

Plant species selection and contribution of agroforestry systems to the income of local and transmigrant famers in East Luwu Regency, Indonesia

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Abstract

Each tribe has unique experiences and knowledge regarding plant utilization and cultivation. This knowledge and experience are passed down from generation to generation until they become a habit. The habit of selecting and cultivating plants is reflected in the agroforestry system that is developed. Differences in the composition of plant species within the agroforestry system affect farmers' income of local tribe and transmigrant. This study aims to determine the considerations for selecting plant species, analysing the composition of plant species, farmers' income, and the contribution of agroforestry systems to farmer household income. A vegetation survey and structured interviews using questionnaires were conducted. Respondents were determined using the purposive sampling method with the criteria of farmers who implement an agroforestry system and a minimum managed land area of 0.5 ha. Data were analysed descriptively and quantitatively. The results showed that the composition of plant species differed between local and transmigrant farmers. Transmigrant farmers tend to cultivate vegetable crops, such as tomatoes and chilies, while local tribes tend to develop high-value commodity crops, such as pepper and cocoa. Both tribes tend to consider economic rather than socio-cultural factors when selecting plant species. The average agroforestry income of local tribe is greater than that of transmigrant, but the contribution of the agroforestry system to the household income of local tribe is smaller than that of transmigrant, as a consequence of local tribes having other sources of income besides the agroforestry system. It is recommended to maintain the composition of plant species in the local tribe's agroforestry system by optimizing the arrangement of plant growth spaces.

Key words: economic factor, farmer household income, high-value commodity, species composition.

Introduction

Each tribe has a set of life values that are different from other tribes in cultivating,

utilizing, and preserving plants. Differences in cultivating, utilizing, and preserving plants were caused by variations in environmental, social, and cultural conditions

(Millang et al. 2024). Local communities, such as the Luwu tribe, utilize plants in their environment according to their cultural level. The local wisdom of an ethnic group in cultivating, utilizing, and preserving plants reflects their cultural practices in managing biological resources. The socio-cultural background of the ethnic group contains local knowledge and wisdom that is unique and different from other ethnic groups (Permana et al. 2011). They have close relationship with these plants, because they have experienced the process of getting to know, cultivating, and utilizing these plants over a long period of time (Ogwu et al. 2017).

Agroforestry systems are a collective term for all land-use management practices that intentionally cultivate woody perennial plants on the same land management unit as agricultural crops and/or livestock, either in a spatial mixture or in a temporal sequence (Lundgren 1987, Craswell et al. 1998, Tiwari 2022) and there are ecological and economic interactions between woody and non-woody components (Zhang et al. 2023). Agroforestry systems are natural resource management systems that integrate trees on agricultural land and agricultural landscapes to diversify, maintain production and maintain environmental sustainability (Molla 2019, Dhakal and Rai 2020, Purba et al. 2020, Nagar et al. 2021). Agroforestry systems are land management systems that combine the production of agricultural crops, woody plants, shrubs, livestock and/or aquatic resources that can provide many benefits, increase agricultural resilience and environmental sustainability, and improve people's livelihoods (Qurniati 2023). Farmers, who implement agroforestry patterns, will maximize the use of available land by planting various types of plants in suc-

cession, so that the diversity produced on a land includes not only the diversity of plant types and ages but also the diversity of products (Markum et al. 2021), including providing ecological services, maintaining biodiversity, and increasing community resilience in terms of food security (Kumar 2006, Gonçalves et al. 2021, Tirkey et al. 2024). With the diversity of plant species and products, farmers can harvest and utilize the production of their agroforestry system sustainably to meet their economic needs (Nurjanah et al. 2020). The combination of forestry and agricultural components applied to the agroforestry system creates strong interactions between each component based on the composition of the types of plants developed, so that the application of the agroforestry system can provide economic value for farmers' income (Olivi et al. 2015, Wanderi et al. 2019, Notaro et al. 2022). Nair (1993) classified agroforestry systems based on structural, functional, socio-economic, and ecological distribution. Structural basis refers to the nature and arrangement of agroforestry components, forming agroforestry systems such as agrisilviculture, silvopastural, and agrosilvopastural.

The success of an agroforestry system is determined by many factors (Millang 2021, Widiyanto and Hani 2021, Zhang et al. 2023), one of which is the selection of agroforestry component types. The factors and process of selecting the right and appropriate agroforestry component types (forestry, agriculture and/or livestock) are one of the crucial stages in agroforestry development. Consideration of the ease of these species to be combined with various cultures and the concept of multipurpose tree species are the most important characteristics (Tiwari 2022). The main criteria for selecting tree species are that they are

preferred by farmers, well known by farmers (famous), and provide high income and low costs (Tengnas 1994). Other important factors are the economy (Hartoyo et al. 2024) and the socio-culture of the community. Wulandari et al. (2014) stated that the involvement of communities around forests can optimize forest land by implementing agroforestry based on the socio-economic conditions of the community, such as community preferences and adoption of agroforestry patterns. The selection of plant species composition and management methods is very important and determines the success of the agroforestry system (Millang 2021). Not only in Indonesia (Cahyono et al. 2020), but several countries have adopted the agroforestry system in managing their land, such as Pakistan (Ahmad et al. 2023), Ethiopia (Amare and Darr 2023) and Uganda (Buyinza et al. 2020).

