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Karakterisasi praktik agroforestri di Kalibawang, Kabupaten Wonosobo, Jawa Tengah, Indonesia

Characterization of agroforestry practices in Kalibawang, Wonosobo Regency, Central Java, Indonesia

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Abstrak. *Nurwulandari M, Fitriawan MN, Karina R, Khoirunnisa S, Setyawan AD. 2024. Karakterisasi praktik agroforestri di Kalibawang, Kabupaten Wonosobo, Jawa Tengah, Indonesia. Pros Sem Nas Masy Biodiv Indon 10: 110-142.* Agroforestri adalah sistem pengelolaan penggunaan lahan yang mengintegrasikan pohon dengan tanaman pertanian atau padang rumput. Agroforestri dapat menghasilkan berbagai produk, seperti kayu, buah-buahan, sayuran, tanaman obat, pakan ternak, dll, yang bermanfaat bagi petani sambil mempertahankan keberlanjutan lingkungan. Penelitian ini bertujuan untuk mengidentifikasi dan mengkarakterisasi praktik agroforestri tradisional serta mengkaji kontribusinya terhadap mata pencaharian masyarakat lokal di Kecamatan Kalibawang, Kabupaten Wonosobo, Jawa Tengah, Indonesia. Data dikumpulkan dengan menggunakan kuesioner dan wawancara semi-terstruktur dengan 85 informan. Penelitian menunjukkan bahwa agroforestry didominasi oleh kebun rumah dengan luas >0,5 hektar, termasuk kegiatan pertanian skala kecil hingga menengah. Vegetasi dominan di lahan agroforestri yang diteliti terdiri dari *Durio zibethinus* (durian), *Albizia chinensis* (albisia), *Swietenia mahagoni* (mahoni), serta tanaman pertanian, yaitu *Capsicum annuum* (cabai), *Zingiber officinale* (jahe), dan *Musa paradisiaca* (pisang). Praktik agroforestri tidak hanya memberikan manfaat ekonomi melalui penjualan kayu dan produk pertanian oleh masyarakat lokal, tetapi juga meningkatkan produktivitas lahan dan keberagaman vegetasi.

Kata Kunci: Pertanian, agroforestri, tanaman pangan, sosial ekonomi, kayu

Abstract. *Nurwulandari M, Fitriawan MN, Karina R, Khoirunnisa S, Setyawan AD. 2024. Characterization of agroforestry practices in Kalibawang, Wonosobo Regency, Central Java, Indonesia. Pros Sem Nas Masy Biodiv Indon 10: 110-142.* Agroforestry is a land use management system that integrates trees with agricultural crops or pastures. Agroforestry can produce various products, such as timber, fruits, vegetables, medicinal plants, animal fodder, etc. beneficial to farmers while maintaning environmental sustainability. This study aimed to identify and characterize traditional agroforestry practices and examine their contribution to the livelihood of local communities in Kalibawang Sub-district, Wonosobo District, Central Java, Indonesia. Data was collected using questionnaires and semi-structured interviews with 85 informants. The research showed that agroforestry is dominated by home gardens with an area of >0.5 hectares, including small to medium-scale agricultural activities. The dominant vegetation in the agroforestry land studied consisted of *Durio zibethinus* (*durian*), *Albizia chinensis* (*albisia*), *Swietenia mahagoni* (*mahoni*), as well as crop plants, i.e. *Capsicum annuum* (*cabai*), *Zingiber officinale* (*jahe*), and *Musa paradisiaca* (*pisang*). Agroforestry practices not only provide economic benefits through the selling of wood and agricultural products by local communities, but also improve land productivity and vegetation diversity.

