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The Role of the Agricultural Sector in Reducing Rural Poverty: A Case Study in Papua

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Abstract: Rural poverty remains a major development challenge in Papua, Indonesia, where agriculture serves as the primary livelihood for many households but is often constrained by low productivity, limited market access, and inadequate infrastructure. This study examines how agricultural sector participation contributes to rural poverty reduction through farm productivity, market access, employment diversification, household income, and food security, while also considering the roles of infrastructure and services access and social capital as enabling factors. A quantitative cross-sectional survey was conducted involving 420 rural households in Papua. Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM), supported by descriptive statistical procedures in SPSS. The results show that agricultural sector participation has significant positive effects on farm productivity, market access, and employment diversification. These factors, in turn, positively influence household income, which strengthens food security and ultimately reduces rural poverty. Infrastructure and services access were also found to improve productivity and market access while directly reducing poverty, whereas social capital significantly supports market access and employment diversification. The findings indicate that agricultural participation reduces poverty not through a single direct pathway, but through multiple interconnected mechanisms involving production, commercialization, income generation, and household welfare. This study contributes to the literature by offering a more integrated explanation of agriculture-led poverty reduction in a remote rural context. Practically, the findings suggest that poverty reduction strategies in Papua should combine agricultural development with improvements in infrastructure, market connectivity, and community-based support systems.

Keywords: Agricultural Participation, Rural Poverty, Farm Productivity, Market Access, Food Security, Papua.

INTRODUCTION

Rural poverty remains a persistent development challenge in Papua, Indonesia, where geographically dispersed settlements, high transportation costs, and limited access to markets and public services continue to constrain household welfare. In this context, agriculture remains the main livelihood source for most rural households and therefore holds significant potential as a driver of poverty reduction. However, the poverty-reducing role of agriculture does not

depend solely on participation in farming activities. Its effectiveness is also shaped by a range of interconnected factors, including farm productivity, market access, employment diversification, household income, food security, infrastructure, and social capital.

Previous studies have consistently shown that agricultural development can contribute to poverty alleviation, particularly in rural and low-income areas. Nevertheless, much of the existing literature tends to examine these relationships in a fragmented manner, focusing only on selected variables such as productivity, income, or market access. Limited attention has been given to the integrated mechanisms through which agricultural participation influences rural poverty through multiple mediating pathways. In addition, empirical evidence from geographically remote and institutionally constrained regions such as Papua remains relatively limited. As a result, there is still insufficient understanding of how agricultural participation interacts with enabling conditions and welfare outcomes in this specific context.

This study seeks to address these gaps by developing and testing an integrated model of the relationship between agricultural sector participation and rural poverty reduction in Papua. Specifically, the study examines the indirect effects of agricultural participation through farm productivity, market access, employment diversification, household income, and food security, while also considering the roles of infrastructure and services access and social capital as enabling factors. By doing so, the study extends the existing literature by offering a more comprehensive explanation of the pathways through which agriculture contributes to rural poverty reduction in a remote regional setting.

Accordingly, the objectives of this study are: (1) to analyze the effect of agricultural sector participation on farm productivity, market access, and employment diversification; (2) to examine the effects of farm productivity, market access, and employment diversification on household income and food security; and (3) to assess how these relationships ultimately contribute to rural poverty reduction in Papua. In line with these objectives, the study addresses the following research questions: (1) How does agricultural sector participation influence farm productivity, market access, and employment diversification? (2) How do productivity, market access, and diversification affect household income and food security? and (3) To what extent do these factors contribute to reducing rural poverty in Papua?

Agriculture has long been recognized as a strategic sector for poverty reduction, particularly in rural and low-income regions where households depend heavily on farming for their livelihoods. In such contexts, agriculture contributes to welfare not only through direct income generation but also through improved food availability, employment opportunities, and linkages with local markets. However, the relationship between agriculture and poverty reduction is not linear. Its effectiveness depends on whether agricultural participation can be transformed into higher productivity, broader market access, more stable household income, and stronger food security outcomes.

Agricultural sector participation refers to the extent to which rural households actively engage in farming activities, adopt agricultural practices, access extension support, and participate in farmer groups or local production systems (Rogers, 2003). Higher participation is generally associated with improved farm management, better use of inputs, and greater exposure to innovation, all of which can enhance farm productivity. Prior studies suggest that farmers who are more actively engaged in agricultural systems are more likely to adopt improved seeds, fertilizers, pest management practices, and post-harvest handling techniques, thereby increasing output and production efficiency (Anderson & Feder, 2004).

Farm productivity is a crucial mechanism linking agriculture to household welfare. Greater productivity allows households to generate larger yields from available land and labor, thereby increasing both subsistence consumption and marketable surplus. In rural development theory, productivity growth is considered one of the main pathways through which agriculture can reduce poverty because it enhances income-generating capacity and strengthens resilience

against economic shocks. In addition, higher productivity may directly improve food security by increasing food availability at the household level.

