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Tumpangsari as Agroforestry Practices in Gunung Arjuna-Lalijiwo Forest Reserve, East Java, Indonesia

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Abstract

Agroforestry is a land that uses a management system in which trees are mixed in the same land with food crops or pasture for domestic animals. The interactions were reflected in community-based activities by utilizing forest land to cultivate crops using *tumpangsari* agroforestry system. The study was conducted at the Karangploso sub-district in Tawangargo, Donowarih and Ngenep villages in Universitas Brawijaya Forest (UBF) forest reserves. The objectives of this study are to examine factors contributing to the total area of cultivated land from *tumpangsari* agroforestry and to assess the impact caused by the transition of the forest management system on the socioeconomic in terms of income. Data was gathered through questionnaires, in-depth interviews, and site observation. This study applied the dominant quantitative approach and less dominant qualitative as well as convenience sampling technique. Descriptive and multiple linear regression analyses have been used to analyze socio-economic factors contributing to the total area of cultivated land. The study revealed that the income of *tumpangsari* farmers at UBF have increased after five years of transition, from IDR1M - 2M to IDR 2M - 3M monthly. The highest income are from respondent who cultivated coffee, vegetables and other crops range between IDR 3M - IDR 4M or 10.1% of the total respondents and 1.7% earned more than IDR 4M monthly. In addition, 82.29% of farmers strongly agreed that UBF management play an important role in helping farmers in *tumpangsari* agroforestry practices to increased their family income.

Key words: Agroforestry community; Socioeconomic; Tumpangsari agroforestry; Livelihood

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1. INTRODUCTION

Forest play an important role in reducing poverty around the world in two ways. First, the forest serves as a vital safety net, helping rural people get out of poverty or helping poor people reduce their suffering. Secondly, forests have several potentials that are still untapped to assist some people living in the rural to live out of poverty (Sunderlin et al., 2005). In agroforestry, land-use planning involves the systematic assessment of forestland and its potential for various land uses. It is driven by the need for improved management and a different pattern of land use, as dictated by changing circumstances. To avoid the deeper pressure of tropical forests, the various aspect of sustainable management may be applied as the solution.

Implementation of agroforestry as a technique is considered as a sustainable management system for land that increases production and ecological stability and supports sustainable development. This system can assist in various short, medium and long term benefits both for local farmers and government. This system provides cash income to the farmers and a diverse range of products. The environmental benefit of agroforestry is the protection of soils and water resources, microclimate, sequestration of carbon, and the high degree of spontaneous regeneration, which allow conservation of a proportion of the original forest biodiversity.

1.1 International Agenda on Sustainable Use of Land

The governments worldwide took bold and decisive action by adopting the 2030 Agenda for Sustainable Development (UN, 2015). Since then, the 2030 Agenda and its 17 Sustainable Development Goals (SDGs) have become the overarching framework for sustainable development. The universal and inclusive nature of the 2030 Agenda commits the international community to act together to overcome the multiple and complex challenges facing the world in the twenty-first century.

Sustainable land use is that which meets the needs of the present while, at the same time, conserving resources for future generations. This requires a combination of production and conservation: the production of goods needed by people, combined with the natural resources. Production depends on ensuring continued production in the future. The use of land resources, including soils, water, animals, and plants for the production of goods, meets changing human needs while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions. The rural populations living surrounding the forests are usually large, impoverished and growing. In particular, the population growth has led to an increase while straining the earth's natural resources at the same time (FAO, 2018). According to Mayers and Vermeulen (2002), agroforestry has many advantages compared to other sectors offering the potential means out of rural poverty. It can also provide resource safety nets. In more specific, forest ecosystems offer several services, including supplies of timber, wood fuel (charcoal and firewood) and non-wood forest product, water purification, stabilization of local climate and preservation of biodiversity (MEA, 2005).

1.2 Agroforestry Management System

Agroforestry is a land-use that involves the deliberate combination of trees and/or shrubs with crops and/or animals to benefits from resultant ecological and economic interaction (Nair, 1993). It is the simultaneous management of land in terms of the production of crops and trees. Many farmers follow this system to utilize their limited land efficiently. In general, there are commonly three basic sets of components that consist of an agroforestry system; (i) tree, (woody perennial), (ii) herbs (agricultural crops including pasture aspects); and (iii) animals. In fact, agroforestry has been developed as an interface between agriculture and forestry in order to respond to special needs and conditions. It will restore a part of the lands that have been degraded. Agroforestry also can improve rural livelihood and enhance the integrated management of the natural resource base.

