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Research

Determinants of household income changes following agricultural land-use conversion in Gununghalu, Indonesia

Maura Zhafira Putri [*)1)], **Dini Rochdiani** [1)], **Sara Ratna Qanti** [1)], **Nur Syamsiyah** [1)]

[1)] Universitas Padjadjaran, West Java, Indonesia

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ABSTRACT
Economic challenges and specific policies often trigger land conversion in the countryside. The primary objective of this study is to explore the repercussions of land use change on household income and determine which household types are most vulnerable to the decline in income due to land use changes. The study was carried out in Gununghalu sub-district and used a quantitative approach. Surveys were conducted to collect data, which was subsequently evaluated through multivariate analysis using multiple linear regression to examine the significance of various socioeconomic factors on household income after land conversion. The results showed a positive and significant impact of land area, education, and age on income. In contrast, the number of commodities cultivated exerted a substantial negative influence, although involvement in farmer groups and the number of family dependents shown no significant effect. An other significant conclusion was that households overseeing an excessive number of commodities often encountered reduced revenue, attributed to their constrained ability to manage excessively diversified enterprises. Consequently, non-selective diversification measures may impose a burden on households. This study emphasizes the significance of capacity-oriented agricultural planning and enhancing access to education and land tenure in mitigating the dynamics of land use change.

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INTRODUCTION

Land serves as a natural resource which is vital in the life cycle of all organisms while simultaneously providing the backbone to the economy, society, and ecology of the rural population (Chang, 2024; X. Wang et al., 2022). Sustainable land management aims to equilibrate economic production with environmental sustainability, while also underpinning household economic resilience, particularly within the agriculture sector. Integrating land use

[*)] Corresponding Author

M. Z. Putri | Email: *maura19002@mail.unpad.ac.id*

into an optimal framework for rural development is important for achieving enduring sustainability. Given the focus of existing land use and food policies on short-term and fragmented approaches, integrated planning of rural land use along with the food systems is crucial for fostering sustainability (Jónsdóttir & Gísladóttir, 2023). Land use connects closely with Sustainable Development Goal 15, which aims to protect terrestrial ecosystems (Blanco-Sacristán et al., 2024). SDG 15 highlights the importance of protecting terrestrial ecosystem, in particular via the reduction of land degradation and deforestation, often resulting from unfettered land use change. Land use planning must be based on principles of sustainability and community involvement, while respecting inherent ecological and social functions. Land, managed adequately, can be an important mechanism for reducing poverty and improving household incomes (Dhyatmika et al., 2022; Heger et al., 2020).

In reality, the land is easily abused because of economic necessity and immediate benefit. Land transformation one use to another is a widespread phenomenon in many areas of Indonesia. Such a conversion of land use inevitably affects the availability of cultivated land, regional food security and ecological balance. Types of land conversion can be seen in the form of agricultural land into non-agricultural land, from one type of crop into another and from forest into plantations sparking environmental equilibrium and sustainability concerns (Bai et al., 2024; Dampa et al., 2021; Dewi et al., 2023). In several areas, including West Bandung regency, there is a tendency of land conversion that is perceived as more market-oriented. Such alterations are frequently executed without comprehensive land-use planning and limited supervision, jeopardizing environmental sustainability and the welfare of local residents. Alterations in land use shifts in the region involved the transformation of forest into plantations, evidenced by statistics indicating a reduction in forest area accompanied by a rise in plantation area from 2020 to 2025 (Central Bureau of Statistics of West Bandung Regency, 2025). This alteration in land use choices was probably influenced by economic requirements and the optimizing of agricultural yields (Christian et al., 2021). This economic necessity has intricate effects on income. Land use change does not consistently yield favorable economic results for all community groups (Z. Wang et al., 2022). Certain households may gain by transitioning to high-value commodities, but others may suffer livelihood losses due to diminished access to productive land or the degradation of ecological functions that underpin their economic activity (Jellason et al., 2022).