In each different region, farmers' habits in implementing and managing agroforestry systems are also different, as well as differences in tribe affecting the amount of income of agroforestry farmers (Olivi et al. 2015). Transmigration is a development equalization program carried out by the Central Government of Indonesia. The program is carried out by moving very densely populated areas such as Java, Bali, and Madura to an island or region with a small population such as Sulawesi (Manay 2016, Anggraini and Hamid 2024). Wasuponda District, East Luwu Regency is one of the areas where transmigrants from several regions were placed in 1984 (Hamzah and Cangara 2018). Transmigrant farmers certainly bring their habits, customs, and culture, including in terms of selecting cultivated plant species. The two tribes have long interacted and lived in harmony and peace. The two tribes ap-

ply an agrisilviculture system in managing their agricultural land. For this reason, research was conducted on considerations in selecting plant species. Research on considerations and reasons for selecting plant species and the contribution of the agrisilviculture systems to farmer household income in relation to tribe differences has never been revealed. Therefore, this research is very important to be conducted to reveal considerations in selecting plant species, the composition of plant types developed, the income of local and Javanese transmigrant farmers, and the contribution of the agroforestry system to farmer household income.

Material and Methods

Time and research location

This research was conducted from June to October 2023 in four villages, namely Tabarano, Balambano, Ledu-Ledu, and Perumpanai Villages, Wasuponda District, East Luwu Regency, South Sulawesi. The area of Wasuponda District is 1244 km². The research area is classified as a lowland tropical rainforest with an altitude of 391–950 m a.s.l. According to data from the Makassar Class I Meteorological Station, the research area's climate falls under Type A based on the Schmidt and Ferguson classification. The average air temperature is 22.68 °C with a minimum air temperature of 14.60 °C and a maximum of 31.8 °C. The average area of land owned by local farmers is 1.5 ha with a range of 0.5 – 4.0 ha, while transmigrants own 1.2 ha with a range of 0.5 – 2.0 ha (Central Statistics Agency of East Luwu Regency 2022). The research location is illustrated in Figure 1.