Keywords: Agriculture, agroforestry, crops, socio-economics, timber

INTRODUCTION

Changes in vegetation cover affect ecosystem functions and services, moreover on ecosystems naturally covered by complex vegetation, such as forests. The loss and degradation of forest vegetation is a global problem because it reduces the ability of soil to deliver various functions (Igwe et al. 2017). Among several causes, agricultural activities to produce foods are responsible for forest loss and degradation. Therefore, some studies suggest looking into other ways to grow foods, like Agroforestry Systems (AFS), a type of integrated land management that grows a mix of woody vegetation (mainly trees) with annual agricultural crops or pastures.

Agroforestry systems can make farming more productive, while protecting the environment at the same time. Agroforestry can increase agricultural productivity while also playing roles in carbon sequestration, nutrient cycling, soil biodiversity, water retention, and pollination. In addition, agroforestry can reduce soil erosion, prevent fires, and provide recreational and cultural benefits. Agroforestry has been practiced long time ago as traditional land use

management by indigenous communities (Viswanath and Lubina 2017). There is a variety of products generated from agroforestry, ranging from food to fuel wood and fiber, while maintaining environmental sustainability (Sharma et al. 2017).

Agroforestry system is considered as the right choice to balance socioeconomic needs with the ecological function of land (Jose et al. 2021). It also is promoted as a sustainable land management option to realize productive landscape to achieve sustainable development goals while maintaining environment (Montagnini and Metzel 2017). Scientific studies which explore the role of agroforestry in sustainable management strategies adopt an interdisciplinary perspective which combines ecological, agricultural, and socioeconomic sciences and, in some cases, practical knowledge. These studies relate to various ecosystem goods and services and various sectors of society, such as agriculture, forestry, and nature conservation (De Mendonça et al. 2022). Thus, the importance of agroforestry can be seen from two points of view, i.e.: the ecological potential of vegetation forming agroforestry and the economic potential of agroforestry products (Putra et al. 2020). The ecological importance can be viewed from its roles in regulating hydrology of rivers and watersheds, reducing the concentration of greenhouse gases, and maintaining biodiversity, while the economic benefits can be measured from the types of wood and non-timber forest products to improve the community's economy (Swieter et al. 2022). Other objectives of agroforestry are increasingly recognised for example to restore forest functions and increase community involvement in land use management (Reppin et al. 2020; Duffy et al. 2021).

Environmental factors influence the distribution, abundance, density, frequency, and dominance of vegetation (Dubovyk et al. 2016). Such factors also affect the type and pattern of agroforestry implemented by farmers by considering plant integration, species diversity, efficient land use, plant interactions, and water management (Pantera et al. 2021). These principles are guidelines or basic concepts for designing, implementing, and managing agroforestry systems, emphasizing land management that considers ecological, social, and economic aspects (Siregar 2023). Several agroforestry systems combine various types of plants with several canopy strata to resemble natural forests to make this land use management more environmentally friendly (Wattie and Sukendah 2023).

This study aimed to identify and characterize traditional agroforestry practices that contribute to the livelihoods of the community in Kalibawang Sub-district, Wonosobo District, Central Java, Indonesia. There is no prior documentation of agroforestry practices in the region, as well as the uniqueness of biodiversity and ecosystem services. This research is expected to improve the understanding of how agroforestry systems can contribute to biodiversity conservation, while producing agricultural crops, maintaining environmental sustainability, and community welfare.

MATERIALS AND METHODS

Study area

The research was conducted in March 2024 in Kalibawang Sub-district, Wonosobo District, Central Java, Indonesia, covering three villages, including Karang-sambung, Depok, and Mergolangu (Figure 1). Kalibawang is geographically located at the coordinates of 7°21′ S and 109°53′ E, at 549-984 m asl., with rainfall of 908 mm (in 2022); and has an area of 47.81 km^2 consisting of 8 villages, i.e., Dempel, Depok, Kalialang, Kalikarung, Karangsambung, Mergolangu, Pengarengan, and Tempurejo, with a population of 29,082, composed by male and female population of 49% and 51%, respectively (BPS Kabupaten Wonosobo 2023).