This study offers a novel contribution by providing micro-level empirical evidence on household income dynamics following agricultural land-use conversion, an aspect that has received limited attention compared to ecological and spatial analyses. Focusing on Gununghalu sub-district, West Bandung regency an area characterized by forest-to-plantation conversion and distinct socioeconomic conditions this research identifies key household-level

determinants influencing post-conversion income changes. By integrating income comparison before and after land conversion with regression-based analysis of socioeconomic factors, this study advances the understanding of how land-use change differentially affects rural households and highlights vulnerability patterns that are often overlooked in macro-level studies (Zhang et al., 2023). Accordingly, this study aims (1) to examine changes in household income before and after agricultural land-use conversion, and (2) to identify socioeconomic factors that significantly influence household income following land conversion in Gununghalu sub-district. The results are expected to provide an empirical basis for land management and rural development strategies that are aligned with local socioeconomic conditions and support sustainable household welfare.

METHOD

Research Sites

This study was carried out in West Bandung regency, particularly in Gununghalu sub-district. This sub-district was intentionally selected due to its substantial land conversion from forest to plantations. The Gununghalu sub-district possesses distinctive geographic and socioeconomic attributes, including mountainous topography, prevalent agricultural enterprises, and the community's reliance on natural resources for everyday necessities. Data was gathered during a duration of one month, from April to May 2025. This era encompassed field observations, interviews with household respondents, and the acquisition of secondary data from pertinent agencies. The timing of this decision included seasonal conditions, people' agricultural practices, and the availability of sufficient field information to acquire representative and pertinent data for the research aims.

Data Collection Technique

Data were collected through a structured household survey conducted in Gununghalu sub-district, West Bandung regency. The target population of this study consisted of plantation-farming households that had experienced agricultural land-use conversion, particularly from forest land to plantation-based agriculture. A total of 100 households (200 respondents husband and wife) were selected as respondents using purposive sampling. To determine the sample size, the Slovin formula is used by specifying the population size, tolerance limits, or confidence level. In this context, the confidence level used is 1%.

$$n = \frac{N}{1 + Ne^2}$$

Where:

n : Number of samples

N : Population size

e : Tolerance limit (error tolerance) or degree of confidence

The number of plantation farming households in Gununghalu sub-district is 4,688 people and the error rate is 1%, the number of samples obtained is 98 households after rounding. The calculation of the number of research samples for Gununghalu sub-district is as follows:

$$n = \frac{4688}{1 + 4688(0{,}01)} = 97{,}9 \approx 98$$

The number of samples used in this study was 98 intact households (containing husband and wife) which were plantation farming households. Two additional households were included to round the total sample to 100, ensuring a more representative and manageable dataset. This technique was applied to ensure that only households directly affected by land conversion were included, as they were most relevant for analyzing post-conversion income dynamics. Respondents were household heads or economically active members who possessed adequate knowledge of household income and land management decisions. Primary data were collected through face-to-face interviews using a structured questionnaire developed based on a review of relevant literature and prior empirical studies. The questionnaire covered demographic characteristics, socioeconomic variables, land characteristics, and factors influencing household income following land conversion.

Data Analysis

This research employs a descriptive quantitative methodology aimed at identifying and assessing factors that affect household income following land conversion in Gununghalu sub-district. Primary data collected via a home survey were carefully processed and analyzed through multiple stages of descriptive and inferential statistical approaches to yield a thorough grasp of the phenomenon under investigation. Descriptive analysis was employed to delineate the characteristics of respondents, encompassing demographics (age, education, number of dependents) and socioeconomic attributes (land area, income, farmer group affiliation). Descriptive analysis approaches are illustrated through minimum, maximum, mean, and standard deviation values to offer a comprehensive summary of the conditions of the examined farming households.

The reliability of the research instrument was first confirmed through internal consistency testing using Cronbach's Alpha, ensuring the instrument was suitable for analysis. Data were then analyzed using multiple linear regression to examine the effects of selected socioeconomic variables on land conversion outcomes. Prior to estimation, a series of diagnostic tests were conducted to verify that the classical linear regression assumptions were met. Construct validity was checked using correlation analysis, while normality,

heteroskedasticity, and multicollinearity were evaluated through standard statistical tests to ensure the data were appropriate for regression modeling.