Market access is another important factor that determines whether agricultural production can translate into meaningful welfare gains. Even when farm productivity improves, the impact on poverty may remain limited if households face barriers in selling their produce. Access to markets enables farmers to obtain price information, connect with buyers, reduce transaction costs, and participate more effectively in value chains. Better market access can therefore increase farm-gate prices, improve sales stability, and create incentives for further investment in productivity-enhancing practices.

Beyond farming itself, employment diversification also plays an important role in rural poverty reduction (Haggblade, et al., 2010). In many rural economies, agricultural households rely not only on farm income but also on non-farm or off-farm activities to stabilize earnings. Diversification reduces vulnerability to seasonal fluctuations, crop failure, and market uncertainty. Households with more diverse income sources are generally better able to maintain consumption, manage risks, and avoid falling deeper into poverty. For this reason, employment diversification is often viewed as a complementary pathway through which agricultural participation can strengthen household welfare.

Household income occupies a central position in the poverty-reduction process because it reflects the extent to which productivity gains, commercialization, and diversification are converted into improved economic welfare. Higher income increases purchasing power, allows households to invest in education and health, and improves their ability to cope with shocks. In the present study, household income is also expected to improve food security, since households with higher and more stable income are better able to access sufficient, nutritious, and diverse food throughout the year.

Food security is an essential dimension of rural welfare because poverty cannot be understood solely in monetary terms. A household may experience poverty not only because of low income but also because of inadequate access to food, poor dietary quality, and high vulnerability to shortages. Thus, food security functions both as an outcome of improved agricultural and economic performance and as an important mechanism through which poverty can be reduced. When households have reliable access to adequate food, their overall well-being and productive capacity are likely to improve.

The role of enabling factors should also be emphasized. Infrastructure and services access, such as roads, transportation, electricity, extension services, financial access, and market information, are essential for enhancing agricultural performance and welfare outcomes (de Janvry & Sadoulet, 2010). Adequate infrastructure lowers transaction costs, reduces post-harvest losses, improves access to inputs and buyers, and expands economic opportunities. In remote regions such as Papua, the lack of such support systems often prevents rural households from fully benefiting from agricultural participation. Therefore, infrastructure and services are expected to improve both farm productivity and market access, while also exerting a direct influence on poverty reduction.

In addition to physical infrastructure, social capital is an important institutional resource in rural communities. Social capital refers to trust, cooperation, networks, and shared norms that facilitate collective action and mutual support. In areas where formal institutions are weak or market systems are underdeveloped, social capital can play a vital role in helping households access information, organize production, coordinate marketing, and diversify livelihoods. It can therefore strengthen both market access and employment diversification, ultimately supporting improved household welfare (Coleman, 1988).

Although previous studies have demonstrated the importance of agriculture for rural development, much of the literature has examined these variables separately rather than as part of an integrated framework. Studies often focus on direct relationships, such as agriculture and income, or infrastructure and productivity, without sufficiently explaining how these factors

interact through multiple pathways to influence rural poverty. Moreover, empirical evidence from remote and geographically challenging contexts such as Papua remains limited. This study responds to that gap by proposing a more comprehensive conceptual framework that links agricultural participation, productivity, market access, diversification, income, food security, infrastructure, social capital, and rural poverty within a single analytical model.

Based on the theoretical arguments above, this study proposes that agricultural sector participation positively influences farm productivity, market access, and employment diversification. Infrastructure and services access are expected to improve productivity and market access and to reduce rural poverty directly. Social capital is expected to strengthen market access and employment diversification. Furthermore, farm productivity, market access, and employment diversification are expected to increase household income (Fafchamps & Minten, 2002); household income is expected to improve food security (Putnam, et al., 1993); and both household income and food security are expected to reduce rural poverty (Feder, et al., 1985). These proposed relationships form the basis for the hypotheses tested in this study.

Hypotheses

H1: Agricultural sector participation positively influences farm productivity.
H2: Agricultural sector participation positively influences market access.
H3: Agricultural sector participation positively influences employment diversification.
H4: Infrastructure and services access positively influences farm productivity.
H5: Infrastructure and services access positively influences market access.
H6: Infrastructure and services access directly reduces rural poverty.
H7: Social capital positively influences market access.
H8: Social capital positively influences employment diversification.
H9: Farm productivity positively influences household income.
H10: Market access positively influences household income.
H11: Employment diversification positively influences household income.
H12: Household income positively influences food security.
H13: Farm productivity positively influences food security.
H14: Household income negatively influences rural poverty.
H15: Food security negatively influences rural poverty.