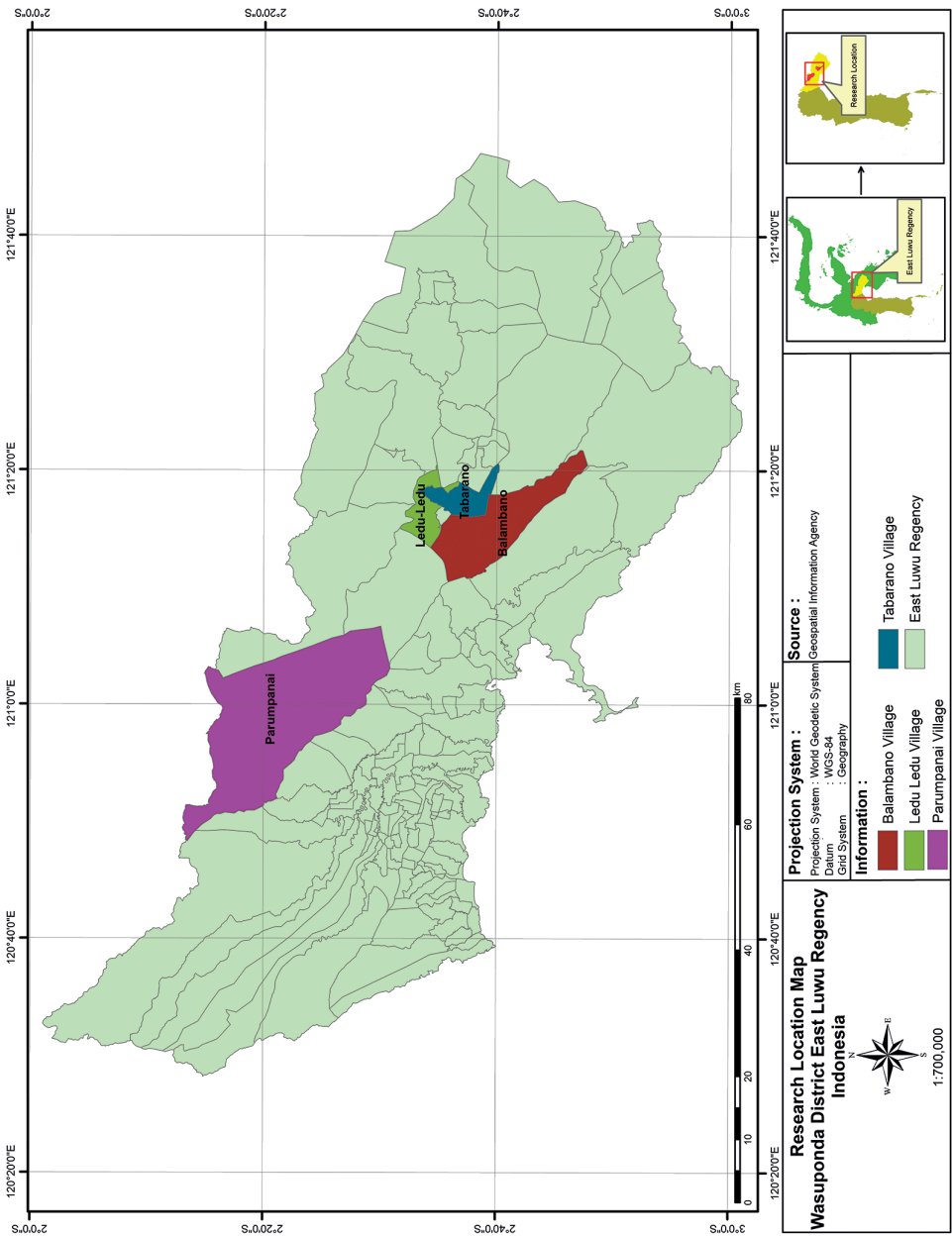


Fig. 1. Research location map.

Data collection

The research method used was survey and structured interview. Determination of respondents and sampling plots were carried out using the Purposive Sampling method with the criteria that respondents had a minimum land area of 0.5 ha and implemented an agroforestry system. The number of interviewed respondents were 45 people consisting of 25 local tribe farmers (Luwu) and 20 Javanese transmigrant farmers. Socio-economic data were obtained by conducting interviews based on a previously created questionnaire. Vegetation surveys were conducted on 20 sampling plots to obtain data on plant types, plant height and diameter.

Data analysis

The obtained data and information were tabulated and analysed using formulas. The stem volume of the trees was determined using formula (1).

$$V = G \cdot H \cdot q, \quad (1)$$

where: V is stem volume of trees, m^3 ; G is tree base area ($\pi \cdot d^2 \cdot 4^{-1}$), m^2 ; H is total height, m ; q is bar form number (0.8).

Mean annual increment by volume per year that occurs up to a certain period. It was determined using formula (2).

$$Z_v = V_t \cdot t^{-1}, \quad (2)$$

where: Z_v is mean annual increment, $m^3 \cdot yr^{-1}$; V_t is tree stem volume at age t , m^3 ; t is age, years.

The cost analysis was done using formula (3).

$$TC = FC + VC, \quad (3)$$

where: TC is total cost, $IDR \cdot ha^{-1} \cdot yr^{-1}$; FC is fixed cost, $IDR \cdot ha^{-1} \cdot yr^{-1}$; VC is variable cost, $IDR \cdot ha^{-1} \cdot yr^{-1}$ (1 $IDR = 58 \cdot 10^{-6}$ € and 1 € = 91.41 IDR – at the rate as of November 02, 2024).

The revenue analysis was done using formula (4).

$$TR = P \cdot Q, \quad (4)$$

where: TR is total revenue, $IDR \cdot ha^{-1} \cdot yr^{-1}$; P is price of product, IDR ; Q is production obtained in an agroforestry system business (wood's product, m^3 ; or commodity, food and vegetables, kg).

The income analysis was done using formula (5).

$$I = TR - TC, \quad (5)$$

where: I is income, $IDR \cdot ha^{-1} \cdot yr^{-1}$; TR is total revenue, $IDR \cdot ha^{-1} \cdot yr^{-1}$; TC is total cost of production, $IDR \cdot ha^{-1} \cdot yr^{-1}$.

The contribution of agroforestry systems to farmer household income was done using formula (6).

$$I_{af} = I_{hr} \cdot 100 \cdot I_{tot}^{-1}, \quad (6)$$

where: I_{af} is the percentage of income from the agroforestry system, %; I_{hr} is total income from the agroforestry system, $IDR \cdot ha^{-1} \cdot yr^{-1}$; I_{tot} is total household income of farmers, $IDR \cdot yr^{-1}$.

Results and Discussion

Considerations for selecting plant species

The most important thing to consider in designing an agroforestry system is what products are produced, how to choose the right type of components, determine how the components are arranged and how to fully support environmental factors. The results of the study showed that the selection of plant types in the agroforestry system by farmers was mostly based on economic factors, both by local tribes and Javanese transmigrants.

A total of 22 plant species were developed in the agroforestry system by local tribes, there were 19 plant species among

them based on economic considerations and only 3 types of plants were chosen based on ecological considerations. Likewise, with Javanese transmigrants, there were 17 plant species chosen based on economic considerations and only 2 plant species chosen based on ecological considerations. The factors considered by farmers in choosing plant species in the agroforestry system are presented in Figure 2.