Multiple linear regression was employed to discover factors that significantly affect household income following land conversion. This method was selected to clarify the statistical association between a singular dependent measure (monthly household income) and several predictor variables presumed to exert influence, including age, land size, education level, social participation, number of family dependents, and number of commodities cultivated (Santosa et al., 2024). The general model of multiple linear regression can be expressed by the following equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \epsilon$$

Where:

Y = Household income
β_0 = Constant
$\beta_1 - \beta_5$ = Regression coefficient
X_1 = Age
X_2 = Land size
X_3 = Education level
X_4 = Social participation (farmer group)
X_5 = Number of dependents in the family
X_6 = Number of commodities cultivated
ϵ = Errors

The interpretation of regression results encompasses not only statistical significance but also the substantive implications of each variable (Adhikari, 2022). If the measure of X_2 (land size) exhibits a significant positive correlation, it indicates that households with bigger land holdings generally experience greater incomes following land conversion. Moreover, the analytical findings are utilized to pinpoint household demographics most susceptible to income reductions stemming from land conversion, so establishing a foundation for developing more focused policy suggestions. Data analysis was done with the help of SPSS 26 software.

RESULTS AND DISCUSSION

Land Conversion and Farmers' Household Income

Most respondents were within the productive age group, indicating that decisions related to land use and household income were largery made by economically active farmers. However, relatively small landholdings, limited formal education, and low income levels suggest levels suggest that some households may have limited capacity to adapt to changes in land use

(Tridakusumah et al., 2022). Although farmer group membership was relatively high, the limited diversification of cultivated commodities may constrain households' ability to maintain income stability after land conversion. The respondent characteristics are presented in Table 1.

Table 1. Respondent Profiles

Variable	n	%
Age (years)		
15-64	190	95
≥65	10	5
Land size (ha)		
<0.5	78	39
0.5-0.99	32	16
≥1.0	90	45
Education level (years)		
0-9	116	58
≥9	84	42
Farmer group membership	**183**	**91.5**
Number of dependents family (people)		
1-3	169	84.5
4-6	31	15.5
Number of commodities cultivated		
1	93	46.5
2	93	46.5
3	12	6
4	2	1
Monthly household income (IDR)		
≤ 6000000	180	90
6000001 - 12000000	13	6.5
>12000000	7	3.5

Source: Data processed by researchers, 2025

Land conversion in Gununghalu sub-district has reshaped agricultural activities and influenced the economic conditions of farming households. The effects vary across households depending on the type of land-use change, the commodities cultivated, and farmers' capacity to manage the converted land productively. In this study, the economic impact of land conversion is measured through changes in monthly household income after the conversion

of land use or commodities cultivated. The distribution of income changes following land conversion is presented in Table 2.

Table 2. The Impact of Land Conversion in Gununghalu Sub-District, West Bandung Regency on Farmers' Household Income

Impact on Monthly Income	Number of Respondents	Percentage (%)
Increased	127	63,5
Remained	57	28,5
Decreased	16	8
Total	**200**	**100**

Source: Data processed by researchers, 2025

The findings indicate that land conversion in Gununghalu sub-district has had varied effects on farmers' monthly household income. Among the 200 respondents, 127 farmers, or 63.5%, reported an increase in income after land conversion, while 57 respondents, or 28.5%, experienced no income change, and 16 respondents, or 8%, reported a decline in income. This pattern suggests that land conversion does not produce a uniform economic outcome, but its effects depend on how converted land is managed, the type of commodity cultivated, and the capacity of farmers to transform land-use change into productive economic activity.

The increase in income among the majority of respondents indicates that land previously used as forest or less economically productive land can generate higher household income when converted into plantation-based agricultural activities. This finding is consistent with Liu et al. (2023), who emphasized that converted land can create new income sources when it is used for productive agricultural purposes. In addition, the positive income effect also aligns with Desmiwati et al. (2021), who found that agroforestry contributes to farmers' household income by integrating forestry and agricultural activities. Therefore, in the context of Gununghalu, land conversion may be interpreted not merely as a physical change in land use, but also as an opportunity for farmers to expand income-generating activities through plantation agriculture and agroforestry systems.

The findings also support Mangatas et al. (2021). who argued that land clearing for agricultural purposes can generate employment opportunities for local communities. In Gununghalu, the conversion process may have increased household income not only through direct farm production, but also through additional labor opportunities created during land preparation, cultivation, and plantation management. Furthermore, the positive impact of land conversion is strengthened when farmers operate at medium or larger scales. This is in line with Haryanto et al. (2023), who showed that larger business scales allow farmers to achieve better technical efficiency, optimize production factors, and improve access to markets and distribution

networks. Thus, the income gains observed among most respondents may reflect the combined effects of productive land use, labor absorption, business scale, and market access.