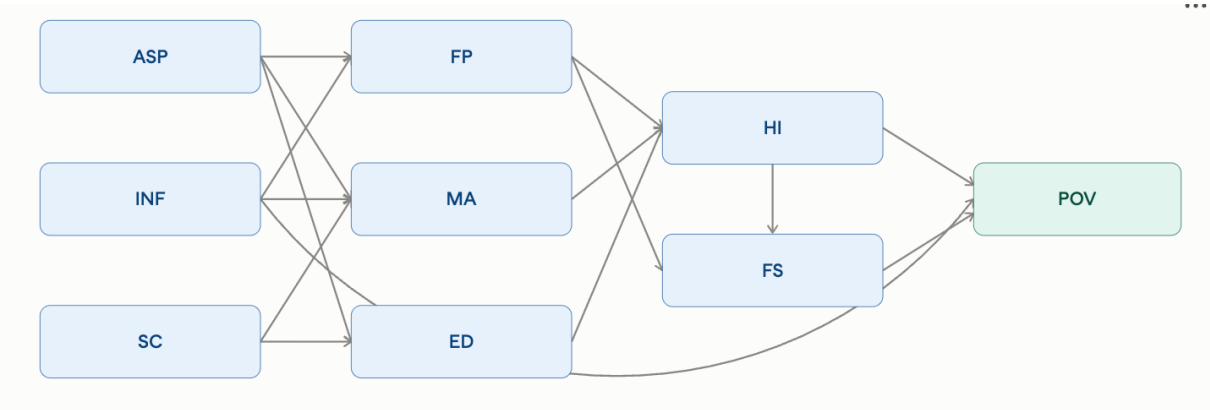

Figure 1. Conceptual Framework

Source : Data processed by SEM-PLS (2025)

Interpretation of the Conceptual Framework Results (SEM-PLS)

Based on Figure 1 – Conceptual Framework (SEM-PLS, 2025)

The attached figure presents the constructs and hypothesized pathways. Because numerical SEM-PLS outputs (path coefficients, t-values/p-values, R^2, f^2, Q^2, etc.) are not included in the attachment, this interpretation explains how to read and discuss the results once

those statistics are available, and provides a logically consistent narrative for the expected direction of effects in this framework.

Constructs and abbreviations:
ASP = Agricultural Participation
FP = Farm Productivity
HI = Household Income
FS = Food Security
POV = Rural Poverty
INF = Infrastructure & Services
MA = Market Access
SC = Social Capital
ED = Employment Diversification

Direction of relationships: A positive path coefficient (β) means an increase in the predictor is associated with an increase in the outcome; a negative β indicates an inverse relationship. Statistical support: Paths are interpreted as supported when the bootstrapped t-statistic exceeds the chosen threshold (e.g., 1.96 for 5% significance in a two-tailed test) or when the p-value is below the chosen alpha level. Magnitude and practical relevance: Beyond significance, assess effect size using the standardized coefficient (β) and f^2 (small ≈ 0.02, medium ≈ 0.15, large ≈ 0.35 as common heuristics). Explanatory power: R^2 for endogenous constructs (FP, HI, FS, POV) shows how much variance is explained by their predictors. Higher R^2 indicates stronger explanatory performance for that construct. Predictive relevance: Q^2 (Stone–Geisser) values above zero suggest the model has predictive relevance for a given endogenous construct. Indirect (mediation) effects: Some constructs influence outcomes through intermediate variables (e.g., FP → HI → POV). Total effects equal direct + indirect effects.

The framework centers on a livelihood pathway in which agricultural engagement and enabling conditions shape farm performance and household welfare. The core chain is typically discussed as:

1. ASP → FP: Higher participation in agriculture is expected to improve the use of land, labor, and inputs, leading to higher productivity.
2. FP → HI: Increased productivity usually raises farm output and marketable surplus, strengthening household income.
3. HI → FS: Higher income improves the household's ability to access sufficient and nutritious food, reducing food insecurity.
4. HI → POV (negative): Increased income is expected to reduce poverty incidence or poverty severity.
5. FP → FS (optional direct path if tested): Productivity can directly improve food availability at the household level, even before income effects are considered.

INF (Infrastructure & Services): When the INF paths are significant, this implies that improvements in roads, irrigation, extension services, utilities, and public services materially support productivity and/or income by lowering transaction costs, reducing losses, and improving access to inputs and information.

MA (Market Access): Significant MA effects indicate that households benefit from better connectivity to buyers, market information, and value chains, which can increase farm-gate prices, stabilize sales, and incentivize productivity-enhancing investments.

SC (Social Capital): Significant SC effects suggest that networks, trust, and collective action help households gain information, coordinate marketing, access informal support, and improve resilience—often strengthening market participation and enabling diversification.

ED (Employment Diversification): Significant ED effects indicate that engaging in off-farm/non-farm work stabilizes earnings and reduces vulnerability to agricultural shocks, which can improve food security and reduce poverty.

In SEM-PLS, many policy-relevant insights come from indirect effects. In this framework, common mediation patterns include:

1. ASP → FP → HI: Agricultural participation may increase income primarily because it first improves productivity.
2. FP → HI → POV: Productivity can reduce poverty mainly through higher income; if the direct FP → POV path is weak but the indirect effect is strong, income is the key transmission channel.
3. INF/MA/SC → FP → HI → FS: Enabling conditions may improve food security by increasing productivity and then income (a multi-step indirect pathway).
4. ED → HI → FS/POV: Diversification may affect food security and poverty chiefly through a more stable and higher income base.