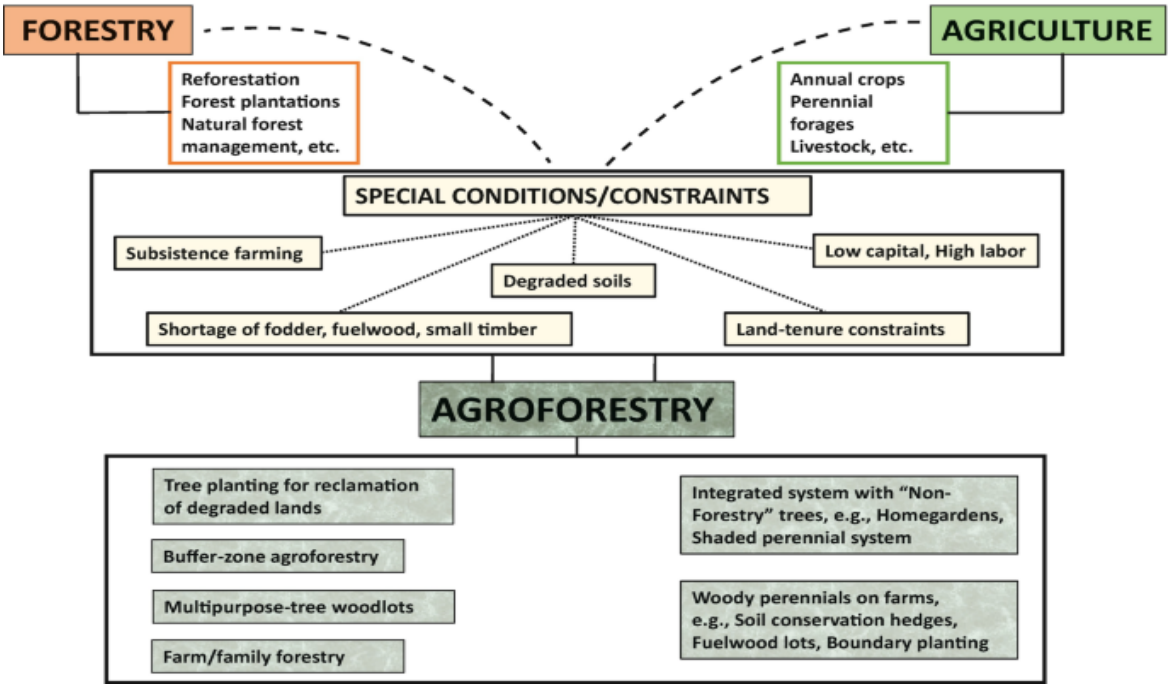

Figure 1
The concept of agroforestry through an interface between agriculture and forestry (Source: Nair, 1993)

The emergence of the concept of agroforestry in response to the special needs and conditions of tropical developing countries **(Figure 1).** A few significant factors need to be considered in developing these land management systems namely; (i) subsistence farming, degraded soil, low capital, efficient utilization of labor, fuelwood, and small timber.

According to Nair (1993), agroforestry systems be classified into four categories which based on their structure and its functions; namely (i) agrisilvicultural

systems, includes all practices in which trees and crops are integrated, namely, alley cropping, shifting cultivation, multipurpose trees, multi-layer tree gardens, and or shrubs on farmland, home gardens, windbreaks and shelterbelts, live-hedges, fuelwood production and integrated multi-storey mixtures of plantation crops; (ii) silvopastoral system, includes protein banks which is multipurpose fodder trees on/or around farmland live fences on fodder edges and shrub trees and shrub on pastures as well as integrated production of animal and wood; (iii) agrosilvopastoral systems, includes home garden practice with breed animals, multipurpose woody hedgerows and integrated production of all crops, animals and wood; (iv) others, includes multipurpose woodlots, apiculture with trees, and aquaculture in mangrove areas.

2. HISTORICAL ASPECTS OF FORESTRY BUREAUCRACIES IN INDONESIA

In Java, forestry bureaucracies control vast land areas. Many such agencies were formed during the colonial era to generate revenues for the government and protect state forest resources. As population and state controls on forest land have expanded, the conflict between forestry agencies and local communities over land access has increased. Various studies have been conducted pertaining to the importance of tumpangsari in sustaining the socioeconomic of rural communities, such as by Kustanti (2021), Kartasubrata et al. (1995), Sunderlin (1997), Stoney & Bratamihardja (1990), Aminudin, (1998), Ambayoen et al., (2021) to determine the potential of tumpangsari programs on alleviating the socioeconomic problems of the rural forest communities in Indonesia. Other studies on the ecological history of the forest in relation to the government policy and involvement of rural people in the tumpangsari program over time in Java have been studied by some scholars (Geertz 1963; Peluso 1992; Boomgaard 1997; Nawiyanto 2009).

In East Java, the swidden farming system in the regency was seriously changed due to the Dutch Colonial Government policy. Slash and burn or swidden farming system was legally prohibited. Cutting trees and burning the forest are considered as disturbing forest and soil fertility (Kools, 1935). Ironically, at the same time the forest areas of the highlands were enormously cut and dramatically converted to the commercial garden through the cultural system (*cultuur stelsel* or *tanam paksa*), which was practiced in 1830-1870 (Gertz, 1963). Johannes Van den Bosch later introduced the cultivation system in the form of tax in Indonesia in 1830. It replaced land taxes owed to the Dutch with a requirement that one/fifth of village land was used to grow cash crops for the colonial government.