However, the fact that 28.5% of respondents reported no change in income indicates that land conversion does not immediately generate economic benefits for all farmers. This condition may occur when newly converted land has not yet reached its productive stage, particularly in plantation-based systems that require time before producing optimal yields. This is consistent with Pandey et al. (2024), who noted that early-stage agricultural or land restoration activities may not immediately provide economic returns because production systems are still developing. Therefore, households whose income remained unchanged may be in a transitional phase, where land conversion has occurred but has not yet produced measurable financial benefits.

The decline in income experienced by 8% of respondents further confirms that land conversion may also create economic risks. This finding supports Maxwell (2025), who emphasized that limited management capacity, high production costs, and unstable market prices can reduce the expected benefits of land conversion. Similarly, Olsson et al. (2024) explained that some plantation commodities require a long maturation period, which can delay income generation and temporarily reduce household earnings. In addition, Widyati et al. (2022) and Yaseen et al. (2024) showed that conversion from forest to plantations can reduce soil fertility and disrupt ecological functions, including natural pest control, thereby increasing maintenance costs and lowering initial productivity initial productivity. These previous findings help explain why a smaller proportion of farmers in Gununghalu experienced declining income after land conversion.

Household Income Before and After Land Conversion in Gununghalu

The comparison of household income before and after land conversion reveals a general upward trend in farmers' earnings, indicating that land-use change can enhance income-generating potential under certain conditions.

Table 3. Average Monthly Household Income Before and After Land Conversion

	Min	Max	Mean	Std. Dev
Before	0	15000000	2441750	2188708,91
After	0	20000000	3683750	3492654,49

Source: Data processed by researchers, 2025

Table 3 shows that the conversion of land, when followed by productive agricultural use, may create new economic opportunities and improve household welfare. Such findings are consistent with Chang (2023), who emphasized that land-use change can increase income

potential, although the outcomes depend on local conditions and farmers' capacity to utilize available resources effectively.

However, the observed increase in average income is accompanied by a widening variation among households, indicating that the benefits of land conversion are unevenly distributed. This disparity reflects differences in farmers' access to productive resources, technical knowledge, and the ability to manage newly converted land. In line with previous studies, this suggests that while land conversion can generate economic gains, it may simultaneously intensify inequality in income distribution among rural households.

Furthermore, the presence of households that have not yet generated income after land conversion highlights the transitional nature of agricultural transformation. In the early stages, particularly within a few months after conversion, production systems may not yet be fully established, resulting in delayed economic returns. This condition supports the argument Pandey et al. (2024) that the economic benefits of land-use change are not immediate, but instead depend on the maturity of agricultural activities and the time required for crops to reach productive stages.

Descriptive Statistics

As an initial step in identifying the determinants of household income changes following agricultural land-use conversion in Gununghalu sub-district, a descriptive analysis was conducted to summarize the social, economic, and resource characteristics of farm households. This overview provides important contextual information for understanding variations in income outcomes after land-use change. Descriptive Statistics are presented in Table 4.

Table 4. Descriptive Statistics

	Min	Max	Mean	Std. Dev
Age (year)	25	90	47,82	10,031
Land size (ha)	0,04	12	1,3237	1,82787
Education level (year)	1	16	8,81	3,379
Social participation (farmer group) (yes=1, no=0)	0	1	0,9150	0,27958
Number of dependents in the family	0	5	2,27	1,10599
Number of commodities cultivated	1	4	1,6150	0,64720
Household monthly income (IDR)	150000	19000000	3448500	3013161,71

Source: Data processed by researchers, 2025

Respondents' ages range from 25 to 90 years, with an average of 47.82 years, indicating that income-related decisions following land conversion are largely made by farmers in their productive years. Landholding size varies considerably, from 0.04 to 12 hectares, with an average of 1.32 hectares, suggesting that most households operate on relatively small plots and may be more exposed to income shocks when agricultural land is converted. Educational attainment is modest, with a mean of 8.81 years, which may limit households' capacity to adapt to new economic opportunities after land-use change.

Social participation is relatively high, as most respondents are members of farmer groups, potentially facilitating access to information, support programs, and alternative livelihood options. Household economic pressure is also reflected in the average number of dependents (2.27 persons), which may influence income adjustments following land loss. In terms of production strategies, the average number of commodities cultivated is low (1.62), indicating limited diversification that could otherwise buffer income fluctuations after conversion.