Figure 2 explains that the main factor that farmers consider in choosing plant species is the economic factor. This is different from that stated by Murthy et al. 2016, Mukhlis et al. 2022 that the purpose of developing agroforestry is not only the economic aspect but also various aspects, such as ecology and environment, aesthetics and culture, social status of farmers and mitigation and adaptation to climate change. However, in line with the research results of Prabawani et al. (2024) that farmers prioritize meeting the basic needs of their households while still considering land sustainability as a secondary matter. Subsistence farmers

always prioritize family needs over the interests of natural resource sustainability, for example maintaining land fertility, preventing erosion. Also, in line with Wolle et al. (2021), Fahad et al. (2022), Jinger et al. (2022), and Salceda-Gonzalez et al. (2024), agroforestry can overcome various environmental problems, such as land degradation, climate change, and loss of biodiversity.

Although both tribes have introduced several plant species from the Fabaceae family that can fertilize the soil (El Sabagh et al. 2020), such as gamal (*Gliricidia sepium* (Jacq.) Steud.) (Beedy et al. 2010, Aroonluk 2021, Camelo et al. 2021, Alamu et al. 2023, Kisaka et al. 2023, Maier et al. 2023) and sengon (*Paraserianthes falcataria* (L.) Greuter & R.Rankin) (Elfis et al. 2023, Ristanu et al. 2023), farmers of both tribes do not understand and do not mention ecological considerations (increasing soil fertility). Gamal plants are chosen and planted only to replace the function of tajar (poles for climbing pepper plants) (Prasmatiwi et al. 2024). Tajar is very expensive because it is made of

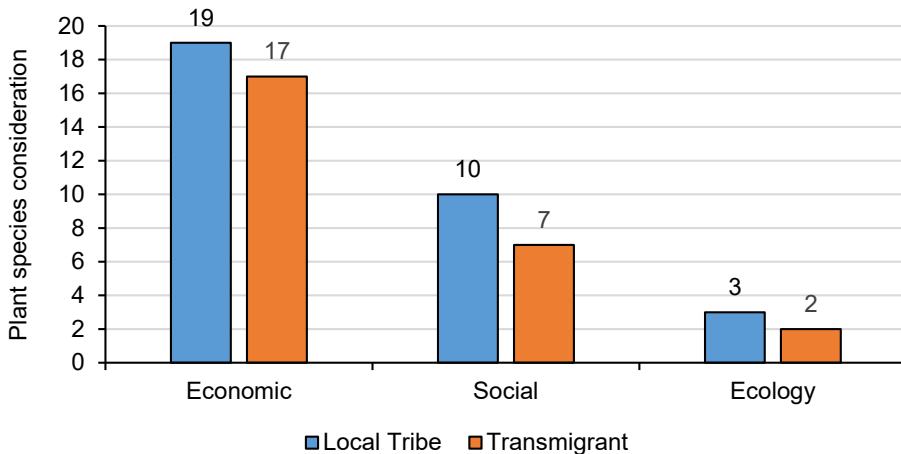


Fig. 2. Considerations for selecting plant species in agroforestry systems by local tribes and Javanese transmigrants.

strong and durable wooden poles (not easily attacked by insects). This indicates that ecological factors have not been widely considered in the selection of plant species for agroforestry systems, both among local tribes and Javanese transmigrants. This is in contrast to Zada et al. (2022) in Shangla and Swat districts, Khyber Pakhtunkhwa Province (KPK), Pakistan, that small-scale agroforestry provides non-financial benefits, such as environmental sustainability, higher living standards, less soil erosion, and shade.

Socio-cultural factors, farmers have not been the main consideration in selecting plant types, unlike the Toraja tribe, who make socio-culture the main factor in selecting agroforestry component types (Millang et al. 2024). It seems that farmers have not planted plant species related to customs and socio-culture, such as petai (*Parkia speciose* Hassk.) and jengkol (*Archidendron pauciflorum* (Benth.) I.C. Nielsen) among Javanese transmigrants. This is different from Javanese farmers in Temanggung and Magelang Regencies, who like petai and jengkol vegetables as traditional food ingredients, so that both plant species are developed and combined with woody plants, fruits, and food crops, such as suren, durian, and rice in their agroforestry system (Pralawani et al. 2024). The same thing was found in plant species that are often used for traditional food 'Bugalu/kapurung' by local tribes, such as 'patikala' (*Etilingera elatior* (Jack) R.M.Sm.) and 'kadundung' (*Spondias pinnata* (L.f.) Kurz) were not found in the study. Factors that are more often conveyed by farmers as socio-cultural considerations, such as easy to plant, easy to harvest and short harvest time, and can be used by themselves. This gives an illustration that cultural factors are less considered in the selection of plant species.

Plant species composition

The results of the study showed that the agroforestry system applied by farmers of both tribes is simple agroforestry characterized by the presence of one or two species of main plants, such as pepper in local tribes and tomatoes in transmigrants. The number of plant species planted by each farmer, both local and transmigrants, is very limited. Timber and fruit crops as tree components and high-value commodity crops and vegetables as agricultural components. The number of plant species found was 27, classified into 4 groups, namely timber crops, fruit crops, commodity crops, food and vegetables. The number of plant species is relatively the same between local tribes and Javanese transmigrants, namely 22 and 18 species respectively. The composition of plant species found in the agroforestry system of local and Javanese transmigrant farmers is presented in Table 1 and Figure 3.