When reporting mediation, present the indirect coefficient (product of path coefficients), its bootstrapped significance, and the total effect. If both direct and indirect effects are significant, this indicates partial mediation; if only the indirect effect is significant, it indicates full mediation. Strengthening farm productivity is likely to be the most direct lever for improving household income, which then improves food security and reduces poverty. Investments in infrastructure and market access typically generate welfare benefits by enabling productivity gains and better commercialization (higher returns to farming). Programs that build social capital (farmer groups, cooperatives, community institutions) can enhance information flow and collective action, amplifying the impact of infrastructure and markets.

Promoting employment diversification (skills training, rural enterprises) can protect households against seasonal or climate-related shocks and reduce poverty vulnerability.

If income shows the strongest link to food security and poverty reduction, interventions should ensure that productivity gains translate into cash income (e.g., post-harvest handling, price information, contract farming, storage, and access to finance).

1. Direct effects: Report each hypothesized path with β, t, p, and whether the hypothesis is supported.
2. Explanatory power: Report R^2 for FP, HI, FS, and POV, and interpret whether explanatory power is weak/moderate/substantial.
3. Effect sizes: Report f^2 for key drivers to identify which predictors matter most in practice.
4. Predictive relevance: Report Q^2 for each endogenous construct and interpret whether predictive relevance is present.
5. Mediation: Report indirect and total effects (e.g., FP → HI → POV) and classify mediation type (partial/full).

SEM-PLS results are sample-dependent; interpret coefficients in the context of the study area, measurement quality, and the sampling design. Causality should be argued carefully: SEM-PLS estimates associations consistent with the hypothesized structure, but causal claims require strong design/identification arguments (Hair, J., Hult, G., Ringle, C., & Sarstedt, 2014). If some expected paths are non-significant, discuss plausible contextual reasons (e.g., market failures, price volatility, inadequate infrastructure quality, or limited off-farm opportunities). Always report reliability and validity (e.g., composite reliability, AVE, HTMT) to justify that the constructs are measured well before drawing substantive conclusions.

METHOD

This study employed a quantitative research design using a cross-sectional survey approach to examine the relationship between agricultural sector participation and rural poverty reduction in Papua. A quantitative design was considered appropriate because the study aimed to test hypothesized relationships among multiple latent constructs and to estimate both direct and indirect effects within an integrated analytical framework.

The population of the study consisted of rural households in Papua whose livelihoods were closely related to agricultural activities. The unit of analysis was the household, represented by the household head or an adult household member who was actively involved in farming or household economic decision-making. The study used a structured questionnaire to collect primary data from respondents. In total, 420 observations were included in the analysis.

The sample was selected using a purposive sampling approach. Respondents were chosen based on several criteria: (1) they resided in rural areas of Papua, (2) they were engaged in agricultural activities either as their primary or secondary livelihood, and (3) they had sufficient knowledge of household income sources, farming conditions, and food-related conditions to answer the questionnaire reliably. This sampling approach was used because the study specifically targeted households with relevant experience in agricultural participation and rural livelihood strategies.

The study examined several latent variables: agricultural sector participation (ASP), farm productivity (FP), market access (MA), employment diversification (ED), household income (HI), food security (FS), infrastructure and services access (INF), social capital (SC), and rural poverty (POV). All constructs were measured reflectively using multiple indicators on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. Agricultural sector participation referred to the degree to which households actively engaged in farming activities, adopted agricultural practices, and interacted with agricultural support systems. Farm productivity referred to the perceived effectiveness of agricultural production in generating output. Market access captured the ease with which households could obtain market information, reach buyers, and sell agricultural products. Employment diversification referred to the extent to which households engaged in multiple income-generating activities beyond primary farming. Household income represented the perceived adequacy and stability of household earnings. Food security reflected the household's ability to access sufficient and reliable food. Infrastructure and services access referred to the availability of roads, transportation, extension services, electricity, financial services, and market-related facilities. Social capital captured trust, cooperation, and local network support within the community. Rural poverty was measured in such a way that higher values indicated more severe poverty conditions.

In addition to the main latent variables, the analysis also considered several control variables, including gender, age, household size, education level, land size, years of farming experience, farm type, and the share of off-farm income. These variables were included to provide a broader understanding of household characteristics that may influence welfare outcomes.

Data analysis was conducted in two stages. First, preliminary analysis was carried out using SPSS to generate descriptive statistics, respondent profiles, and basic diagnostic tests. This stage included frequency distributions, mean scores, standard deviations, and an assessment of common method bias using Harman's single-factor test. These procedures were intended to ensure that the data were suitable for further multivariate analysis.

Second, the hypothesized relationships were tested using Partial Least Squares Structural Equation Modeling (PLS-SEM). PLS-SEM was selected because the study involved multiple latent constructs, mediation pathways, and a prediction-oriented model. This method is suitable

for analyzing complex relationships among variables while simultaneously assessing the measurement model and the structural model.