During the period of cultivation system, most forest areas were predominantly planted with various comodities crops, including tobacco, pepper, coffee, and cinchona, considered commercial commodities and highly demanded in Europe. Large area of virgins forest in the area's highland was inevitably opened (Boomgaard 1997). Coffee and indigo are major products for export instead. The colonial government fixed the price of the crops so that the Dutch were guaranteed a profit when they sold the produce in European markets. The policies imposed by Van den Bosch may have been the saving of the Dutch state, but they spelt disaster for the Javanese. It is because only a very small amount of people benefited from the system and have led to famine and environmental damage.

2.1 The Agrarian Law

Mass destruction of forest for agriculture activities lead to the introducing of agrarian law. The law was introduced at the end of the cultural system in 1870. Based on the agrarian law, the forest land was leased to landlords for approximately seventy-five years. The law focuses on the unification of agrarian regulations in order to create a unified agrarian legal system.

The agrarian principle stated that all people have access to their lands in order to secure their happiness and prosperity, as well as to ensure that the people are treated fairly. The agrarian law which has remained effective up to the present moment was developed partly on the basis of the purposes and principles of the colonial government and partly out of the influences of the said government. It is, therefore, in conflict with the people's and State's interests in the completion of the current national revolution and in the implementation of overall development. The agrarian law is dualistic in nature, given that adat (customary) law is also effective in addition to the former, which is based on western law. In addition, to the indigenous people, the colonial agrarian law does not guarantee any legal certainty (Act No.5,1960).

Since the Dutch Colonial, the rural people of East Java have been employed in forest-related activities as laborers, such as in the tumpangsari forest (Peluso, 1992). After independence in 1945, the former Dutch plantation was taken over by the Indonesian government. The production forest was managed by the Forest Service (Dinas Kehutanan) of West Java and later by the State Forestry Corporation (Perhutani).

3. *TUMPANGSARI* AS AGROFORESTRY PRACTICES IN INDONESIA

The application of *tumpangsari* in Indonesia agrarian community has a long tradition. Consequently, there is an extensive body of empirical knowledge on using and managing the trees and associated crops. In addition, the economic productivity of the product is relatively well documented, but more tree studies should be undertaken (Kartasubrata, 1979). The commonly used method in Indonesia for reforestation of both clear-felled

and degraded areas is the taungya (locally called the *tumpangsari*) system. *Tumpangsari* is an agroforestry system adopted in Indonesia to establish forest plantations. *Tumpangsari* means co-occupation for a limited period, and the occupants are agricultural crops in the forest area (Kartasubrata, 1979). In this system, landless farmers receive 0.25 hectares of forest land on which they have to plant trees and cash crops until the third year, and the labour wage is paid in-kind with the yields of the cash crops. Table 1 shows the classification of *tumpangsari* based agroforestry activities by structural components.

During the Dutch colonial era, forest villagers provided labor force in forest plantations and in return they received temporary land access for dry land farming activities in between the main forest trees. This activity is subsequently well known as *tumpangsari*. Perum Perhutani, or the State Forestry Corporation, adopted this kind of reforestation system later after independence in response to declining land holdings in rural areas that could lead to forest encroachment. The size of land holdings in rural areas declined. When taungya or *tumpangsari* was widely applied in Java as a reforestation system, the system attracted landless peasants since it provided a piece of arable land for agricultural crops for a certain period (Peluso, 1990). This method of reforestation was also adopted after independence in 1945 by the State Forestry Corporation (SFC or Perhutani in Indonesian) in forestry development programs such as the prosperity approach (1972-1982), the forest village development program (1982-1986), the social forestry program (1986-1995) and the integrated village development program (1995-1999).

Table 1
Classification of *tumpangsari* based agroforestry activities by structural components

System	Description	Examples of practices
1. Agrosilviculture	Intercropping of timber and fuelwood species and annual/ seasonal crops.	Alley cropping, multistorey agroforestry, home gardens, shelterbelts and windbreaks.
2. Silvopastoral	Combining tree species and domesticated animals in managed grazing lots.	Browsing banks, trees in rangelands, plantation crops with pastures and animals.
3. Agrosilvopastoral	Integration of trees and/or shrubs, crops and animals in managed farming units.	Multipurpose woody hedgerows, home gardens with animals, apiculture with trees, silvofishery.

Source: Nair, 1993

The development of *tumpangsari* system in Indonesia has increased the growth of the main species of forest trees and the yield of food crop species (Sukandi, 1993). It was initially intended to plant forest trees that are combined with annual crops and contribute both directly and indirectly to the forest rural households income. Farmers can also extend the contract to the end of the forest trees rotation period. Rural forest villagers are only allowed to grow annual (and not perennial crops) such as coffee, maize, cassava, and other vegetation that can contribute to their well-being from their *tumpangsari* land.