Table 1 shows that the composition of plant species in the agroforestry system consists of 27 species spread across 20 families with a sample plot area of 2.0 ha. The limited number of plant species cultivated by both tribes is due to the simple agrisilviculture system applied. Simple agrisilviculture systems generally have a limited species structure and composition due to the presence of one or two plant species that are prioritized. The number of plant species found is less when compared to several research results on agroforestry systems in tropical and subtropical areas, namely Eyasu et al. (2020) found 32 species and 20 families; Negash (2021) found 59 species and 36 families; Vibhuti et al. (2019) found 70 plant species; Afentina et al. (2020) found 101 species and 34 families; and Millang (2009)

Table 1. Composition of plant species in the agroforestry system of local tribes and Javanese transmigrant farmers.

No	Plant species			Number of respondents		
	Name in Indonesia	Scientific	Family	Local tribe	Javanese transmigrant	Both tribes
1	Merica	<i>Piper nigrum</i> L.	Piperaceae	17	0	17
2	Durian	<i>Durio zibethinus</i> L.	Bombacaceae	16	5	21
3	Gamal	<i>Gliricidia sepium</i> Jacq.	Fabaceae	14	5	19
4	Rambutan	<i>Nephelium lappaceum</i> L.	Sapindaceae	11	8	19
5	Langsat	<i>Lansium domesticum</i> Corr	Meliaceae	10	5	15
6	Kakao	<i>Theobroma cacao</i> L.	Malvaceae	9	5	14
7	Alpukat	<i>Persea americana</i> Mill.	Lauraceae	9	13	22
8	Mangga	<i>Mangifera indica</i> L.	Anacardiaceae	8	11	19
9	Cengkeh	<i>Syzygium aromaticum</i> L.	Myrtaceae	7	5	12
10	Kapuk	<i>Ceiba pentandra</i> L.	Malvaceae	6	4	10
11	Jati putih	<i>Gmelina arborea</i> Roxb.	Verbenaceae	4	4	8
12	Jabon	<i>Neolamarckia cadamba</i> Roxb.	Rubiaceae	4	5	9
13	Sukun	<i>Artocarpus altilis</i> (Parkinson ex F.A.Zorn) Fosberg	Moraceae	3	0	3
14	Jagung	<i>Zea mays</i> L.	Foaceae	2	0	2
15	Nangka	<i>A. heterophyllus</i> J.	Moraceae	2	9	11
16	Kemiri	<i>Aleurites moluccanus</i> L.	Euphorbiaceae	2	0	2
17	Aren	<i>Arenga pinnata</i> Merr.	Arecaceae	2	0	2
18	Vanili	<i>Vanilla planifolia</i> A.	Orchidaceae	2	0	2
19	Sengon	<i>Paraserinthes falcataria</i> L.	Fabaceae	2	0	2
20	Sawit	<i>Elaeis guineensis</i> Jacq.	Arecaceae	2	0	2
21	Lombok	<i>Capsicum annum</i> L.	Solanaceae	1	14	15
22	Buah naga	<i>Hylocereus polyrhizus</i> Rose	Cactaceae	1	0	1
23	Kacang panjang	<i>Vigna unguiculata</i> L.	Fabaceae	0	5	5
24	Buncis	<i>Phaseolus vulgaris</i> L.	Fabaceae	0	5	5
25	Tomat	<i>Solanum lycopersicum</i> L.	Solanaceae	0	14	14
26	Kangkung	<i>Ipomea aquatica</i> (Parkinson ex F.A.Zorn) Fosberg.	Convolvulaceae	0	4	4
27	Sawi	<i>Brassica chinensis</i> L.	Brassicaceae	0	4	4

found 32 species in a 4.0 ha sample plot in a house yard in Pattalikang Village, Gowa Regency, South Sulawesi. Likewise, when compared to the results of a study of the yard agroforestry system in Southwest Bangladesh, which found 419

species (Kabir et al. 2010); yards in South and Southwest Ethiopia were found to have 206 species (Kassa et al. 2022). The number of plant species developed by farmers is relatively small because each tribe develops certain types of plants that

are considered main crop and other plants are only complementary. Local tribes prioritize commodity crops, such as pepper and cocoa, while Javanese transmigrants prioritize food crops and vegetables, such as tomatoes and chilies. With both tribes, each having one or two main/superior plants that are given more growing space, other plants have less opportunity to get space. Especially transmigrants, who plant more tomato and chili species that require full light, so other plants that can provide shade will be cut or pruned. Thus, the number of species developed by both tribes is limited.