The measurement model was evaluated through reliability and validity testing. Internal consistency reliability was assessed using Cronbach's alpha and composite reliability, with values above 0.70 considered acceptable. Convergent validity was examined through average variance extracted (AVE), with a threshold of 0.50 or higher. Indicator loadings were also reviewed to ensure that each item adequately represented its respective construct. Discriminant validity was assessed using the Fornell–Larcker criterion and the heterotrait–monotrait ratio (HTMT). The structural model was then assessed by examining collinearity, path coefficients, coefficients of determination (R^2), and effect sizes (f^2). Variance inflation factor (VIF) values were used to detect multicollinearity among predictors. Hypothesis testing was conducted using a bootstrapping procedure with 1,500 resamples to estimate the significance of direct and indirect effects. In addition, mediation analysis was performed to identify the pathways through which agricultural sector participation influenced rural poverty through farm productivity, market access, employment diversification, household income, and food security.

Overall, this methodological approach was intended to provide a systematic and transparent basis for examining how agricultural participation contributes to rural poverty reduction in Papua through multiple interrelated mechanisms.

RESULTS AND DISCUSSION

Respondent profile and descriptive statistics

Table 1 presents the profile of the respondents included in the study. The sample was dominated by male respondents (63.8%), indicating that agricultural and household economic activities in the study area are still largely represented by men. In terms of education, the majority of respondents had low to moderate educational attainment, with most having no formal education, primary education, or high school education. This pattern suggests that the human capital base of rural households remains limited, which may influence the adoption of agricultural innovations and access to better livelihood opportunities. Food-crop farming was the most common type of agricultural activity, followed by horticulture and mixed farming. On average, respondents were 40 years old, lived in households of approximately five members, cultivated 1.54 hectares of land, and had 14.4 years of farming experience. Overall, these characteristics indicate that the sample represents rural agricultural households with substantial farming involvement but constrained socioeconomic resources.

Table 1. Respondent Profile (N = 420)

Category	n	%
Gender: Male	268	63.8
Gender: Female	152	36.2
Education: No formal	92	21.9
Education: Primary	117	27.9
Education: High school	113	26.9
Education: Diploma	77	18.3
Education: University	21	5.0
Farm type: Food crops	224	53.3
Farm type: Horticulture	105	25.0
Farm type: Mixed	91	21.7
District: Jayapura Regency	79	18.8
District: Mimika	74	17.6
District: Jayapura City	72	17.1
District: Nabire	67	16.0
District: Biak Numfor	46	11.0
District: Keerom	41	9.8
District: Sarmi	41	9.8

Source : Data processed by SEM-PLS (2025)

Table 2 reports the descriptive statistics for the main latent variables. The mean values of most constructs are close to the midpoint of the scale, suggesting moderate levels of agricultural participation, productivity, market access, diversification, and welfare conditions. The average value of rural poverty is also near the midpoint, indicating that poverty-related vulnerability remains a meaningful concern among respondents. These descriptive findings are important because they show that the study context reflects a rural population that is neither completely excluded from agricultural development nor fully advantaged by it, thereby justifying further examination of the pathways through which agricultural participation may influence poverty reduction.

Table 2. Descriptive Statistics of Latent Variable Composites

Construct	Mean	SD	Min	Max
ASP	3.007	0.952	1.0	5.0
FP	3.033	0.951	1.0	5.0
MA	3.009	0.96	1.0	5.0
ED	3.033	1.015	1.0	5.0
HI	3.003	1.017	1.0	5.0
FS	2.988	0.963	1.0	5.0
INF	2.984	0.961	1.0	5.0
SC	3.008	0.961	1.0	5.0
POV	3.001	0.962	1.0	5.0

Source : Data processed by SEM-PLS (2025)

Common method bias diagnostic

To assess the potential influence of common method bias, the study employed Harman's single-factor test. The first unrotated factor accounted for 25.2% of the total variance, which is well below the commonly used threshold of 50%. This result suggests that common method bias is unlikely to pose a serious threat to the validity of the findings. Although this test does not eliminate all concerns related to self-reported survey data, it provides initial support for the adequacy of the data collection instrument and the credibility of the observed relationships among constructs.

Measurement model assessment

The reliability and validity results indicate that the measurement model is acceptable. As shown in Table 3, Cronbach's alpha and composite reliability values for all constructs exceed the recommended threshold of 0.70, indicating satisfactory internal consistency. Likewise, all average variance extracted (AVE) values are above 0.50, suggesting adequate convergent validity. The indicator loadings are also generally above the acceptable level, which indicates that the observed items represent their respective latent constructs reasonably well.

Discriminant validity was further confirmed using the Fornell–Larcker criterion and HTMT values. In Table 4, the square root of the AVE for each construct is higher than its correlations with other constructs, suggesting that each construct is empirically distinct from the others. Similarly, the HTMT values reported in Table 5 are all below the threshold of 0.85, which provides additional support for discriminant validity. Taken together, these results indicate that the constructs used in the study are measured with an acceptable degree of reliability and validity, thereby allowing the structural relationships to be interpreted with greater confidence.