Monthly household income exhibits a wide range, from IDR 150,000 to IDR 19,000,000, with a mean of IDR 3,448,500 and a large standard deviation, highlighting substantial income disparities among households. This variation suggests that while some households are able to maintain or improve income following land-use conversion, others experience significant income declines, underscoring the importance of identifying key determinants of income change, which is the central objective of this study.

The descriptive statistics point to the presence of household groups that are more vulnerable to income changes following agricultural land-use conversion. Limited landholdings, relatively low levels of education, and high dependency ratios indicate constrained productive capacity and reduced flexibility in responding to income shocks after land loss. These structural conditions help explain why income outcomes vary widely across households and are directly relevant to the study's objective of identifying the key determinants of household income changes associated with land-use conversion.

Assumption Tests for Multiple Linear Regression

The reliability of the research instrument was evaluated by measuring internal consistency using Cronbach's Alpha, with coefficient values exceeding 0.70 indicating satisfactory reliability. After confirming instrument reliability, the data were analyzed through multiple linear regression to assess the effects of selected socioeconomic variables on land conversion outcomes. Before estimating the regression model, a series of diagnostic tests were conducted to ensure that the data met the assumptions of the classical linear regression

model. Construct validity was examined using Pearson correlation analysis, in which all questionnaire items were statistically significant at the 5 percent level.

Table 5. Assumption Tests For Multiple Linear Regression

Assumption / Test	Test Used	Value
Instrument Reliability	Cronbach's Alpha	> 0.70
Construct Validity	Pearson correlation	p < 0.05 (all items)
Normality	Kolmogorov-Smirnov	p > 0.05
Heteroskedasticity	White test	p > 0.05
Multicollinearity	Variance Inflation Factor	VIF < 2

Source: Data processed by researchers, 2025

Data normality was assessed using the Kolmogorov-Smirnov test, and the results confirmed a normal distribution as significance values were greater than 0.05. Heteroskedasticity was evaluated using the White test, which indicated homoscedastic residuals based on significance values exceeding 0.05. In addition, multicollinearity was tested using the Variance Inflation Factor (VIF), and all independent variables exhibited VIF values below 2, confirming the absence of multicollinearity concerns. A VIF of less than 2 signifies the absence of substantial multicollinearity among the independent variables (Dalal, 2023). Consequently, it can be inferred that the independent variables employed in the model exhibit no signs of multicollinearity. This enhances the dependability of the regression estimations, as each variable provides a distinct contribution to elucidating variances in household income following land conversion.

Multiple Linear Regression Analysis

This study will advance to the regression analysis phase to statistically ascertain the factors that most significantly affect household income levels in Gununghalu sub-district after land conversion, based on a knowledge of each variable's features. These descriptive findings establish a crucial basis for formulating policies that address the requirements of farming households amid alterations in land use and transformations in local economic frameworks. The results of the regression analysis are presented in Table 6.

These results show that individual characteristics (age, education) and farming characteristics (land area and number of commodities cultivated) have a real influence on household income, while social capital factors and family dependents have not been shown to have a significant effect in the regression model used. The regression analysis results suggest a correlation coefficient (R) of 0.688, signifying a robust association between the independent variables (number of commodities cultivated, number of family dependents, land area, farmer group

participation, education, and age) and household income. The coefficient of determination (R^2) value of 0.474 signifies that 47.4% of the variance in household income is elucidated by the amalgamation of the six predictor variables employed in the model. Concurrently, the Adjusted R Square value of 0.457 refines the R Square value by accounting for the quantity of predictors in the model. The standard error of the estimate, valued at 0.72749, signifies the degree of error in the model's income predictions. These results are relevant to the explanation (Gapurzhanovna, 2025) of how the level of education, productive age, and experience of individuals contribute to increased productivity abilities and economic efficiency which ultimately impacts an increase in household income.

Table 6. Results of Multiple Linear Regression Analysis

Variables	**Unstandardized Coefficients**	**Standardized Coefficients**	**Sig.**
	B	**Beta**	
Constant	1,246	0.435	0.005
Age	0,17	0,006	0,009
Land area	0,240	0,030	0,000
Education	0,094	0,019	0,000
Social participation (farmer group)	0,198	0,138	0,152
Number of family dependents	0,069	0,052	0,186
Number of commodities cultivated	-0,541	0,069	0,000
R = 0,688			
R^2 = 0,474			
F-statistic = 28,952 (p < 0,001)			
N = 200			

Source: Data processed by researchers, 2025

Following the identification of a robust correlation in the regression model, the last stage involved assessing the overall significance of the model. This test utilized analysis of variance (ANOVA) to ascertain whether the concurrently developed regression model could considerably elucidate income fluctuation in comparison to a model devoid of predictors. The ANOVA results establish a crucial foundation for evaluating the model's overall validity prior to the partial assessment of each independent variable (Eye & Wiedermann, 2023).

