Study on the Impact of Agroforestry Intercropping Activities on Increasing Farmers' Income through the Social Forestry Program

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Abstract: Research in the KPH Malang reforestation park contract area aims to determine the level of dependence of farmers on forest resources and the role of Perum Perhutani in increasing farmers' income with the Agroforestry Tumpangsari system forestry program. This research requires empirical data that explains the effect of implementing intensification on productivity, income levels and efficiency of farmers participating in social forestry programs. The research results show that the influencing variables are capital, production results, and the number of program participants. Apart from that, there is a difference between the income of program participant farmers and non-program participant farmers. The government's efforts to conserve forests and carry out reforestation can be carried out well with cooperation between Perhutani and program participant farmers.

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INTRODUCTION

Agricultural development in Indonesia encompasses not only the food crop sector but also fisheries, livestock, plantations, and forestry. These sectors require an integrated approach through intensification, extensification, diversification, and rehabilitation while maintaining the sustainability of natural resources and the environment. In the context of forestry, such efforts aim not only to increase forest production but also to preserve ecological functions. Perum Perhutani, as the state-owned enterprise mandated to manage state forests on the island of Java, faces major challenges in aligning economic productivity with environmental conservation (Azrihisyam et al., 2023).

Communities living around forest areas typically depend on forest resources to meet their daily needs. Limited access to arable land has forced many of these communities to rely on forestland for subsistence farming. According to Soemitro Djojohadikusumo, the average land ownership among poor farmers is only about 0.02 hectares per household. In some forest-adjacent regions, this number is even lower, around 0.01 hectares. This situation often leads to illegal forest exploitation, including timber theft and the conversion of forest areas into

agricultural land (Fleischman et al., 2021; Thompson & Magrath, 2021; Iordăchescu & Vasile, 2023).

This problem highlights the urgent need for synergy between the government, forest managers, and communities to preserve forests while improving local livelihoods. One of the government's key efforts is the Social Forestry Program with the Agroforestry Tumpangsari scheme. This initiative allows communities to legally manage forest areas by cultivating intercropped agricultural plants between forestry trees (Desmiwati et al., 2021).

Agroforestry Tumpangsari is a cultivation system that integrates agricultural and forestry crops on the same plot of land. This system offers both economic and ecological benefits. Economically, farmers can harvest short-term crops planted between the forestry trees. Ecologically, the forestry trees help conserve soil and regulate water cycles. Thus, agroforestry is considered a sustainable solution for forest resource management (Ashiagbor et al., 2020; Plieninger et al., 2020; Ma et al., 2022).

The success of this program depends heavily on the active participation of farmers and institutional support from forest managers. In this context, Perum Perhutani plays a crucial role as a facilitator, providing inputs such as seedlings, fertilizer, and land, as well as offering technical guidance. This collaboration is expected to create a mutually beneficial relationship: farmers gain additional income, and Perhutani ensures the success of reforestation efforts (Hidayat et al., 2024; Kresna et al., 2024).

Agroforestry Tumpangsari is not merely a productivity tool but also part of a sustainable agricultural development agenda. This approach enables the forestry sector to become a driver of local economies while adhering to conservation principles. Such efforts are particularly relevant in the context of rural development and poverty alleviation, which are national priorities (Desmiwati et al., 2021).

This study aims to examine the extent to which the Agroforestry Tumpangsari activities influence the income of farmers participating in the social forestry program in the KPH Malang area. It also seeks to assess the program's effectiveness in supporting farmer productivity and evaluate the efficiency of capital invested by both farmers and Perum Perhutani (Fauziyah et al., 2024).

The research employs not only a descriptive approach but also analytical methods, including regression tests to examine the influence of variables such as capital, production yield, and number of participants on farmers' income. Additionally, a comparative analysis is conducted between program and non-program farmers to identify the tangible economic impacts of the initiative (Reimer et al.m 2018; Muralidharan et al., 2023).

The findings of this research are expected to provide insights for policymakers at both local and national levels in designing community-based forest management strategies. Amidst the government's efforts to ensure national food security, agroforestry stands out as an efficient and inclusive model for integrating forestry and agriculture (Barman et al., 2024; Ghimire et al., 2024).

Moreover, the program's success can serve as a best practice example that may be replicated in other areas with similar characteristics. Thus, the Agroforestry Tumpangsari approach is not merely a local solution but has the potential to be a national strategy for achieving sustainable social forestry (Iskandar et al., 2017; Octavia et al., 2022; Prabawani et al., 2024).

