. The scope of ecology includes micro discussions such as the role of various microorganisms in the decomposition process and global issues such as climate change. Ecological characteristics are the basis for developing various sustainable natural resource management models. These are aimed at meeting the current generation's needs and ensuring the availability of resources for future generations (Hariyadi *et al*., 2014). Recognizing the ecological importance and benefits of this agroforestry system, research is needed to analyze the ecological conditions in Air Bakoman Village so that the agroforestry pattern developed in the Sekampung watershed can be sustainable and can improve land use conditions.

RESEARCH METHODS

This research was conducted in November-December 2024 in the Sekampung watershed, precisely in Air Bakoman Village, Pulau Panggung District, Tanggamus Regency, Lampung Province. The location selection

was based on the evaluation that Air Bakoman Village is one of the villages bordering the protected forest area, namely the area of Forest Management Unit Batutegi (KPH). A map of the research site can be seen in Figure 1.

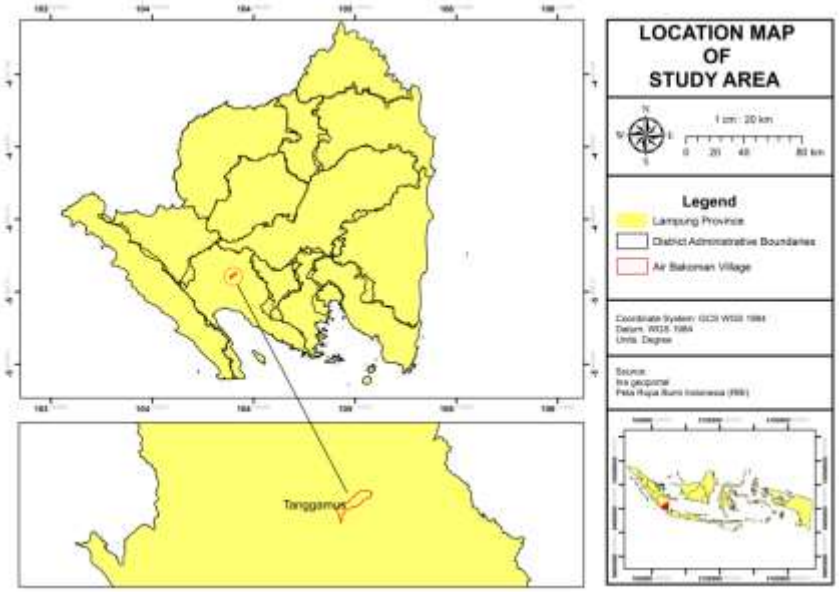

Figure 1. Research site

The tools and materials used in this research are digital cameras for documentation, stationery, computers/laptops, questionnaires, and literature sources, along with related data. The object of this research was conducted on farmers or communities who cultivate their land in the Sekampung Watershed.

The method used in the study was a survey of farmers who manage land in the Air Bakoman Village Sekampung Watershed area with an unknown population of farmers working on the land. The population used the number of households in the village. The number of samples was determined using the Cochran formula to find the proportion of the population as a representative sample of all populations with a sampling error of 6%. Based on the calculation results, the number of samples taken in Air Bakoman Village was 50 respondents. The primary and secondary data were used in this study. Primary data is obtained directly from farmers in Air Bakoman Village who manage the Sekampung Watershed. Primary data includes plant species diversity, functional diversity, strong plant species production stability, and soil cover. Secondary data used is data that supports the research, which includes general conditions of the research location and other data related to the research sourced from supporting literature books, libraries, or agencies that are still related.

The data used in this study were collected based on the results of structured interviews and observations. Interviews used for collecting data were carried out by question-and-answer interactions with respondents directly using a questionnaire as a reference in collecting information related to the research. Observation is collecting data by directly observing in the field and recording and documenting the object under study.

Data analysis was carried out descriptively based on indicators of ecological aspects. According to Maskar and Anderha, (2019), descriptive analysis is an analysis that is the collection, processing, presentation, and interpretation of data in quantitative or percentage. Based on the results of data analysis of ecological conditions, then this study compares ecological in agroforestry patterns with other patterns, namely polyculture patterns (>1 type of agricultural crop), monoculture (1 type of agricultural crop), and plantations (1 type of plantation crop/tree).