Data collection

Specific study sites and agroforestry practices were identified through discussions with stakeholders in the study area in Karangsambung, Depok, and Margolangu Villages. According to discussions, a non-random sampling method was used to select intensive agroforestry practitioners and knowledgeable key informants in the community; key informants were important to obtaining the research information. Various patterns and types of agroforestry systems are rich in species, for example, mixed plantations, tree-lined plantations, intercropping systems, fallow land, home gardens, etc. (Hadi et al. 2016).

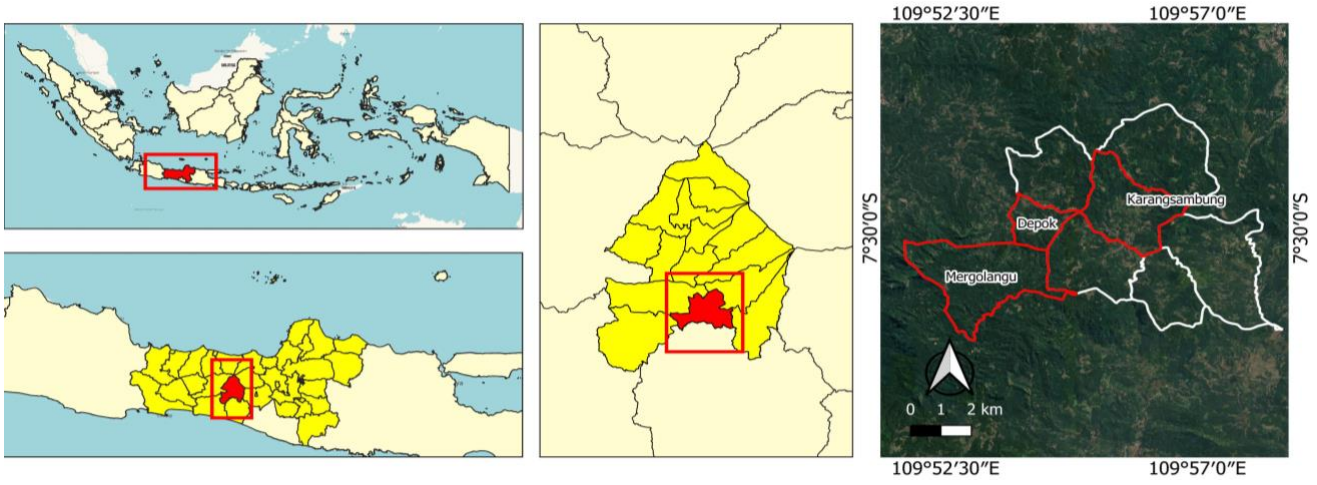

Figure 1. Map of the research area in Kalibawang Sub-district, Wonosobo District, Central Java, Indonesia

The first step of data collection was interviews with key informants and several residents in each village. From this interview, we took samples based on criteria of village coverage, average age, and occupations discussed with key informants. According to Khalefa and Selian (2021), informants were selected to represent each region with a representative number. A total of 85 community members (including three key informants) were selected as respondents from Karangsambung, Depok, and Margolangu Villages. The data was collected through formal, structured questionnaires and key informant interviews. We conducted interviews by visiting residents and then asking predetermined questions. This question covered the informant's identity, occupation, age, and level of education to observe their perspective and socioeconomic characteristics.

The respondents aged 17-55 years were selected based on their level of education, employment, and good knowledge of traditional agroforestry practices, as well as the ability to reveal the function and historical development of traditional agroforestry practices in the region.

Data analysis

The acquired plant data was documented on a structured interview sheet, organized according to the local name, family name, scientific name, and frequency (the quantity of data). Subsequently, Microsoft Excel was used to analyze the data, enabling comparisons and identifying patterns in the specific area. This study employed descriptive analysis and displayed it through graphs and tables. Descriptive analysis was used as a statistical technique to describe and make inferences from collected data (Sugiyono 2017).