Theoretically, this study supports the paradigm of sustainable development, which combines economic, social, and environmental aspects. By actively involving communities in managing forest resources, it is hoped that a sense of ownership and shared responsibility for environmental conservation will be cultivated (Heras & Tàbara, 2016; Zikargae et al., 2022).

Finally, this article emphasizes the importance of synergy between state institutions like Perhutani and civil society in implementing community-based programs. The success of a development program is determined not only by its design but also by how well it responds to the needs and aspirations of its target communities (Greenhalgh et al., 2016' Ika & Donnelly, 2017; Chimhowu et al., 2019).

METHOD

This study employed a quantitative approach with the primary objective of examining the influence of agroforestry *tumpangsari* activities on the income levels of farmers participating in the social forestry program within the administrative area of the Forest Management Unit (Kesatuan Pengelolaan Hutan/KPH) Malang, East Java. A quantitative method was chosen because it enables researchers to measure the relationships between variables objectively and to test hypotheses using structured empirical data.

The study utilized both primary and secondary data sources. Primary data were obtained directly through structured interviews and the distribution of questionnaires to farmers who are members of Forest Farmers Groups (*Kelompok Tani Hutan/KTH*) and are actively involved in the Social Forestry Program. The questionnaire was designed to gather information on the amount of capital received, agricultural production yields from the *tumpangsari* system, the number of group members, and the income levels before and after joining the program. Meanwhile, secondary data were sourced from official reports provided by Perum Perhutani, harvest documentation, and relevant academic literature.

The study involved two types of variables: dependent and independent. The dependent variable was farmers' income level (Y), while the independent variables consisted of: (1) Capital obtained by KTH (X1), (2) Crop production value (X2), and (3) Number of KTH members (X3). The relationship between these variables was analyzed using multiple linear regression, aiming to determine the partial and simultaneous influence of the independent variables on the dependent variable.

The regression model used in this study is formulated as follows:
$$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + e1$$
Where:

a) Y = Farmers' income level
b) X1 = Capital received (in Indonesian Rupiah)
c) X2 = Crop production value (in Indonesian Rupiah)
d) X3 = Number of KTH members (persons)
e) β_0 = Constant
f) β_1, β_2, β_3 = Regression coefficients
g) ε = Error term

The research sample consisted of farmers who were actively participating in the Social Forestry Program under the *tumpangsari* agroforestry system managed by KPH Malang. The sampling technique employed was purposive sampling, considering farmers' direct involvement in agroforestry activities and regional representation within forest-adjacent communities. A total of 18 respondents were selected, based on the assumption that they adequately represent the socio-economic conditions of farmers involved in the program.

Data analysis was conducted using statistical software (e.g., SPSS or EViews). The analysis included instrument validity and reliability tests, multiple linear regression analysis, F-tests to

evaluate the simultaneous effect of the independent variables on the dependent variable, and t-tests to assess the partial effects of each variable. Additionally, the coefficient of determination (R^2) was used to evaluate how much variation in farmers' income could be explained by the three independent variables.

To compare income levels between participant and non-participant farmers, the study also employed an independent sample t-test (two-sample t-test). This was aimed at identifying any significant differences between the two groups, which indirectly reflects the effectiveness of the program in improving farmers' welfare in state forest areas.

This methodological framework is expected to yield valid and reliable findings that comprehensively explain the actual impact of *tumpangsari* agroforestry activities on farmers' economic conditions. The results of the analysis will also serve as a foundation for policy recommendations to enhance inclusive and sustainable community-based social forestry strategies in the future.

RESULTS AND DISCUSSION
Research Results
Table 1. Income of KTH Participant Farmers Measured by Average Minimum Physical Needs of Workers (in Rupiah/Day)

NO	Net income per farmer KTH	Minimum Physical Requirements	+/-
1	39.500,00	35.487,67	4.012,33
2	39.650,00	35.487,67	4.162,33
3	38.975,00	35.487,67	3.487,33
4	40.100,00	35.487,67	4.612,33
5	41.250,00	35.487,67	5.762,33
6	39.575,00	35.487,67	4.087,33
7	39.800,00	35.487,67	4.312,33
8	42.000,00	35.487,67	6.512,33
9	39.700,00	35.487,67	4.212,33
10	40.000,00	35.487,67	4.512,33
11	38.975,00	35.487,67	3.487,33
12	39.400,00	35.487,67	3.912,33
13	39.600,00	35.487,67	4.112,33
14	39.480,00	35.487,67	3.992,33
15	38.900,00	35.487,67	3.412,33
16	40.700,00	35.487,67	5.212,33
17	40.350,00	35.487,67	4.862,33
18	39.680,00	35.487,67	4.192,33

The results of this study indicate that the Social Forestry Program implemented through the Agroforestry Tumpangsari system has a significant impact on improving the income of farmers residing in the forest-adjacent areas managed by the Forest Management Unit (KPH) Malang. The analysis is based on three main tests: (1) adequacy of farmers' income based on the minimum physical needs standard, (2) multiple regression analysis to measure the influence of capital, production yield, and group size on income, and (3) an independent samples t-test to compare the incomes of participating and non-participating farmers.