The findings indicated a computed F value of 28.952 with a significance level of 0.000. Given that the significance value is less than 0.05, it can be inferred that the entire regression model is significant (Eye & Wiedermann, 2023). This implies that one or more independent variables in this model significantly affects household income. The Sum of Squares for the regression

is 91.937, while for the residual it is 102.143, with degrees of freedom (df) of 6 and 193, respectively, signifying a balanced distribution of variation between the explained and unexplained components of the model.

The ANOVA test findings demonstrated that the developed regression model was statistically significant ($p < 0.001$), signifying that the independent variables collectively accounted for substantial changes in household income. Nevertheless, the overall model significance did not specify which variables individually affected income. Consequently, it was essential to proceed with an analysis of the regression coefficients for each independent variable to evaluate the direction, amount, and significance of their partial effects on the dependent variable. According to the findings of the multiple linear regression analysis, four out of the six independent variables examined significantly affected household income following land conversion in Gununghalu sub-district. The land area, education, and age exhibited a positive and substantial impact, whereas the number of commodities cultivated demonstrated a negative although significant effect on household income.

Effect of Age on Household Income

Age had a positive and significant effect on household income after land conversion. This finding suggests that older household members, particularly household heads, tend to have greater farming experience, stronger knowledge of local agricultural conditions, and better decision-making capacity in managing post-conversion land. Although the coefficient of age was relatively smaller than other significant variables, its positive direction indicates that accumulated farming experience remains relevant in supporting household economic adaptation.

The positive effect of age may reflect the ability of older farmers to make more careful production decisions, select suitable commodities, and manage risks based on long-term practical experience. Previous studies have shown that household characteristics, including age and experience, can influence economic decision-making, productivity, and income-generating capacity (Bose et al., 2021). However, this finding should also be interpreted carefully because increasing age may become a constraint when it is associated with declining labor capacity or higher household old-age burden. Lu et al. (2024) found that old-age dependency can negatively affect farm household income when it reduces productive labor availability and increases household care responsibilities. Therefore, in the context of Gununghalu, age appears to function more as a proxy for experience and managerial maturity rather than as a purely demographic factor.

Effect of Land Area on Household Income

Land area had a positive and significant effect on household income, indicating that households with larger landholdings tend to earn higher income after land conversion. This result confirms that land remains a central productive asset in rural agricultural households. Larger land areas provide greater production capacity, allow farmers to expand cultivated areas, and create more opportunities to optimize commodity production.

This finding is consistent with previous studies showing that land ownership and landholding size significantly influence farm household income and welfare. N et al. (2023) found that land area had a positive effect on agricultural household income, while Amalia et al. (2023) emphasized that land control plays an important role in determining income and welfare across different agroecosystems. In the context of land conversion, households with larger remaining or converted land are more capable of transforming land-use change into productive economic activity. Conversely, households with limited land may face greater vulnerability because their production capacity is constrained.

The result also supports the broader argument that land-use change can create income opportunities but may also intensify inequality when access to land is unevenly distributed. Zhang et al. (2023) emphasized that the socioeconomic impacts of agricultural land conversion differ across household groups, particularly between households with strong and weak productive asset bases. Therefore, land area is not merely a production factor but also an indicator of household resilience after land conversion.

Effect of Education on Household Income

Education level had a positive and significant effect on household income. This indicates that households with higher levels of formal education are more likely to achieve better income outcomes after land conversion. Education improves farmers' capacity to access information, understand market signals, adopt agricultural innovations, and make more effective production and financial decisions.

This finding is consistent with Muhtadi & Safruddin (2024), who found that education had a positive effect on farmers' income. Higher education can improve farmers' ability to calculate production costs, evaluate commodity profitability, and respond to market opportunities. Wang (2024) also emphasized that the educational level of household heads is closely related to better household financial decision-making and asset allocation. In post-conversion agricultural systems, this capacity becomes particularly important because farmers must adapt to new production patterns, commodity choices, and market risks.