RESULTS AND DISCUSSION

Characteristic of respondents

The respondents' characteristics are shown in Table 1. In terms of gender, there was a greater number of female respondents than male respondents with 52% and 48%, respectively. Regarding age, 28% of respondents were 17-35 years old, 50% were 36-55 years old, and 22% were 55 years old. Based on education, most respondents had an elementary school (54%), followed by high school (22%), junior high school (17%), not graduating from elementary school (6%), and college graduates (1%). Regarding employment, most respondents were farmers (51%), housewives (27%), wood laborers (9%), and others (8%). The relationship between gender inequality and education influence each other (Ingutia et al. 2020).

Land ownership and land use management

The land ownership area of >0.5 ha was the most dominant (47%) with form of land use management as home garden (79%) and forest garden (21%) as presented in Table 2. This demonstrates that land use management in Kalibawang is dominated by agroforestry in the form of home gardens and forest gardens. Agroforestry-dominated land is generally owned by individuals or families, not large companies or institutions. In agroforestry contexts, land use typically includes small to medium-scale farming activities, mixed crops, crop rotation, and organic fertilization practices. This aims to increase and preserve resource productivity, ultimately improving the community's living standard by diversifying and optimizing local land use (Triwanto 2024).

Table 1. Characteristics of respondents in Kalibawang Sub-district, Wonosobo District, Central Java, Indonesia

Characteristic	Frequency (n)	Percentage (%)
Village		
Depok	41	48
Karangsambung	25	29
Margolangu	19	23
Gender		
Male	41	48
Female	44	52
Age		
17-35 years	24	28
36-55 years	42	50
>55 years	19	22
Education level		
Not education	5	6
Elementary school	47	55
Junior high school	20	24
Senior high school	12	14
College	1	1
Occupation		
Housewife	23	27
Farmers	43	51
Merchant	4	5
Wood laborer	8	9
Others	7	8
Total	**85**	**100**

Table 2. Land ownership and land use management in Kalibawang Sub-district, Wonosobo District, Central Java, Indonesia

Category	Frequency (n)	Percentage (%)
Land area (Ha)		
>0.5	40	47
0.5≤X≤0.1	30	35
<0.1	15	18
Land use		
Forest garden	18	21
Home garden	67	79
Total	85	100

Table 3. Trees and woody plants in the home garden in Kalibawang, Wonosobo District, Central Java, Indonesia

Family	Scientific name	Local name	%
Malvaceae	*Durio zibethinus* Murr	*Durian*	27.59
Myrtaceae	*Syzygium myrtifolium* Walp.	*Pucuk merah*	3.45
Anacardiaceae	*Anacardium occidentale* L.	*Jambu monyet*	6.90
Rutaceae	*Citrus aurantifolia* (Christm.) Swingle, orth.	*Jeruk nipis*	6.90
Melastomataceae	*Medinella speciosa* L.	*Parijoto*	3.45
Fabaceae	*Albizia chinensis* (Osbeck) Merr.	*Albasia*	13.79
Meliaceae	*Swietenia mahagoni* (L.) Jacq.	*Mahoni*	10.34
Clusiaceae	*Garcinia mangostana* L.	*Manggis*	6.90
Casuarinaceae	*Casuarina* sp.	*Cemara*	3.45
Anacardiaceae	*Mangifera indica* L.	*Mangga*	3.45
Lauraceae	*Persea americana* P. Mill.	*Alpukat*	6.90
Oxalidaceae	*Averrhoa carambola* L.	*Belimbing*	3.45
Rubiaceae	*Coffea arabica* L.	*Kopi*	3.45
Total			100

Table 4. Herbs and vegetables in the home garden in Kalibawang, Wonosobo District, Central Java, Indonesia