In the first test, farmers' incomes were assessed against the minimum physical needs standard in East Java Province, set at IDR 1,064,630 per month. Using data from a sample of 18 farmers and assuming 30 working days per month, the results show that the majority of participating farmers' incomes exceed this minimum threshold after joining the program. This reflects the program's tangible contribution to enhancing the economic capacity of farmers, at least in meeting basic household needs.

Table 2. Data for Two-Tailed Mean Test

Description	Amount for Sample of 18 Poeple (in IDR)	Average
1. KTH		
a. Penerimaan	40.000.000,00	2.222,222,22
b. Biaya Produksi	18.580.900,00	1.032.272,22
c. Pendapatan	21.419100,00	1.189.950,00
2. Non KTH		
a. Penerimaan	20.700.000,00	1.150.000.00
b. Biaya Produksi	12.249.000,00	680.500,00
c. Pendapatan	8.451.000,00	469.500,00

The results of the multiple linear regression analysis revealed that the three independent variables capital provided by Perhutani, crop yields from tumpangsari farming, and number of KTH members collectively have a significant influence on farmers' income levels. The F-test showed that the calculated F value exceeds the critical F value, indicating that the regression model is valid for explaining the relationship between variables. Moreover, the coefficient of determination (R^2) demonstrated a sufficiently high value, suggesting that a substantial portion of the variation in farmers' income can be explained by the three variables.

Individually, the t-tests confirmed that each independent variable significantly affects farmers' income. The capital support, in the form of seedlings, fertilizers, insecticides, and legal access to forest land, significantly increased the farmers' production capacity. Meanwhile, the crops grown through the agroforestry system, which are wholly owned by the farmers, served as a direct incentive for income growth. The number of group members also contributed positively by enabling division of labor and scaling up of agricultural operations, which in turn enhanced group productivity.

The third test, the independent sample t-test, was used to compare the incomes of farmers participating in the KTH program with those who did not participate. The analysis revealed a statistically significant difference between the two groups. The calculated t-value was higher than the critical t-value at the defined level of significance, suggesting that farmers who participated in the Social Forestry Program experienced greater income improvements than those who did not.

These findings were supported by field observations, which showed that non-participating farmers continued to face various constraints, such as limited access to capital, low land productivity, and lack of technical guidance. In contrast, participating farmers received comprehensive support from Perhutani in the form of training, agricultural extension services, and legal access to forest land for cultivation purposes.

Overall, the findings confirm that the collaboration between farmers and forestry institutions under the Social Forestry Program has had a positive economic impact on participating households. With measurable income improvements and better access to

productive resources, the program not only supports forest conservation objectives but also serves as an effective tool for poverty alleviation and environmentally-based rural development.

Discussion

The Role of Agroforestry Tumpangsari in Enhancing Household Income

Agroforestry Tumpangsari plays a pivotal role in enhancing the economic resilience of forest-adjacent communities. By allowing the cultivation of intercrops alongside timber species, farmers gain access to seasonal income while also participating in long-term reforestation efforts. This dual-function approach empowers farmers with tangible economic benefits without compromising forest sustainability.

The empirical findings from this study support those of Desmiwati et al. (2021), who observed that agroforestry systems contributed up to 15.8% of household income in state forest areas. The opportunity to legally farm within forest boundaries creates economic incentives that are crucial for subsistence farmers with minimal land ownership. It also helps reduce forest encroachment by providing formalized access.

Moreover, agroforestry practices offer risk mitigation benefits. Through crop diversification, farmers are less susceptible to price fluctuations and climate variability. This resilience is emphasized by Duffy et al. (2023) and Wijayanto et al. (2022), who noted that the adoption of agroforestry practices enhanced not only farmer income but also food security and environmental awareness in Java's upland communities.

Ultimately, the integration of economic incentives within a conservation framework positions agroforestry Tumpangsari as a win-win strategy for both rural development and ecological sustainability. This strengthens the case for mainstreaming such systems within broader national forestry and poverty alleviation policies.