The *tumpangsari* practices are oriented more towards the subsistence needs of the participants. Therefore, it is not surprising that more *tumpangsari* resources are allocated to fulfil household purposes instead of commercial crop development. According to Mayers and Vermeulen (2002), agroforestry activities such as *tumpangsari* have many advantages compared to other sectors in offering the potential means out of poverty and providing resource safety nets. The positive trend of *tumpangsari* land use indicates that forest villagers increasingly demand participation in the *tumpangsari* program. Unfortunately the lands available for *tumpangsari* are becoming more and more scarce. As a result, the *tumpangsari* land area becoming smaller in size ranging between 0.5ha to 3.0 ha.

4. METHODOLOGY

4.1 Study Site

The study was conducted in Universitas Brawijaya Forest (UBF) at Karangploso (Figure 2). This sub-district consists of nine villages namely Ampeldento, Bocek, Donowarih, Girimoyo, Kepuharjo, Ngenep, Ngijo,Tawangargo and Tegalgondo. Karangploso is directly adjacent to Singosari district in the north, and to the east is Malang City. To the south, the village is bordered by Dau and Junrejo districts. In the west, this sub-district is bordered by Bumiaji district, Batu City.

The total area of the area (UBF) according to Decree of the Minister of Environment and Forestry of the Republic of Indonesia Number: 676 / MenLHK-Setjen / 2015 covering an area of ± 514 (Five Hundred and Fourteen) hectares as Education and Training Forest (Forest Training). UB Forest's topography/slope conditions are divided based on three classes, namely 0-8% covering an area of 40.97 Ha, > 8-15% covering an area of 484.89 ha, and > 15% covering an area of 23.81 ha. The average rainfall per year is 250 mm, with an average temperature of 270^{C}. There are three soil types in the UB Forest area: brown alluvial soil, brown latosol, and grey regosol.

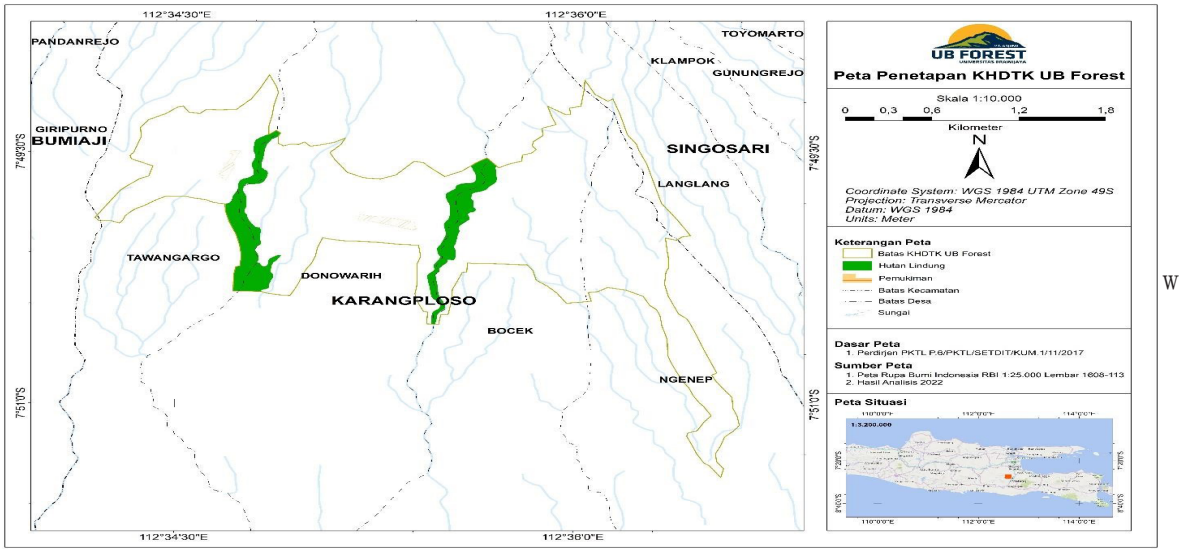

Figure 2
Map for land designation for KHDTK UB Forest.