Family	Scientific name	Local name	%
Solanaceae	*Capsicum annuum* L.	*Cabai*	17.19
Zingiberaceae	*Zingiber officinale* Rosc.	*Jahe*	15.63
Musaceae	*Musa paradisiaca* L.	*Pisang*	10.94
Euphorbiaceae	*Manihot esculenta* Crantz	*Singkong*	6.25
Piperaceae	*Piper betle* L.	*Sirih*	6.25
Zingiberaceae	*Kaempferia galanga* L.	*Kencur*	4.69
Zingiberaceae	*Curcuma longa* L.	*Kunyit*	4.69
Cactaceae	*Cactaceae* sp.	*Kaktus*	4.69
Apocynaceae	*Plumeria acuminata* Ait	*Kamboja*	4.69
Solanaceae	*Solanum melongena* L.	*Terong*	4.69
Zingiberaceae	*Alpinia galanga* (L.) Sw.	Laos	3.13
Asphodelaceae	*Aloe ferox* Miller	*Lidah buaya*	3.13
Caricaceae	*Carica papaya* L.	*Pepaya*	3.13
Asparagaceae	*Sansevieria trifasciata* Hort. ex Prain	*Lidah mertua*	1.56
Lamiaceae	*Lavandula angustifolia* Mill.	Lavender	1.56
Fabaceae	*Calliandra haematocephala* Hassk	*Kaliandra*	1.56
Orchidaceae	*Vanilla planifolia* Andrew	*Vanili*	1.56
Cucurbitaceae	*Cucumis sativus* L.	*Timun*	1.56
Leguminosae	*Phaseolus vulgaris* L.	*Kacang buncis*	1.56
Poaceae	*Zea mays* var. *rugosa* L.	*Jagung manis*	1.56
Total			100

Table 5. Tree and woody plant species in the forest garden in Kalibawang, Wonosobo District, Central Java, Indonesia

Family	Scientific name	Local name	%
Fabaceae	*Albizia chinensis* (Osbeck) Merr.	*Albasia*	25.56
Palmae	*Cocos nucifera* L.	*Kelapa*	21.0
Malvaceae	*Durio zibethinus* Murr	*Durian*	13.53
Meliaceae	*Swietenia mahagoni* (L.) Jacq.	*Mahoni*	11.28
Moraceae	*Artocarpus heterophyllus* Lam	*Nangka*	8.27
Lauraceae	*Persea americana* P. Mill.	*Alpukat*	6.02
Meliaceae	*Lansium domesticum* Corr.	*Duku*	4.51
Elaeocarpaceae	*Elaeocarpus sphaericus* Schum	*Jenitri*	1.50
Clusiaceae	*Garcinia mangostana* L.	*Manggis*	1.50
Araceae	*Arenga pinnate* Merr.	*Aren*	1.50
Meliaceae	*Toona sureni* (Blume) Merr	*Suren*	0.75
Malvaceae	*Hibiscus tiliaceus* L.	*Waru*	0.75
Verbenaceae	*Tectona grandis* L.f.	*Jati*	0.75
Fabaceae	*Calliandra calothyrsus*	*Kaliandra*	0.75
Myrtaceae	*Psidium guajava* L.	*Jambu*	0.75
Mangifera	*Mangifera indica* L.	*Mangga*	0.75
Rutaceae	*Citrus* sp.	*Jeruk*	0.75
Total			100

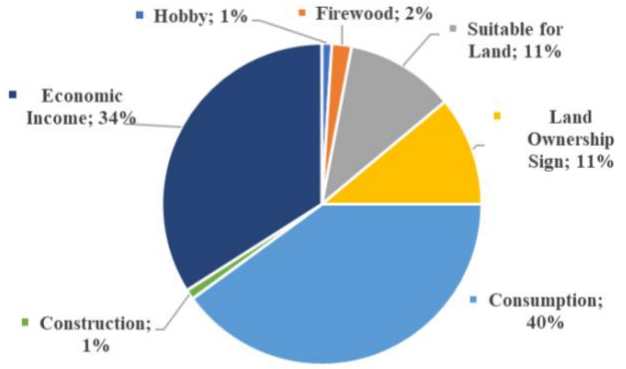

Figure 2. Purposes of growing tree species in agroforestry land in Kalibawang, Wonosobo, Central Java, Indonesia