Table 3. Reliability and Convergent Validity

Construct	k	Cronbach_ Alpha	Composite_ Reliability	AVE	Loading _1	Loading _2	Loading _3	Loading _4
ASP	4	0.785	0.861	0.607	0.736	0.778	0.781	0.82
FP	4	0.76	0.847	0.582	0.726	0.778	0.781	0.764
MA	4	0.753	0.844	0.574	0.756	0.746	0.76	0.769
ED	3	0.715	0.841	0.638	0.801	0.788	0.807	
HI	3	0.702	0.835	0.627	0.807	0.777	0.792	
FS	4	0.756	0.845	0.577	0.743	0.756	0.771	0.769
INF	4	0.784	0.861	0.607	0.755	0.768	0.794	0.8
SC	4	0.769	0.852	0.591	0.752	0.769	0.771	0.783
POV	4	0.75	0.843	0.572	0.753	0.747	0.763	0.762

Source : Data processed by SEM-PLS (2025)

Discriminant validity was examined using the Fornell–Larcker criterion and HTMT. In Table 4, the square root of AVE (diagonal) is higher than the correlations with other constructs, and Table 5 shows HTMT values below 0.85, indicating adequate discriminant validity.

Table 4. Fornell–Larcker Criterion

Construct	ASP	FP	MA	ED	HI	FS	INF	SC	POV
ASP	0.779	0.479	0.512	0.309	0.432	0.379	0.266	0.267	-0.367
FP	0.479	0.763	0.372	0.187	0.392	0.425	0.398	0.168	-0.376
MA	0.512	0.372	0.758	0.303	0.428	0.362	0.492	0.366	-0.386
ED	0.309	0.187	0.303	0.798	0.323	0.189	0.121	0.331	-0.232
HI	0.432	0.392	0.428	0.323	0.792	0.536	0.292	0.296	-0.57
FS	0.379	0.425	0.362	0.189	0.536	0.76	0.248	0.186	-0.58
INF	0.266	0.398	0.492	0.121	0.292	0.248	0.779	0.149	-0.303
SC	0.267	0.168	0.366	0.331	0.296	0.186	0.149	0.769	-0.199
POV	-0.367	-0.376	-0.386	-0.232	-0.57	-0.58	-0.303	-0.199	0.756

Source : Data processed by SEM-PLS (2025)

Table 5. HTMT Ratio of Correlations

Construct	ASP	FP	MA	ED	HI	FS	INF	SC	POV
ASP	1.0	0.62	0.665	0.413	0.582	0.492	0.338	0.343	0.478
FP	0.62	1.0	0.492	0.255	0.538	0.56	0.514	0.219	0.495
MA	0.665	0.492	1.0	0.415	0.588	0.48	0.639	0.483	0.514
ED	0.413	0.255	0.415	1.0	0.456	0.257	0.162	0.446	0.315
HI	0.582	0.538	0.588	0.456	1.0	0.734	0.394	0.402	0.783
FS	0.492	0.56	0.48	0.257	0.734	1.0	0.323	0.243	0.769
INF	0.338	0.514	0.639	0.162	0.394	0.323	1.0	0.193	0.394
SC	0.343	0.219	0.483	0.446	0.402	0.243	0.193	1.0	0.263
POV	0.478	0.495	0.514	0.315	0.783	0.769	0.394	0.263	1.0

Source : Data processed by SEM-PLS (2025)

Structural model assessment

Before testing the hypotheses, collinearity diagnostics were assessed. Table 6 shows that all VIF values are relatively low, indicating that multicollinearity is not a major concern in the model. This means that the predictor variables contribute distinct explanatory information and do not unduly distort the estimated path coefficients.

The coefficient of determination values reported in Table 7 suggest moderate explanatory power for the endogenous constructs. The model explains 30.9% of the variance in farm productivity, 44.2% in market access, 16.2% in employment diversification, 32.0% in household income, 34.2% in food security, and 45.4% in rural poverty. These values indicate that the proposed model captures a meaningful share of the variation in the key welfare-related outcomes, particularly market access and rural poverty. Although unexplained variance

remains, the results suggest that the selected predictors are substantively relevant in explaining how agricultural participation is linked to poverty reduction.

The structural path estimates in Table 8 provide strong support for the main theoretical expectations of the study. Agricultural sector participation has a positive and significant effect on farm productivity, market access, and employment diversification. These findings imply that households that are more actively involved in agricultural activities tend to perform better in terms of production, access to markets, and livelihood diversification. This result is theoretically consistent with the view that active participation in agricultural systems improves access to knowledge, production practices, and economic opportunities.

Infrastructure and services access also has significant positive effects on farm productivity and market access, while exerting a negative direct effect on rural poverty. This finding highlights the importance of enabling conditions in remote rural areas. Households are more likely to benefit from agricultural participation when they have access to roads, transport, extension services, and market-supporting facilities. The direct negative effect on poverty suggests that infrastructure is not only an agricultural input but also a broader welfare-enhancing condition that can reduce household deprivation more generally.

Social capital significantly improves both market access and employment diversification. This result suggests that trust, networks, and local cooperation are important social resources that help households gain information, coordinate economic activities, and identify alternative livelihood opportunities. In areas where formal market institutions may be limited, social capital appears to complement physical infrastructure by strengthening the social foundations of economic participation.

The results further show that farm productivity, market access, and employment diversification all have positive and significant effects on household income. This confirms that agricultural welfare gains operate through multiple channels. Productivity improves the quantity of output, market access improves the ability to commercialize that output, and diversification reduces dependence on a single income source. Together, these pathways contribute to stronger and more stable household earnings.