Source: UB Forest, 2022

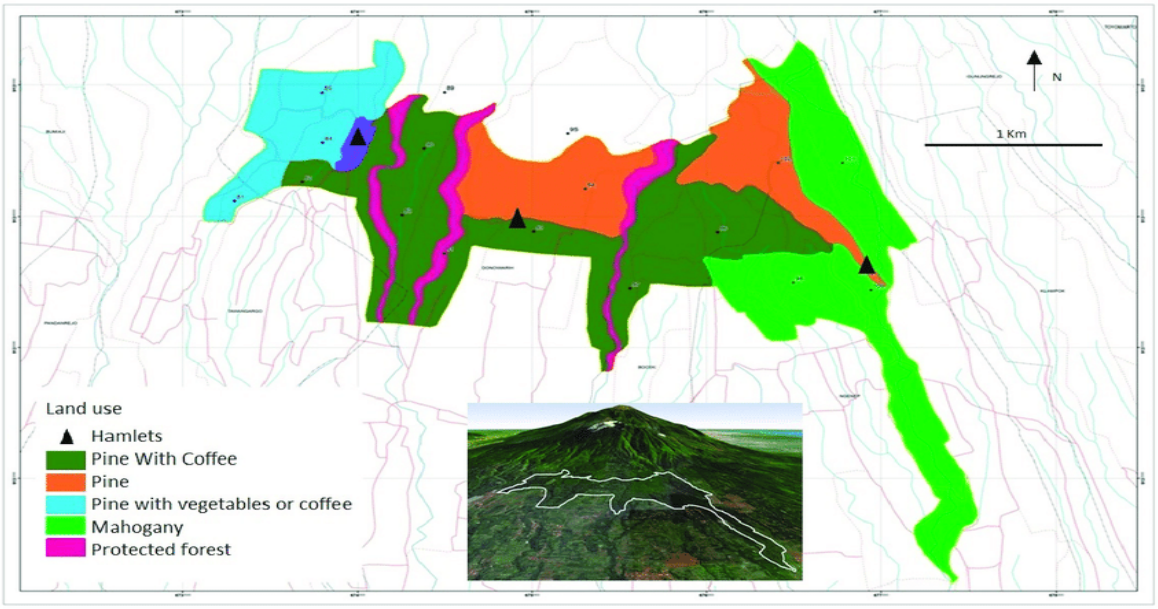

Figure 3
Forest cover at the study site.
Source: UB Forest, 2022

4.2 Data Collection

Data collection was carried out from 18 Mac 2022 to 29 June 2022. Four techniques of data collection were applied, which are questionnaire survey, interviews and site observations. Primary data consists of a questionnaire distributed to selected 350 respondents. In-depth interviews and site observations were conducted to gather additional and details information. Secondary data were collected from literature review through the journal, articles and government official documents. The questionnaire has three parts, namely part A, part B and part C. For part A, it was about respondent demographics, part B pertaining to village community social activities related to the forest and part C collected forest produce and their socio-economic. Data collections have been analyzed by using the descriptive and multiple linear regression.

4.3 Results and Discussion

Forest Area with Special Purpose (KHDTK) UBF was inaugurated on 19th September 2016. UBF forest area (544.74 ha) located on Mount Arjuna, Malang, East Java,

Indonesia. This forest has functions such as protected areas, research areas and production areas. As production area, this forest has many agriculture commodities that have been developed, such as coffee, mustard, carrot and cabbage with pine and mahogany stands. UBF forest playing an important role for education, agricultural production and marketing.

The UBF was located at an altitude of 1,200 meters (a.s.l.) and its forest cover consists of pine (80%) and mahogany (20%) (Figure 3). It is suitable climate for highlands vegetables such as mustard greens, cabbage, chilli and carrots. Other commodities crops and resources in the UBF are pine and coffee.

In terms of economic activities in the forest areas, the villagers are allowed to collect non-timber products for example, leaves, bark, lianas, honey beekeeping, herb for natural medicines, promoting ecotourism etc. Other include shrubs, thickets (*bischoffia javanica*), dadap (*erythirma lithosperma*), anggrung *(trema orientalis)*, ringin *(ficus benjamina)*, kesek *(muntingia calabura),* gondang (*ficus variegata*), bamboo (*bambusa spp*.), tepus (*etlingera solaris*), ferns (*cycas spp*.), puspa (*schimawallicii*), eucalyptus (*eucalyptus spp)*, calliandra *(calliandracallothyrsus),* and others.

The conservation of protected forest for coffee plantations highly contributed and utilizing space for non-forest needs by planting coffee plants. Traditionally, coffee has a reputation of being of lower quality. Desperately, farmers picking both ripe and unripe beans, which were then sold to intermediary buyers in the area. Poor marketing system led to farmers selling their entire crop for a low price. As a result, poor farmers could not have return investment to their attached smallholdings. After the transition of management, monitoring by UB management, with comprehensive masterplan implementation, the farmer currently have better capability to produce high-quality coffee with higher value added. The sustainable and secure marketing system has been developed where UB playing an important role to promote the product exclusively. Such economic activities could be able to strengthen the forest community and avoid social disparities.

4.4 Community and the UB Forest

The current interaction between the community and the forest area is UB Forest area has been established for a long time. The people who live around the UB Forest area are dominant as farmers who depend on their resources economy in the surrounding forest, including the UB Forest area. UB Forest has very fertile land supported by alternating air, rain and heat, causing everything planted in this regency to thrive and produce dollars. The community cultivates forest land used for cultivation or planting annual and seasonal crops. Previously the UB Forest area was a forest area managed by Perhutani, one of the Indonesians Government agencies under the Ministry of Forestry. The UB Forest surrounding community focused on the planted plants, but the community also tapped pine trees. The proceeds from the tapping of the pine sap were transferred to Perhutani. Some of the community said that the tapping could increase their income and fill the vacancies for farmers while waiting for the crops to be harvested. However, some people are happy with the elimination of tapping on pine trees. This is because the community does not have to look for pine sap or buy it elsewhere if the target set by Perhutani for tapping results is not met. Currently, people who have cultivated land in an area that has become the UB Forest area are asked to stop tapping and focus on coffee plants. Coffee plants become plants that are expected to produce continuously and can be marketed as well known by the wider community.