RESULTS AND DISCUSSION

Plant species diversity

In agroforestry practices, most farmers in Air Bakoman Village manage their land by planting 4-6 types of plants in one plot with an average plot size of 1.6 ha. The percentage of farmers in the diversity of plant species is shown in Figure 2.

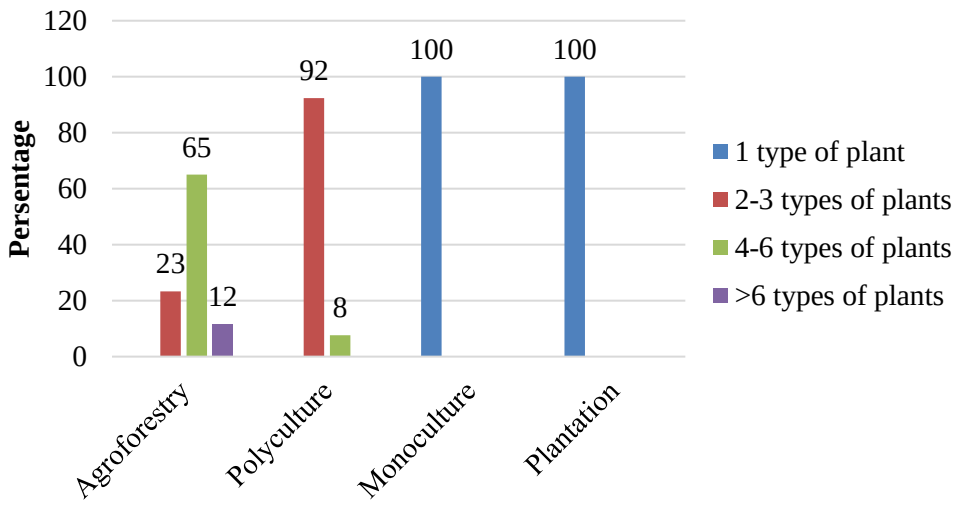

Figure 2. The percentage of farmers is based on the number of crop types.

The results showed that the agroforestry system contributed significantly to the diversity of plant species compared to other cropping patterns. In this agroforestry system, 65% of farmers managed land with a diversity of 4-6 plant species in one plot. The combination farmers choose generally includes fruit trees and forest trees, creating a layered vegetation structure that reflects a complex agroforestry system. Crop diversity includes various species with different ecological and economic functions. The types of agroforestry plants in Air Bakoman Village are Sengon (Albizia chinensis), Avocado (Persea americana), Aren (Arenga pinnata), Clove (Syzigium aromaticum), Duku (Lansium domesticum), Durian (Durio zibenthinus Murr), Maize (Zea mays L), Jengkol (Archidendron pauciflorum), Cocoa (Theobroma cacao L), Rubber (Hevea brasiliensis), Coconut

(Cocos nucifera, Aleurites moluccanus), Candlenut (Terminalia catappa), Coffee (Coffea arabica), Pepper (Piper nigrum), Mahogany ((Swietenia mahagoni), Mango Mangifera indica), Rice (Oryza sativa L), Nutmeg (Myristica fragrans), Petai (Parkia speciosa), Pinang (Areca catechu), Banana (Musa paradisiaca), Sonokeling (Dalberia latifolia). The existence of these various types of plants forms an agricultural ecosystem that is interrelated with each other.

In the upper strata layer, sengon and mahogany trees play an important role in creating a microclimate that supports the growth of the plants below. These trees are shade in the hydrological cycle, providing litter-fertilizing soil organic content (Darmayanti and Solikin, 2023). The ability of these trees to adapt to local conditions is demonstrated through good growth and their ability to support the overall agroforestry system. In the middle stratum, various fruit trees, such as durian, duku, and avocado, fulfill ecological niches that suit their growth characteristics. At the same time, the lower layer is dominated by coffee, cacao, and pepper plants, which require shade conditions for optimal growth. This combination of different crop types creates a resilient farming system adaptable to environmental changes. The layered vegetation structure provides protection against soil erosion, retains moisture, supports soil fertility through continuous nutrient cycling, and maintains soil root systems (Senoaji *et al*., 2022).