Figure 3 shows that plant species planted by local tribes and Javanese transmigrants are divided into 5 categories. There are differences between the two tribes, namely that Javanese transmigrants tend to develop and cultivate food crops and vegetables, while local tribes tend to plant commodity crops, such as pepper, cacao, and cloves. Local tribes plant cash crops because local people have relatively larger land than Javanese transmigrants. In

addition, Javanese transmigrants generally do not have additional income outside the agroforestry system, so Javanese transmigrants prioritize daily needs, such as food and vegetables to fulfil their lives. This is by what was stated by Wanderi et al. (2019), who stated that the composition of various plant species will have different impacts on the income that will be received by farmers. In addition to the main types of plants, farmers also plant various secondary crops, which serve as shade plants and additional income sources (Prasmatiwati et al. 2020, Novasari 2022).

Revenue

The study results revealed that income sources for local and transmigrant Javanese agroforestry farmers originated from four categories, namely timber crops, fruit crops, food and vegetables, and commodity crops. The amount of farmer income in each category varies. The amount of income for local and transmigrant Javanese tribes is presented in Figure 4.

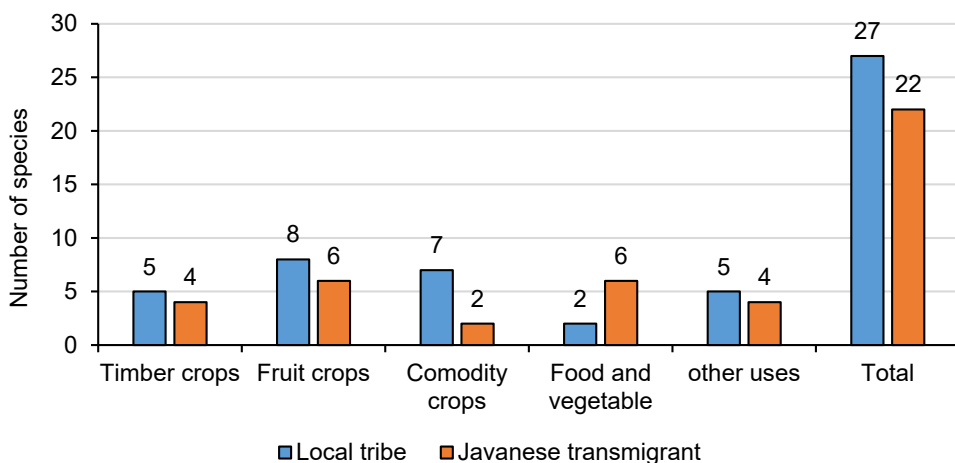


Fig. 3. Composition of agroforestry plant species categorized by local tribes and Javanese transmigrants.

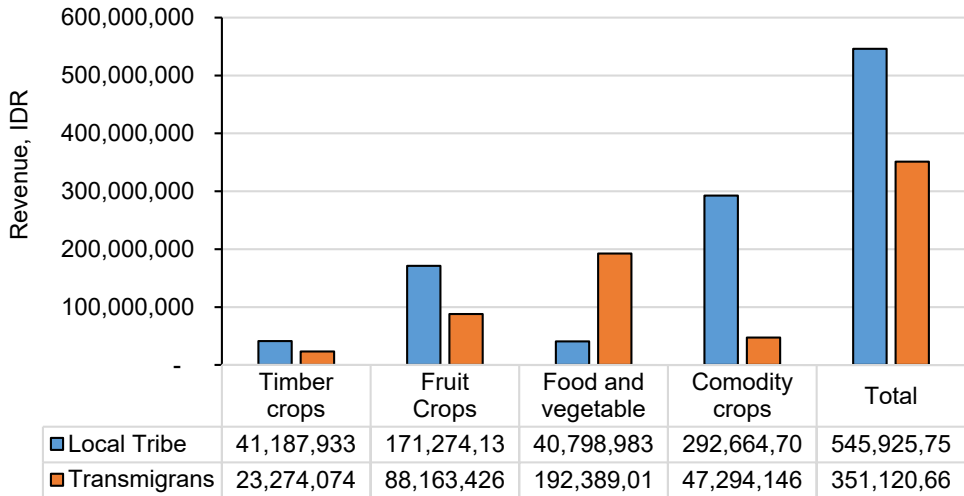


Fig. 4. Category of sources and amount of income of agroforestry farmers in local tribes and Javanese transmigrants.

Figure 4 shows that the largest revenue of local tribes comes from commodity crops of IDR 292,664,704 and fruit crops of IDR 171,274,130, while for Javanese transmigrant farmers from food crops and vegetables of IDR 192,389,015. The difference in the amount and group of revenue between local tribes and Javanese transmigrants is due to differences in the focus of management and selection of plant species. Local tribes focus on the management and selection of commodity crops and fruits (Hendri et al. 2023), while Javanese transmigrants focus more on the management and selection of food crops and vegetables. This is in line with the statement of Duffy et al. (2021) that agroforestry systems contribute to food access, income, health, environmental stability and climate change resilience. If the management of the agroforestry system is commercial and focuses on one type of commodity crop, such as coffee, the income that can be obtained from that one type is 54 %, while traditional agro-

forestry systems allow greater access to plants that have medical benefits. In addition to differences in plant species, differences in revenue can also be influenced by the knowledge, experience, and culture of each tribe. Fruits, animal feed, wood, logs, and cash generation are the main productive roles of this tree species. In addition, these trees also have agroecological services through increasing soil fertility, controlling erosion, mitigating climate change, and conserving biodiversity (Lelamo 2021).