Practically, the people who live in Dusun Sumbersari and Dusun Sumberwangi have arable land in the forest area, which is currently the UB Forest, but also owns land outside the UB Forest area and cultivates it. The crop product by the community is usually sold directly to the middleman but not to the coffee planted in the UB Forest area. Instead, the yields of the coffee plants grown in the UB Forest area is transferred to UB Forest. The formation of a farmer group and one of the activities for women in Dusun Sumbersari and Dusun Sumberwangi, namely Posdaya, illustrates that the people living in the village have good relations with each other and can accept a change for the progress of the community's economy. This is evidenced by the socialization activities that are often carried out in the village.

4.5 *Tumpangsari* and Cultivated Crops

Pine *(pinus)* and mahogany *(swietenia macrophylla)* are the most common species planted in the UBF. Other plants are annual and seasonal crops, such as coffee, ginger, turmeric, carrots, green beans, mustard greens, cabbage, chillies, eggplant, banana, and corn. Table 2 shows that he crops cultivated using *tumpangsari* agroforestry system, home garden agroforestry system and forest product collected are for their own consumption or sale to the middleman. The *coffea arabica, coffea canephora* and *persea americana mill* are examples of coffee planted in the UBF. Other are for food, medicinal and cosmetic value and *zingiber officinale roxb.*, *piper betle L.* is cultivated for its therapeutic value. For handicraft and building material they collects *bambusa sp*. and *musa paradisiaca L., manihot esculenta, solanum lycopersicum* and *capsicum frutescens* are cultivated for sale and personal consumption. The plantation sector in Sumbersari, Sumberwangi and Tumpangrejo hamlet is still dominated by traditional smallholders. In UBF, 250ha of land are planted with more modern techniques of coffee plantations (arabica and robusta). Other smaller scale products are garlic, passion fruit macadamia (*macadamia integrifolia L*). vetiver (*vertiveria zizanioides*) and patchouli (*pongostemon cablin*).

Table 2
Crops and forest products cultivated through *tumpangsari* agroforestry system

Species cultivated using *tumpangsari* AF system at UBF	Local name	Own consumption	Sale	Utilization
Coffea arabica	Kopi arabika		√	For food/cosmetic /medicine
Coffea canephora	Kopi robusta		√	For food/cosmetic /medicine
Persea americanaMill	Alvokat/ Apoka'		√	Food/cosmetic & Medicine
Musa paradisiaca L.	Pisang/Punti	√	√	Food & Medicine
Zingiber officinaleRoxb.	Jahe/ Laiya	√	√	Food & Medicine
Manihot esculenta	Pucuk ubi	√	√	For food
Solanum lycopersicum	tomat	√	√	Food
Allium sativum	garlic	√	√	Food & Medicine
Dimocarpus longan	mata kucing / longan		√	For food
Pometia pinnata	matoa/ Longan		√	For food
Annona muricata Linn	Sirsak/ Sarikaya balanda	√	√	Food & Medicine
Carica papaya L.	Pepaya/Kaliki	√	√	Food & Medicine
Capsicum frutescens	Cabe/cili	√	√	For food
Brassica oleracea var.capitata	kubis	√	√	For food
Brassica	sawi	√	√	For food
Daucus carota subsp.sativus	wortel/ lobak	√	√	For food
Pomelo citrus maxima	Jeruk		√	For food
Citrus aurantifolia (Chrism) Swing	Jeruk nipis/ Lemo tadi		√	Food & Medicine
Durio	durian	√	√	For food
Piper betle L.	Sirih/ Bolu		√	Food & Medicine
Hylocereus undatus	Buah Naga	√	√	Food & Medicine

Source: Field study (2022)

4.6 Factors Contributing to the Total Area of Cultivated Land by Farmers From *Tumpangsari* Agroforestry System

The land is one of the capitals of farming. Respondents who have a profession as a farmer from Sumbersari, Sumberwangi and Tumpangrejo hamlets use forest land as a cultivated area with annual crops and seasonal crops using the *tumpangsari* agroforestry method. However, the findings show that not all of the respondents' land in the UB Forest has the same size of cultivated area. The number and percentage of respondents based on the area of arable land owned in which they produced crops in the UB Forest area as shown in Table 3.

Table 3
Cultivated land area in UBF

Cultivated Land Area In UB Forest (ha)	Respondents from three (3) Hamlets	
	Number (Person)	Percentage (%)
< 0.5 ha	6	1.7
0.5-1.0 ha	94	26.9
1-1.5 ha	120	34.3
1.5-2.0 ha	91	26.0
> 2.0 ha	39	11.1
Total	350	100.0

Source: Field study (2022)

Based on the Table 3, most of the respondents (34%) or 120 persons, operate a cultivated crop in a land area between 1.0 to 1.5 ha size in UB Forest. This was followed by 29.9% (94) of them owning an area of 0.5 to 1.0 ha. Ninety-one farmers (26%) cultivated land area between 1.5 to 2.0 ha, and 39 farmers or 11.1%, cultivated land more than 2.0 ha. Finally, only six farmers or 1.7% of the respondents, cultivated land less than 0.5 ha.