Capital Provision as a Catalyst for Farmer Productivity

One of the most significant factors identified in this study is the role of capital provision in boosting productivity. Farmers receiving agricultural inputs—such as seeds, fertilizers, and pest control—through Perum Perhutani were found to significantly increase their yields. This capital, though non-cash in form, functions as an investment that enhances input accessibility and operational scale.

This finding is consistent with Setyadi et al. (2025), who noted that access to productive capital and structured support is a prerequisite for agroforestry enterprises to generate sufficient value-added income. Their case study in Central Java showed that model businesses using the agroforestry approach saw improved production consistency and financial viability due to initial capital support.

Furthermore, input provision linked with technical assistance improves resource utilization and knowledge transfer. Farmers are not only equipped with tools but also with know-how on proper application, leading to better outcomes. Rose & Bharadwaj (2023) emphasized that such dual support—material and educational—creates a sustainable loop of productivity and innovation.

By reducing the entry barrier for marginalized farmers, capital assistance serves not just as an economic tool, but as a social equalizer. It opens up participation opportunities and helps farmers transition from subsistence to market-oriented production systems.

The Influence of Farmer Group Participation on Economic Outcomes

Participation in forest farmer groups (*Kelompok Tani Hutan/KTH*) has a significant effect on improving farmers' economic performance. Group-based structures facilitate economies of scale, knowledge exchange, and collective bargaining—enabling smallholder farmers to overcome constraints they would face individually. In this study, the number of group members positively influenced overall income.

This aligns with findings by Shiferaw et al. (2022), who revealed that participation in farmer organizations leads to increased access to training, financial resources, and market opportunities. Their research in West Java showed that collective efforts enhanced productivity by over 25% compared to individual initiatives in similar settings.

Furthermore, group cohesion builds social capital, which is essential in community-based programs. Farmer groups also act as intermediaries in program delivery, enabling institutions like Perhutani to channel resources more efficiently and monitor forest use. This organizational infrastructure supports both conservation and income-generation goals.

Strengthening farmer groups is critical not only for maximizing program impact but also for fostering local governance. Community empowerment through participatory structures plays a central role in sustainable forest management and equitable development.

Income Disparity between Participants and Non-Participants

This study revealed a stark contrast in income levels between program participants and non-participants. Farmers enrolled in the Social Forestry Program reported significantly higher earnings due to institutional support, access to legal land, and input subsidies. In contrast, non-participants often relied on degraded lands with limited productivity.

Such disparities underscore the importance of inclusion and outreach. One of the main challenges in forestry reform is the low awareness and limited administrative capacity of rural communities, preventing them from joining programs that could enhance their livelihoods (Binam et al., 2017; Tirivayi et al., 2018; Ekanayake et al., 2021).

The findings suggest that unless non-participating communities are actively brought into the program framework, structural inequality will persist. Efforts must be made to reduce bureaucratic barriers and provide guidance on the application process to encourage broader adoption.

Therefore, policy responses must ensure the equitable distribution of program benefits. Only through inclusive participation can the Social Forestry Program fulfill its dual mandate of poverty reduction and sustainable forest use.

CONCLUSIONS

The findings of this study affirm that the implementation of Agroforestry Tumpangsari under the Social Forestry Program has contributed significantly to improving the income of forest-edge farmers in East Java. By enabling legal access to forest land for agricultural activities and providing essential capital inputs, the program has offered practical solutions to long-standing issues such as landlessness, poverty, and forest degradation. The income levels of program participants were not only above the minimum physical needs standard but were also statistically higher than those of non-participating farmers, underscoring the program's measurable economic impact.

Furthermore, the analysis reveals that capital support, agricultural productivity, and group participation are key variables influencing farmer income. The structured support

system—through seed provision, technical training, and group organization—demonstrates that the synergy between community-based forest management and institutional assistance is vital for sustainable rural development. Agroforestry Tumpangsari, in this regard, emerges as an integrative model that balances ecological conservation with economic empowerment, aligning with national goals of poverty alleviation and environmental stewardship.

Given these outcomes, it is imperative for policymakers and forestry institutions to expand the reach of the Social Forestry Program, particularly among marginalized communities that remain excluded. Enhancing program awareness, simplifying participation procedures, and strengthening farmer group capacities are critical to scaling its benefits. In doing so, agroforestry not only becomes a mechanism for sustainable forest governance but also a driver of inclusive and resilient rural economies.

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