Figure 4 shows that the income from the tree component producing sawnwood and firewood is the lowest, this is because the number of trees planted by each farmer is very limited, the price of wood at the research location is very cheap (ranging from IDR 200,000 – 3,500,000 m⁻³) and the harvest period is long. This is in line with the results from the study by Lehmann et al. (2020) that the gross margin received from the tree component for wood chips is relatively small, even 3 times smaller than

the establishment cost, while the revenue from the agricultural component, namely winter wheat, is very large, even 6 times greater than the production cost. Thus, farmers are generally reluctant to plant trees unless there is a subsidy due to the longer payback period.

Income

The results of the study showed that the average income obtained by local and transmigrant farmers was different and that local farmers were higher than transmigrants. The average income of local and transmigrant farmers is presented in Figure 5.

Figure 5 shows that the income of local farmers is greater than that of transmigrant, local farmers earn an average income of IDR 19,992,447 $\text{ha}^{-1}\cdot\text{yr}^{-1}$, while transmigrant Javanese farmers only earn IDR 15,994,783 $\text{ha}^{-1}\cdot\text{yr}^{-1}$. This is because local farmers tend to develop commodity crops and fruits that are more expensive and stable in the market, such as pepper, cloves, and cocoa, while transmigrant farmers tend to develop food crops and vegetables, such as tomatoes and chilies that are unstable and cheaper. Local

tribes plant and develop more high-value fruit and cash crops, while they develop less food crops and vegetables because local food sources (staple foods) already exist or are available, either in the form of paddy fields or sago. Meanwhile, transmigrants plant and develop more vegetables that have a short life span, so that they can earn income in a short time to meet their families' daily needs. The same thing was stated by Molla (2019) that the main reason farmers implement the agroforestry system is to earn income and meet their family's food needs.

The average income of agroforestry farmers of the two tribes (local/Luwu and transmigrants/Java) of IDR 18,215,707 $\text{ha}^{-1}\cdot\text{yr}^{-1}$ is greater when compared to the income of agroforestry farmers in Parungpanjang Bogor of IDR 16,780,000 (Desmiwati et al. 2021). Likewise, the average income of agroforestry farmers in the Kendeng Mountains Area, Java, Indonesia, was IDR 14,390,771 $\text{ha}^{-1}\cdot\text{yr}^{-1}$ (57.43 % of the total household income of IDR 25,071,029 yr^{-1}) Santosa et al. (2023). However, it is smaller when compared to the income of agroforestry farmers in Sukoharjo 1 Village, Pringsewu Regency, Lampung, Sumatra of IDR 50,142,696 $\text{ha}^{-1}\cdot\text{yr}^{-1}$ (Olivi et

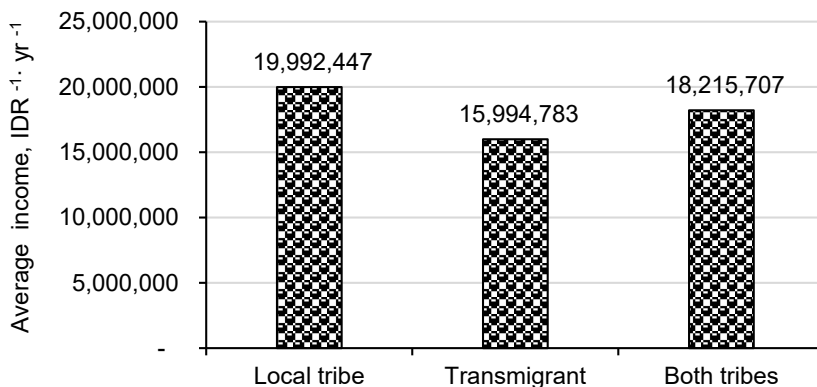


Fig. 5. Average income of local and transmigrant Javanese agroforestry farmers.

al. 2015) and agroforestry productivity in Marena, Enrekang Regency, South Sulawesi of IDR 20,512,208 $\text{ha}^{-1}\cdot\text{yr}^{-1}$ (Samrin et al. 2024).

The results of the study showed that there was a difference in income between local tribes and transmigrants, local tribes generated higher incomes. This could be due to differences in the area of cultivated land owned and the types of crops planted. The average area of land owned by local tribes and transmigrants was 1.5 and 1.2 ha, respectively. There is a tendency that the wider cultivated land owned, the higher income received. Likewise, the suitability of plant species selected and planted also plays a major role in increasing income. If expensive commodity plant species (cloves, pepper, cocoa) are widely planted, farmers' income tends to be higher and vice versa, if the agroforestry system is dominated by sawn wood trees, the income tends to be lower (Duffy et al. 2021, Millang et al. 2024).