Multiple linear regression analysis was used to determine the magnitude of the influence between the independent variable (size of land) and the dependent variable, the relationship between each positive or negative independent variable, and the independent variable's predicted value. For analysis (Y) as the dependent variable (size of land), as well as the length of work in the forest (LB), the number of species crop (M), length of education (TP), income (PEN), and a number of members family (JAK) as the independent variable. Table 4 shows the multiple regression results and coefficient of determination (R2).

Table 4
Results of Multiple Linear Regression and coefficient of determination (R^2)

Model	Unstandardized Coefficients
	B
(Constant)	2.011
LB	-0.115
M	0.110
TP	-0.062
PEN	-0.161
JAK	0.100

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.746a	0.556	0.479	0.366

a. Predictors: (Constant), LB, M, TP, PEN, JAK Model

Source: Primary Data Processed (2022)

Based on the analysis, the equation of multiple linear regression equation can be made as follows:

Y = 2.011 - 0.115LB + 0.110M - 0.062TP - 0.161PEN + 0.100JAK + e

Where,

Y = The area of land cultivated by the community in the UB Forest area (Ha)

i = Respondent i (i = 1,2,.....n)

0 = Regression constant or intercept

1 - 5 = Regression coefficient

LB = Length of work in the forest (years)

M = Number of plant species (number of plant species)

TP = Level of education (years)

PEN = Income (rupiah per month)

JAK = Number of family members (persons)

e = Standard error

The equation shows the effect of each independent variable (length of work, number of types of plants, income, and number of family members) on the dependent variable (size of the area). Therefore, the regression coefficient can be interpreted as follows:

a. The constant value is known to be 2.011, which states that if the variable length of work, number of plants, number of plants, income, and number of family members is zero (0), then the value of the area of arable land is constant at 2,011.

b. The value of the regression coefficient (B) of the variable length of work is -0.115 showing that the change in length of work in one year will change the area of arable land by -11.5% with the assumption that the variable other independent remains.

c. The value of the regression coefficient (B) of the variable number of plant species is 0.110, which shows that changes in the number of plant species in one plant type will change the area of arable land by 11.0% with the assumption that the variable other independent remains.

d. The value of the regression coefficient (B) of the income variable is -0.161, showing that the change in income in one rupiah will change the area of arable land by -16.1% with the assumption that the variable other independent remains.

The value of the regression coefficient (B) of the variable number of family members is 0.100, which shows that changes in the number of family members in one person will change the area of arable land by 10% with the assumption that the variable other independent remains.

The coefficient of determination of the regression model shows the magnitude of R^2 is 0.556. The assumption obtained is that the effect is explained by the variation of independent variables, namely length of work, number of plant species, level of education, income, and number of family members to changes in the value of the area of arable land in the UB Forest area by 55.6%.

The explanation of the remaining percentage is 44.4% is a factor outside the model that also affects the broad dependent variable arable land in the UB Forest area. Therefore, the standard Error of Estimate (SEE) was obtained at 0.366, assuming that the smaller the SEE value indicated, the regression model more precisely predicted the dependent variable.

The resulting coefficient of determination is also supported by previous research conducted by Pasha & Agus (2009) in Bukit Barisan National Park in the South. They found that the magnitude of the influence of the socioeconomic factors of the community includes the number of family members, length of stay, level of education, income, duration of land use, age, and amount of land occupied (field) to the area of forest land use. Therefore, the coefficient value is determined to be less than 50%, only 48.4%, while the rest is caused by factors other than the socio-economic factors of the community.

4.7 Assessing the Impact Caused by the Transition of the Forest Management System on the Socioeconomic By Income

One critical aspect is the respondents income in these three hamlets. Based on the income we can explain the socioeconomic conditions of the household within the community. Result from the interviews in the three hamlets revealed that the respondents strongly agreed that there is a significant income difference during Perhutani system and after the UBF transition in 2016. In the early stage, there was no difference in income for the UB Forest farmers. However, from the studies done in 2017 and 2018, some farmers said that their income was reduced because UB Forest management stopped pine tapping and they lost their income during Perhutani management. But now, their income has increased from implementing the UB Forest management master plan strategy with knowledge sharing, collaboration, marketing strategy, exploration of new opportunities, and other factors. As a result, their income from the three hamlets ranges from IDR 500,000 to more than IDR 4,000,000 monthly. Table 5 shows the respondent's income from the three hamlets under UB Forest management.

Table 5
Respondent's income (UBF management) from the three hamlets

Income (IDR)	Respondents from three hamlets	
	Number (Person)	Percentage (%)
100rb-1M	7	2.0
1M-2M	103	29.4
2M-3M	198	56.6
3M-4M	36	10.3
> 4M	6	1.7
Total	350	100.0

Source: Primary Data Processed (2022)

Most respondents have an income between IDR 2M - 3 M (56.6%), followed by respondents with an income between 1M - 2M (29.4%). The third one is the respondents with an income between 3M - 4M (10%).