Household income has a strong positive effect on food security, while both household income and food security have significant negative effects on rural poverty. These relationships are especially important because they demonstrate that poverty reduction is not only driven by increased income in a narrow monetary sense, but also by improved access to food and household resilience. In other words, the findings show that income and food security operate as key mediators between agricultural participation and poverty reduction.

The effect size analysis reported in Table 9 provides additional insight into the practical importance of the relationships. Household income has a medium effect on food security, while infrastructure and services have a meaningful effect on market access, and agricultural participation has a meaningful effect on farm productivity. These results suggest that some relationships are not only statistically significant but also substantively important for policy and intervention design.

Table 6. Collinearity Statistics (VIF)

Equation	Predictor	VIF
FP	ASP	1.076
FP	INF	1.076
MA	ASP	1.141
MA	INF	1.084
MA	SC	1.084
ED	ASP	1.077
ED	SC	1.077
HI	FP	1.177
HI	MA	1.25

HI	ED	1.116
HI	Education Level	1.01
HI	Log Land	1.009
HI	Off Farm Income Share	1.005
FS	HI	1.182
FS	FP	1.182
POV	HI	1.459
POV	FS	1.424
POV	INF	1.11
POV	Household Size	1.004

Source : Data processed by SEM-PLS (2025)

Table 7. Coefficient of Determination (R^2)

Endogenous	R2
ED	0.162
FP	0.309
FS	0.342
HI	0.32
MA	0.442
POV	0.454

Source : Data processed by SEM-PLS (2025)

Table 8 below, presents the path coefficients with bootstrapped standard errors (1,500 resamples). Agricultural participation significantly improves farm productivity ($\beta = 0.402$, $p < 0.001$), market access ($\beta = 0.358$, $p < 0.001$), and employment diversification ($\beta = 0.237$, $p < 0.001$). Both productivity ($\beta = 0.264$, $p < 0.001$) and market access ($\beta = 0.258$, $p < 0.001$) increase household income. Higher income increases food security ($\beta = 0.436$, $p < 0.001$). In turn, income ($\beta = -0.342$, $p < 0.001$) and food security ($\beta = -0.365$, $p < 0.001$) reduce rural poverty. Infrastructure/services reduce poverty directly ($\beta = -0.117$, $p < 0.01$) and indirectly through productivity and market access.

Table 8. Structural Path Estimates (Bootstrapping = 1,500)

Predictor	Endogenous	Beta	SE	t	p	CI2.5 %	CI97.5%	Sig.
ASP	ED	0.237	0.048	4.953	0.0	0.146	0.333	***
SC	ED	0.268	0.046	5.787	0.0	0.175	0.354	***
ASP	FP	0.402	0.044	9.073	0.0	0.316	0.491	***
INF	FP	0.292	0.042	6.898	0.0	0.208	0.369	***
FP	FS	0.254	0.043	5.909	0.0	0.171	0.335	***
HI	FS	0.436	0.042	10.441	0.0	0.356	0.519	***
ED	HI	0.186	0.044	4.237	2e-05	0.102	0.27	***
Education Level	HI	0.162	0.038	4.218	2e-05	0.082	0.234	***
FP	HI	0.264	0.046	5.782	0.0	0.177	0.352	***
Log Land	HI	0.102	0.04	2.544	0.01097	0.022	0.177	*
MA	HI	0.258	0.047	5.539	0.0	0.164	0.345	***
Off Farm Income Share	HI	0.077	0.045	1.715	0.08642	-0.009	0.166	ns
ASP	MA	0.358	0.039	9.272	0.0	0.283	0.433	***
INF	MA	0.364	0.037	9.869	0.0	0.295	0.436	***
SC	MA	0.217	0.039	5.56	0.0	0.139	0.292	***
FS	POV	-0.365	0.044	-8.369	0.0	-0.452	-0.28	***
HI	POV	-0.342	0.044	-7.702	0.0	-0.425	-0.254	***
Household Size	POV	0.107	0.037	2.895	0.00379	0.031	0.177	**
INF	POV	-0.117	0.039	-2.987	0.00281	-0.193	-0.039	**

Source : Data processed by SEM-PLS (2025)

Effect sizes (f^2) indicate that household income has a medium effect on food security ($f^2 = 0.244$). Infrastructure/services on market access ($f^2 = 0.219$) and agricultural participation on farm productivity ($f^2 = 0.217$) are also meaningful contributors (Table 9).

Table 9. Effect Size (f^2) by Predictor

Predictor	Endogenous	f^2
SC	ED	0.08
ASP	ED	0.063
ASP	FP	0.217
INF	FP	0.114
HI	FS	0.244
FP	FS	0.083
FP	HI	0.087
MA	HI	0.078
ED	HI	0.046
Education Level	HI	0.038
Log Land	HI	0.015
Off Farm Income Share	HI	0.009
INF	MA	0.219
ASP	MA	0.201
SC	MA	0.078
FS	POV	0.171
HI	POV	0.147
INF	POV	0.022
Household Size	POV	0.021

Source : Data processed by SEM-PLS (2025)

Mediation analysis

The mediation analysis strengthens the central argument of the study by showing that agricultural participation reduces rural poverty primarily through indirect pathways. As shown in Table 10, the total indirect effect of agricultural participation on poverty is negative, indicating that more active participation in agriculture is associated with lower poverty through improvements in productivity, market access, employment diversification, household income, and food security.