Thus, education functions as an important form of human capital that strengthens household adaptation after land conversion. Farmers with higher education levels are more likely to manage land-use change as an economic opportunity rather than merely as a production disruption. This suggests that rural development policies should not only focus on land and physical infrastructure but also on improving farmer education, extension services, and managerial capacity.

Effect of Social Participation (Farmer Group) on Household Income

Social participation, represented by farmers' involvement in farmer groups, showed a positive but statistically insignificant effect on household income. This means that membership in farmer groups alone does not automatically lead to higher household income. Although farmer groups may provide access to information, training, government programs, and social networks, their economic impact depends on how actively and productively these groups function.

This result is in line with the argument that farmer organizations generate income benefits only when they provide concrete economic services, such as collective input purchasing, access to credit, technical assistance, collective marketing, post-harvest handling, and bargaining power in output markets. Jaacks et al. (2025) found that households participating in farmer producer organizations had higher monthly household income than non-participating households, but the income effect was related to the productive and market-oriented role of the organization. Similarly, Gurung et al. (2024) reported that farmer producer organization membership increased net returns, return on investment, and profit margins among organic farming households in India.

In the case of Gununghalu, the insignificant effect indicate that farmer groups have not yet functioned optimally as economic institutions. They still serve mainly as administrative channels or informal social networks rather than as institutions that directly improve production efficiency and market access. Therefore, the policy implication is not to disregard farmer groups, but to strengthen their economic functions so that participation can generate measurable income benefits. Previous studies have similarly reported that membership in farmer organizations does not guarantee higher household income, as other factors such as non-farm income sources and farming experience play a more critical role in determining economic outcomes (Otitoju & Olaiya, 2024).

Effect of Family Dependents on Household Income

The number of family dependents had a positive but statistically insignificant effect on household income. This result suggests that household size does not play a decisive role in

determining income after land conversion. Additional family members may increase labor availability for agricultural activities, but they may also increase consumption needs and household financial burden. When these two effects offset each other, the net impact on income becomes statistically insignificant.

This finding is consistent with Horlu et al. (2023), who showed that household size may influence farm production and food consumption outcomes, but its effect depends on whether household members contribute productively to farming activities. A larger household does not automatically increase income unless family members are actively involved in productive labor or income-generating activities. Lu et al. (2024) also emphasized that dependency burden can reduce farm household income when non-productive household members increase care and consumption responsibilities.

Therefore, in the context of Gununghalu, the number of dependents should not be interpreted simply as an indicator of household labor availability. Its economic effect depends on the productive composition of household members, their age structure, labor contribution, and involvement in farming or non-farm activities. This explains why family dependents did not show a significant direct effect on household income in the regression model.

Effect of Number of Commodities Cultivated on Household Income

The number of commodities cultivated had a negative and significant effect on household income. This finding indicates that cultivating more commodities does not necessarily increase household income. Instead, excessive diversification may reduce income when farmers lack sufficient capital, labor, technical knowledge, market access, and managerial capacity.

This result is consistent with Kurdyś-Kujawska et al. (2021), who found that crop diversification may reduce economic efficiency when it is not supported by adequate management capacity. Recent evidence from Hien (2025) also shows that the effect of crop diversification on farm performance varies by farm size and socioeconomic context. Diversification may improve resilience and reduce risk in some cases, but it may also create income challenges when it increases production complexity and management costs.

In smallholder farming systems, cultivating too many commodities can lead to fragmented resource allocation. Farmers may face higher input costs, greater labor requirements, more complex pest and disease management, and difficulties in synchronizing production and marketing. Without clear prioritization, diversification may reduce focus on high-value or more profitable commodities. Therefore, the negative coefficient in this study suggests that non-selective diversification may become an economic burden for farming households after land conversion.

This does not mean that diversification should be avoided entirely. Rather, diversification should be strategic, selective, and based on household capacity, land suitability, commodity profitability, and market demand. Farmers may benefit more from managing fewer but economically viable commodities than from cultivating many commodities without sufficient technical and managerial support.

Relative Contribution of Socioeconomic Factors to Household Income

A higher absolute beta value of a variable indicates a larger contribution to explaining the variation in household income, as can be seen in Table 7. Based on the standardized beta coefficients, land area was the most influential factor affecting household income after land conversion, followed by the number of commodities cultivated and education level. This indicates that household income in post-conversion agricultural systems is primarily shaped by productive resource ownership, the effectiveness of commodity management, and the quality of household human capital.