At the same time, the lowest income gain is between 100 thousand - 1M, which is (2.0%). The highest income represents 1.7%, where the income is more than 4M.

Table 6
Respondent's income (PERHUTANI management) from the three hamlets.

Income (IDR)	Respondents from three (3) Hamlets	
	Number (Person)	Percentage (%)
100rb-1M	40	11.4
1M-2M	192	54.9
2M-3M	110	31.4
3M-4M	8	2.3
>4M	0	0.0
Total	350	100.0

Source: Primary Data Processed (2022)

Table 6 shows that during Perhutani management, most of the respondents earned between 1M - 2M, which is 192 respondents (54.9%), followed by 110 respondents with an income between 2M - 3M (31.4%). On the other hand, forty respondents earned less than 1M monthly (11.4%), then only eight respondents earned the highest income monthly from these three hamlets, which is between 3M - 4M (2.3%). Therefore, the average income from Perhutani management for the three hamlets, Sumbersari, Sumberwangi and Tumpangrejo, was low. The difference between the monthly income gained by the respondents during Perhutani and after the transition to UB Forest management in 2016 as shown in Figure 7**.**

However, some respondents/farmers earn income from other sources. Respondents who earn low monthly income usually only get to sell their yields from crops that can be harvested in a matter of days or weeks. For example, from most chayote plants respondents cultivated around the house, based on the respondent's information, chayote plants can be picked every three days and produce 2 to 5 kg yields. At the same time, other plants can also be harvested to increase income, namely chilli plants cultivated around the house and producing 7 to 10 kg weekly yields. Other income is also obtained from working as agricultural laborers.

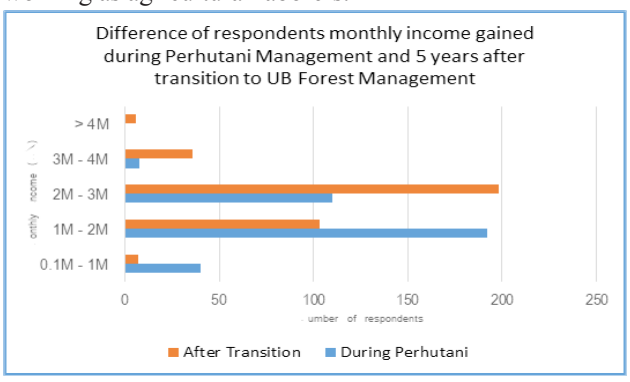

Figure 7
The difference between the monthly income gained by the respondents during Perhutani and after the transition to UB Forest.
Source: Data processed (2022)

Based on the interviews, respondents informed that they usually earn wages as farm laborers for men between IDR 45,000 to 50,000 per day, while women earn IDR 35,000 to 40,000 per day. Respondents who earn moderate income usually look for another job to earn more income to feed their needs. Respondents, apart from being farm laborers, also work as laborers in construction, giving them up to IDR 75,000 to 80,000 per day. Besides that, there are also several respondents who work as laborers in a plantation outside the hamlet area with a wage greater than farm laborers. Others also earn from selling fruit and work outside hamlets such as motorcycle taxis, grab and other petty trading.

5. CONCLUSION

The potential of agroforestry to simultaneously provide economic, environmental, conservation, and social benefits to agroecosystems are rapidly being recognized by federal and state agencies, universities, and conservation organizations. The need for and interest in agroforestry are national, but specific needs and priorities vary by region and institution. This study revealed that the community in UBF at Sumbersari, Sumberwangi and Tumpangrejo hamlet at Karangploso, intensively practised *tumpangsari* agroforestry system. The UBF area consists of four areas covering pine forests, pine-coffee agroforestry, pine-vegetable agroforestry and mahogany-coffee agroforestry. In the UB Forest, not all farmers have the same size of cultivated area. Based on the analysis done on multiple linear regression, most farmers (34%) operate a cultivated crop in a land area between 1.0 to 1.5 ha size in UBF. The regression coefficient of determination (R^2) is 0.556. This is explained by the variation of independent variables, namely length of work, number of plant species, level of education, income, and number of family members, to changes in the value of the area of arable land in the UBF area by 55.6%. This study concluded that more than half of the respondents in UBF agreed and satified the transition of forest management from Perhutani to UBF because it significantly improved their socioeconomic, social interaction and infrastructure facilities. The result revealed that there's a significant difference between the farmers' income during the Perhutani system and after the transition to UBF in 2016. The *tumpangsari* farmers income at UBF increased after five years of transition, from IDR1M - 2M to IDR 2M - 3M monthly. The highest income ranges for the respondent who cultivated coffee, vegetables and other crops using *tumpangsari* method in UBF range between IDR 3M - IDR 4M or 10.1% of the total respondents, and there are 1.7% of respondents gained income more than IDR 4M monthly. A total of 82.29% of farmers strongly agree that UBF had contribute to promote and escalated their income through sustainable *tumpangsari* agroforestry techniques.

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