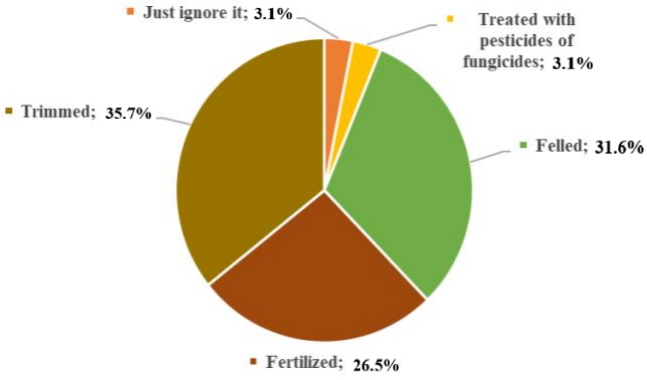

Figure 3. Tree species management in agroforestry land in Kalibawang, Wonosobo, Central Java, Indonesia

Home garden agroforestry

This study found that home gardens comprised many plant species and were divided into two groups: home gardens with trees and home gardens with non-woody trees (vegetables and herbs). Thirteen species of woody plants were recorded in the home garden dominated by seven woody plant species, the three most abundant species are *Durio zibethinus* (*durian*) with 27.59%, *Albizia chinensis* (*albasia*) with 13.79%, and *Swietenia mahagoni* (*mahoni*) with 10.34% (Table 3). Wonosobo is known as one of the largest *durian* producers in Central Java due to several factors, such as favorable soil conditions, climate and topography, availability of quality seeds, and the good knowledge of local residents about durian cultivation (Sutaminingsih and Sujana 2020). The dominance of *mahoni* and *albasia* trees is due to the needs of people who use these trees as boundaries for home garden areas, wood or twigs used for firewood or fodder, and as raw materials for making furniture (Astuti et al. 2020).

On the other hand, there were 20 non-woody plant and vegetable species documented in the home garden with a prevalence of three species, namely, *Capsicum annuum* (*cabai*) with 17.19%, *Zingiber officinale* (*jahe*) with 15.63%, and *Musa paradisiaca* (*pisang*) with 10.94% (Table 4). These three crops were abundant due to favorable land and climate conditions and the needs of people who consume a small amount of the harvest and use it to meet market demand (Tantra et al. 2022).

Forest garden agroforestry

Seventeen tree and woody plant species grow in forest garden in Kalibawang Sub-district, Wonosobo, Central Java (Table 5). The *A. chinensis* (*albasia, sengon*) dominated the vegetation in the forest garden, accounting for 25.56% of the total. This tree species is widely used by the community because of its many benefits, including being sold to improve the household economy, and used as firewood and construction material. Apart from the economic aspect, *Albasia* trees are environmentally friendly and can coexist with other trees. *Albasia* also prevents erosion and fertilizes the soil (Kusuma et al. 2014). The suitability of *Albasia* on various land conditions makes this tree dominate the forest garden (Kundrat 2019).

Purpose of planting tree species in agroforestry

Based on the survey and interview, tree species planted in agroforestry land (home garden and forest garden) were used for various purposes (Figure 2). Tree species are among the most valuable plant groups which is used to produce construction materials, crafts, even foods and many other purposes (Suter et al. 2017). Figure 2 shows that tree species are mainly used for self-consumption (40%), followed by generating income (34%) by selling wood products. Tree species in agroforestry can also be used to mark land ownership (11%), the suitability of the land for tree planting (11%), and used for firewood (2%). The smallest percentage is used for construction and hobbies, each with 1%.

Management of tree species in agroforestry

Agroforestry is land management that integrates agricultural crop systems with woody plants to yield more benefits from ecological and economic interactions (Pantera et al. 2021). Although it provides many benefits, agroforestry practices require proper management to achieve optimal product results. This research shows that there are several ways to manage tree species in agroforestry land carried out by local communities in Kalibawang Sub-district, Wonosobo District, including cutting, pruning, organic fertilizers, pesticides, and fungicides, or even not doing any treatment.