Table 7. Contribution of Influential Factors Based on Standardized Beta

Variables	Standardized Beta	Contribution (%)	Rank
Age	0,171	11,3	4
Land area	0,445	29,4	1
Education	0,322	21,3	3
Social participation (farmer group)	0,078	5,2	5
Number of family dependents	0,077	5,1	6
Number of commodities cultivated	-0,420	27,8	2

Source: Data processed by researchers, 2025

Land area contributed the largest relative effect on household income. This finding confirms that land remains a strategic productive asset for rural households, particularly in areas where agricultural activities are the main source of livelihood. Households with larger landholdings have greater production capacity, broader opportunities to adjust commodity choices, and more flexibility in responding to land-use change. This is consistent with studies showing that access to land and land-use arrangements can influence rural income distribution and household welfare. Land-related policies may increase income opportunities, but their effects differ across household groups depending on land access, asset ownership, and the ability to use land productively (Zhang et al., 2023; Z. Wang et al., 2022; Wang, 2024).

The number of commodities cultivated also showed a large relative contribution, although its direction was negative. This finding highlights that commodity diversification does not automatically improve household income. Diversification can strengthen resilience when it is

strategically planned, supported by adequate resources, and aligned with market opportunities. However, when households cultivate too many commodities without sufficient capital, labor, technical knowledge, and managerial capacity, diversification may reduce efficiency and profitability (Schedelik et al., 2023). Recent evidence shows that the effect of crop diversification on farm performance depends on farm size, socioeconomic characteristics, and management capacity (Hien, 2025). Therefore, in the context of Gununghalu, the negative contribution of the number of commodities cultivated suggests that excessive or non-selective diversification may create production inefficiencies and weaken income performance.

Education level contributed substantially to household income, indicating that human capital is an important determinant of household adaptation after land conversion. Better-educated farmers are generally more capable of accessing information, adopting agricultural innovations, managing production costs, and responding to market signals. Education also strengthens farmers' ability to evaluate which commodities are economically feasible after land-use change. Thus, education complements land ownership by improving the household's capacity to transform productive resources into income.

Age had a moderate contribution, suggesting that farming experience and decision-making maturity remain relevant in shaping household income. Older farmers may possess stronger knowledge of local agroecological conditions, production cycles, and market behavior. However, the contribution of age was smaller than land area, commodity management, and education, indicating that experience alone is not sufficient without adequate productive assets and adaptive capacity.

Meanwhile, social participation (farmer group) and the number of family dependents contributed relatively small proportions and were statistically insignificant. This implies that their effects on income are indirect and depend on other conditions. Farmer group participation may generate income benefits only when farmer groups function as active economic institutions that support access to inputs, technology, credit, collective marketing, and market information. Similarly, the number of family dependents may support household income only when family members contribute productively to agricultural or non-agricultural activities. Therefore, the relative contribution analysis shows that household income after land conversion is driven more strongly by land resources, commodity management, and human capital than by social participation or household size alone.

CONCLUSION

The study's findings demonstrate that land conversion exerts disparate effects on household income. Although most respondents reported a gain in income following land conversion, a notable proportion experienced unchanged or declining income, indicating that household characteristics and resource management strategies critically shape economic outcomes. A multiple linear regression analysis showed that land area, education, and age positively and significantly influenced household income, while the number of commodities had a significant negative impact. Participation in agricultural collectives and the number of household dependents had no significant effect. Primary sources of income were land area (29.4%), followed by commodity volume (27.8%) and education (21.3%). Households cultivating an excessive diversity of commodities were most vulnerable to income reductions, highlighting the need for strategic diversification supported by adequate managerial capacity, financial resources, and market access.

While this study provides valuable insights into household income dynamics following land conversion in Gununghalu sub-district, its scope was focused on selected socioeconomic and production factors. Future research could expand on these findings by examining additional dimensions such as market access, technology adoption, and institutional support, which may further enhance understanding of strategies that strengthen household economic resilience. Policies should prioritize secure land tenure, promote education-oriented rural programs, and provide capacity-building for strategic crop diversification. These measures can enhance production efficiency, optimize resource use, and support sustainable household income following land conversion.

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