In the polyculture system in Air Bakoman Village, 92% of farmers mostly plant 2-3 types of crops at the same time in 1 plot of land. This polyculture system has a diversity of plant species, such as banana (Musa paradisiaca), coffee (Coffea Arabica), rampai (Solanum pimpinellifolium), chili (Capsicum sp), cempokak (Solanum torvum), bitter melon (Momordica charantia L.), eggplant (Solanum melongena), cucumber (Cucumis sativus), and cocoa (Theobroma cacao L.), of the many types of plants in this polyculture system, the dominant combination is a mixture of coffee and banana plants. In addition to agroforestry and polyculture systems, monoculture patterns focus on rice cultivation (Oryza sativa L) and coffee plantation patterns (Coffea Arabica). The existence of monoculture systems shows that farmers in Air Bakoman Village adopt various strategies to fulfill their economic needs. combination of various farming systems not only supports food and economic security but also contributes to the preservation of biodiversity and the stability of local ecosystems.

Based on diversity, agroforestry patterns have the highest plant species diversity compared to polyculture, monoculture, and plantation patterns. Complex agroforestry systems with various crops have important and far-reaching environmental benefits, such as providing a range of environmental services, for example, soil and water conservation and providing habitat for various fauna species (Wattie and Sukendah, 2023). In contrast to monocultures that are susceptible to pests and diseases and cause soil degradation, agroforestry provides income diversification for farmers, reduces the risk of crop failure, and increases resilience to climate change, in line

with research by Papa *et al*. (2020), which shows that agroforestry farmers are less affected by stressors associated with climate change than monoculture farmers. In addition, the diverse plant species in agroforestry systems produce various products, including timber fruits, fodder, and crops, which can sustainably fulfill economic and ecological needs.

Plant Functional Diversity

The functional diversity of plants in Air Bakoman Village has diverse food and non-food functions owned by various plants. Based on the National Food Agency (2023), the classification of fresh food of plant origin is divided into cereal grains, tubers, nuts, legumes, grains, vegetables, fruits, spices, fresheners, and sweeteners. The functional diversity of plants in agroforestry land in Air Bakoman Village in 1 plot has an average of 4-5 functions of plant, while in the polyculture pattern in Air Bakoman Village in one field, there are 3 functions of plant. Meanwhile, in monoculture and plantation land, on average, there is only 1 function of plant in a field.

Based on the classification of crops in Air Bakoman Village, they can be categorized into several functional categories, such as the cereal group, namely rice and corn. The diverse fruit group includes durian, duku, avocado, and banana, while freshener and spice plants such as cloves, pepper, nutmeg, and coffee. In addition, the agroforestry system in Air Bakoman Village has plants with important non-food functions, such as sengon and mahogany trees, that function as wood producers and providers of environmental services such as regulating microclimate and preventing erosion. Based on the results of the analysis that has been done, several plants have more than 1 function, such as papaya plants that are included in the vegetable and fruit groups, whereas papaya leaves are included in the function/group of vegetables. In contrast, papaya fruit is included in the function/group of fruit where all these functions are of economic value. The utilization of plants with various functions can provide benefits in optimizing farmers' cultivation of land.

Robust Plant Species

Strong plant species can grow well and healthily, produce optimally, and are pest/disease resistant when met with macro and micronutrient needs (Sodiq and Megasari, 2023). Based on observations of plant species diversity in Air Bakoman Village, there are variations in plant tolerance to biotic (pests) and abiotic (extreme weather) pressures. In the agroforestry and polyculture fields in Air Bakoman Village, an average of 2-3 plant species has different resistance to these two factors. Some species show good resistance to extreme weather but are vulnerable to pest attacks, such as durian and sengon plants. Plants that can withstand extreme weather generally have strong root systems and morphological characteristics that support resistance to environmental stress. Conversely, some species, such as cloves and pepper, can withstand pests but are less tolerant of drastic weather changes. This variation in resilience reflects the complexity of plant adaptation to various stresses.