Figure 3 shows that pruning is the most common management practice done by local communities, with 35.7%. Pruning is a way of managing trees to reduce or remove unnecessary parts so that the tree can grow optimally (Panggabean 2014; Novianti and Setiawan 2018). According to Kurniawan et al. (2023), pruning is one of the optimal management methods for agroforestry land because it can increase the light intensity crucial to tree canopy, increasing tree productivity. This method is the easiest and safest because it can maintain existing plants without cutting them down. The next management method is to cut down by 31.6%, which is done to trees being attacked by disease or pests. Cutting down trees in agroforestry practices in Kalibawang Sub-district has

effectively helped stop pests' spread. According to Potter and Urquhart (2017), sanitation programs to remove trees affected by pests have been implemented to stop the spread of these pests.

Other management practices include providing organic fertilizer (26.5%) and chemicals in the form of pesticides and fungicides (3.06%). This shows that agroforestry practice in Kalibawang Sub-district has been carried out naturally and uses more natural than synthetic agrochemicals. Apart from that, the large number of people raising livestock is also a factor leading to the high use of organic fertilizer. Most people are reluctant to apply pesticides or fungicides to their plants, especially *A. chinensis* (*albasia*), because they are susceptible to chemicals. *Albasia* has a large leaf pore structure and thin stem bark, so pesticides can easily infiltrate and damage plant structures. This is in accordance with Ghosh et al. (2021), which stated that the large leaves of *A. chinensis* with more open pores can accelerate the absorption of chemical substances, thus negatively impacting the health of this species. Additionally, 3.06% of people prefer letting pests and diseases attack their plants; they have no time to care for all the existing plants. Gall rust caused by the fungus *Uromycladium tepperianum* is the main disease of *albasia* in Wonosobo (Triyogo and Widyastuti 2012) with a mortality rate of up to 90% (Rahayu et al. 2010).

Contribution of agroforestry practices to household livelihoods

The interview revealed that agroforestry activities in Kalibawang, can improve the community's economic life by selling products such as crops, wood from trees, and additional yields from medicinal plants or fruits. Using agroforestry, communities can save on production costs by utilizing natural resources, such as organic fertilizers from manure and fallen tree leaves or natural pest control practices (Rosati et al. 2021). Through agroforestry, communities can diversify their income sources by growing crops with economic value. It helps individuals manage economic risk by offering diverse income alternatives that spread the risk of crop failures (Kassie 2018). For example, if one crop fails, the community still has a source of income from other crops growing on their agroforestry land. Besides, agroforestry can increase soil fertility and improve soil structure by incorporating trees into agricultural systems, thereby increasing land productivity and long-term values (Fahad et al. 2022). In addition to improving economic livelihoods, local communities use the harvested products of their agroforestry lands, such as timber as firewood, house construction, and leaves as fodder for livestock (Fahad et al. 2022).

In conclusion, the research revealed that traditional agroforestry practices in Kalibawang Sub-district, Wonosobo, Central Java, use an agrosilviculture system. The type of land use is dominated by home garden with an area of >0.5 hectares, including small to medium-scale agricultural activities. Land management is carried out individually or by family, with the main method being pruning by 35.7% to increase production. Home gardens in Kalibawang Sub-district show high plant diversity, with 13 species of woody plants and 20 species of non-woody plants. Dominant plants include *D. zibethinus*, *A. chinensis*, *S. mahagoni*, *C. annuum*, *Z. officinale*, and *M. paradisiaca*. Soil conditions, climate, and local knowledge also influence plant dominance. On the other hand, agroforestry practices provide economic benefits by selling agricultural products and wood and saving production costs by utilizing the surrounding natural resources. Those practices also improve soil fertility, income diversification, and quality of life of the local communities.

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