The average income received by farmers from the agroforestry system in both tribes was 18,215,707 $\text{ha}^{-1}\cdot\text{yr}^{-1}$, with a range of IDR 8,753,000 to IDR 37,312,778

$\text{ha}^{-1}\cdot\text{yr}^{-1}$. District minimum wage (DMW) of East Luwu Regency in 2024 were IDR 3,434,298 per month (Central Statistics Agency of East Luwu Regency 2024). The income obtained by farmers from the agroforestry system when compared to the DMW of East Luwu Regency is equivalent to 44.20 % of the DMW. This shows that the agroforestry system is an important source of income for farmers (Achmad et al. 2022) and makes a major contribution to the income of farmers in local tribes and transmigrants (Duffy et al. 2021). Therefore, it is necessary to encourage the implementation of an agroforestry system so that farmers' land is more productive and sustainable.

Contribution of agroforestry

The results of the study show that the contribution of agroforestry systems to the average income of local farmers and Javanese transmigrants varies greatly. The contribution of agroforestry systems to the household income of local farmers and Javanese transmigrants is presented in Figure 6.

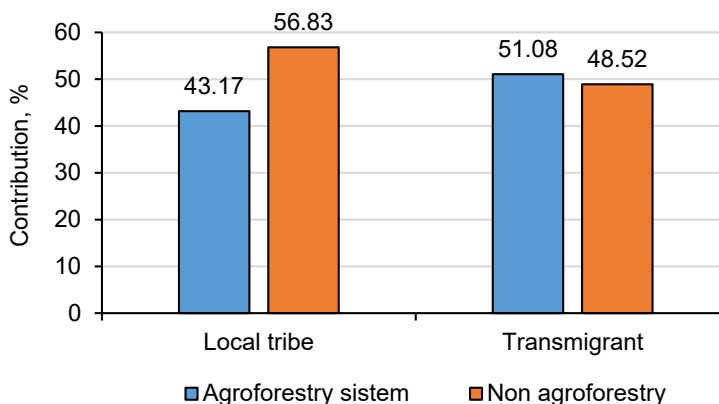


Fig. 6. Contribution of agroforestry systems to household income of local and transmigrant farmers.

Figure 6 shows that the contribution of the agroforestry system to the household income of local tribal farmers is small, and vice versa, for transmigrant farmers the contribution is large, namely 43.17 % and 51.08 %, respectively. The difference in the contribution of the agroforestry system is because local tribal farmers have other jobs besides being farmers. In local tribes, some work as employees of mining companies and sales businesses, in addition to farming agroforestry. Thus, income outside the agroforestry system is greater. This is in line with what was stated by Salatalohy et al. (2019) and Diniyati and Achmad (2020), that farmers do not only have one type of job that they rely on but have other jobs to meet their family's needs. On the other hand, for transmigrants, the contribution is greater because their main job is generally as agroforestry system farmers, so their income outside the agroforestry sector is small.

The contribution of the agroforestry system, especially for transmigrants, is quite high when compared to the results of Zerihun's research (Zerihun 2021), which reported that the contribution of the agroforestry system in the Eastern Cape Province of South Africa was <10 %. However, it is in the same range when compared to the report by Sudomo et al. (2023), that the agroforestry system of smallholder farmers contributes to farmers' income by 51–54 % and if semi-commercial can support 57 %. Likewise, the research results of Santosa et al. (2023) reported that the contribution of the agroforestry system to the household income of farmers in the Kendeng Mountains Area, Indonesia, was 57.43 %. But in contrast to the research results of Murniati et al. (2022) on the cocoa-based agroforestry system as an alternative to resolving land use conflicts in conservation forest areas contributed to

the total income of farmers by 75.63 %.

Conclusions

The selection of appropriate plant species and the proper management of agroforestry systems are influenced by tribe and also have significant implications for farmers' income. The agroforestry systems developed by both tribes tend to be simple agroforestry systems, namely prioritizing one type of plant, especially high-value commodity crops. Local tribe farmers and transmigrants cultivate a relatively limited variety of crops, 27 species from 20 families. Local tribe tend to focus on high-value commodity crops, such as pepper and cocoa, while transmigrants primarily cultivate vegetables, such as chilies and tomatoes. The primary factors influencing the selection of plant species by both local tribes and transmigrants are economic considerations, while ecological and socio-cultural factors are given less priority. The average income of local farmers from agroforestry systems (IDR 19,992,447 ha⁻¹·yr⁻¹) is higher than that of transmigrants (IDR 15,994,783 ha⁻¹·yr⁻¹), as local tribes generally grow high-value, stable-price crops. However, the contribution of agroforestry to the household income of local farmers (43.17 %) is lower than that of transmigrants (51.08 %), since transmigrants predominantly rely on agroforestry, whereas local tribal farmers engage in additional occupations outside agroforestry. To enhance agroforestry systems of both tribes, it is recommended to introduce plant species from the Fabaceae family and improve the spatial arrangement of crops to minimize interspecies competition. These improvements could increase farmers' incomes and help maintain soil fertility.

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