Meanwhile, the existing monoculture and plantation patterns in Air Bakoman Village, namely rice monoculture and coffee plantations, have a low tolerance to pests and extreme weather events. pattern This cropping that only relies on one type of plant creates unfavorable conditions in terms of the resilience of the agricultural system. The low tolerance of rice plants in monoculture systems to pests can be caused by genetic uniformity in a large area that allows pest populations to grow rapidly due to abundant and uniform food sources. The absence of crop diversity reduces the presence of natural enemies of pests that are usually present in more diverse systems such as agroforestry. Regarding resilience to extreme weather, rice monoculture systems also show high vulnerability. In drought, the entire field can fail simultaneously due to the absence of other crops that can help create a more favorable microclimate. Conversely, the risk of plant disease attacks also increases during high rainfall.

Production Stability

The stability of crop production in Air Bakoman Village in various cropping patterns illustrates a system that maintains productivity levels consistently under various environmental conditions. Based on the research results, all systems applied, be it agroforestry, polyculture, monoculture, and plantation systems, have production fluctuating in the last two growing seasons. In the agroforestry system, although it has a high diversity of plant species, it still experiences fluctuations in production. This is due to the complexity of interactions between plants and environmental factors that affect the productivity of each component. However, agroforestry systems have advantages in terms of risk distribution, where a decrease in the production of one type of plant can be compensated by the production of other plants (Wahditiya *et al*., 2024).

Polyculture systems that combine two or three crops also show unstable production patterns. This is fluctuation due to competition between plants for resources such as nutrients, air, and light. However, this system still guarantees better yields than monoculture due to the diversity of crops. In a monoculture system, production can be very unstable. Dependence on a single crop makes this system highly vulnerable to changes in environmental conditions. When conditions become unfavorable, a drastic decline in production can occur without the results of other crops as a buffer. The existing plantation system in Air Bakoman Village also faces production instability. Despite being managed with more intensive inputs, variations in environmental conditions still significantly influence crop productivity levels.

Ground Cover

Ground cover is an important aspect of agricultural systems that plays a role in conserving soil and water resources. The level of soil cover can vary from the simplest to the most complex. Based on the analysis, the agroforestry system in Air Bakoman Village shows that the ground cover consists of seasonal crops such as

fruit trees and forest trees, while the polyculture and monoculture patterns in Air Bakoman Village only involve seasonal crops as ground cover. Meanwhile, the plantation pattern shows that only forest trees function as ground cover on the land.

The diversity of ground cover in the various farming systems in Air Bakoman Village exhibits distinct features, reflecting each system's complexity and ecological functions. The agroforestry system in this village displays the most complex ground cover structure. The combination of seasonal crops and trees creates a layered structure that provides optimal protection to the soil. Annual crops such as rice and corn cover the bottom layer. In contrast, fruit trees such as durian, duku, and avocado, and forest trees such as sengon and mahogany form a canopy that protects from the direct impact of high rainfall, which minimizes soil erosion (Wijayanto *et al.*, 2021). Ground cover is simpler in polyculture and monoculture patterns with only seasonal crops. This system has limitations in terms of long-term soil protection, especially when the annual crops have been harvested, and the land is fertile. The soil is more susceptible to erosion and degradation without trees to provide permanent cover. The plantation pattern shows different characteristics, where forest trees are the only ground cover that serves as erosion control soil amendment and weed growth inhibitor (Erfandi, 2016). While providing good protection against erosion through strong root systems and dense canopies, the absence of understory crops can reduce the effectiveness of vertical space utilization in agricultural systems.

Conclusions

The agroforestry pattern has the highest diversity level compared to other planting patterns, with an average of 4-6 types of plants in one plot of land with the selected combination, including fruit trees and forest trees. In the functional diversity of plants in 1 plot of land, the agroforestry pattern has a high plant function with an average of 4-5 functions, both as food and non-food. Agroforestry also has a more varied ground cover consisting of seasonal crops and trees. However, all patterns experienced fluctuating production in the two growing seasons. It needs to be increased by combining crops with different harvest times in one plot of land to minimize production fluctuations. Therefore, to develop agroforestry patterns more widely, an approach is needed that involves educating farmers about the long-term benefits of agroforestry, economic incentives from the government for the implementation of agroforestry practices, development of management technologies that are adaptive to climate change, and strengthening local institutions that support biodiversity conservation.

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