Among the indirect pathways, those operating through farm productivity and food security appear particularly important. This finding suggests that agricultural participation does not automatically reduce poverty on its own; rather, it does so when it improves the household's productive capacity and ultimately strengthens welfare outcomes such as income and food access. The mediation results therefore support the study's integrated framework and underline the importance of examining agriculture–poverty linkages as a multi-step process rather than a simple direct relationship.

Table 10. Indirect Effects from Agricultural Participation to Rural Poverty

Indirect path	Effect
ASP→FP→HI→POV	-0.036
ASP→MA→HI→POV	-0.032
ASP→ED→HI→POV	-0.015
ASP→FP→FS→POV	-0.037
ASP→FP→HI→FS→POV	-0.017
ASP→MA→HI→FS→POV	-0.015
ASP→ED→HI→FS→POV	-0.007
Total indirect effect (ASP→POV)	-0.159

Source : Data processed by SEM-PLS (2025)

Discussions

The findings of this study support the broader argument that agriculture can serve as an important pathway for rural poverty reduction, especially when supported by enabling economic and social conditions. Agricultural participation was found to improve farm productivity, market access, and employment diversification, all of which contribute positively to household income. This suggests that agricultural engagement is most beneficial when households are able not only to produce more, but also to commercialize their output and diversify their sources of livelihood.

The positive effect of farm productivity on household income is consistent with the view that improvements in production efficiency increase both marketable surplus and the household's capacity to generate economic returns from farming. However, the results also demonstrate that productivity alone is insufficient. Market access plays an equally important role because without reliable access to buyers, information, and market networks, higher production may not translate into meaningful income gains. This is particularly relevant in Papua, where geographical remoteness and transport barriers often constrain commercialization.

The significant role of infrastructure and services further reinforces this interpretation. Better roads, transport facilities, extension services, and access to economic support systems reduce transaction costs and allow rural households to participate more effectively in agricultural and market activities. The direct negative effect of infrastructure on poverty also suggests that basic service access contributes to welfare in ways that go beyond agricultural production, such as improving mobility, access to public services, and overall economic opportunities.

Another important finding is the role of social capital. The results indicate that trust, cooperation, and community networks are not merely social attributes, but productive assets that help households gain market access and diversify their employment strategies. In rural contexts where formal support systems are weak, social capital may function as an alternative institutional resource that enables information exchange, collective marketing, and mutual support. This finding highlights the need to complement investments in physical infrastructure with efforts to strengthen local institutions, farmer groups, and community-based organizations.

The study also confirms the central role of household income and food security in the poverty-reduction process. Higher income significantly improves food security, and both variables significantly reduce rural poverty. This suggests that poverty should be understood as a multidimensional condition rather than solely as low income. Even when households experience modest improvements in earnings, poverty reduction becomes more meaningful when those gains are translated into improved food access and reduced vulnerability. Thus, food security represents an important welfare channel through which agricultural development affects household well-being.

Overall, the results imply that poverty reduction in Papua requires an integrated strategy. Policies aimed solely at increasing production are unlikely to be sufficient unless they are accompanied by improvements in infrastructure, market connectivity, and community support systems. Likewise, interventions that focus only on market integration may have limited impact if productivity remains low. A more effective policy approach would therefore combine agricultural intensification, improved service access, stronger local institutions, and livelihood diversification.

From a theoretical perspective, this study contributes to the literature by demonstrating that the relationship between agriculture and rural poverty is mediated by multiple interrelated mechanisms rather than operating through a single direct channel. From a practical perspective, the findings suggest that rural development programs in Papua should be designed in a coordinated manner, linking agricultural support with investments in transport, market systems,

extension, and social-capital formation. Such an integrated approach is more likely to produce sustainable reductions in rural poverty.

CONCLUSION

This study demonstrates that agricultural sector participation can contribute significantly to rural poverty reduction in Papua through several interrelated pathways. The findings show that greater agricultural participation improves farm productivity, market access, and employment diversification, which in turn enhance household income and food security. Household income and food security were found to play particularly important roles as key mechanisms through which agricultural participation translates into lower levels of rural poverty. In addition, infrastructure and services access not only strengthen productivity and market access but also reduce poverty directly, while social capital supports market participation and livelihood diversification.

From a theoretical perspective, this study contributes to the literature by offering a more integrated explanation of how agriculture affects rural poverty. Rather than treating agricultural development as a single direct determinant of welfare improvement, the study shows that its effects operate through multiple mediating mechanisms involving productivity, commercialization, income generation, and food security. This multidimensional perspective enriches existing discussions on agriculture-led poverty reduction, particularly in remote rural contexts where structural constraints and institutional limitations shape development outcomes.

From a practical and policy perspective, the findings suggest that efforts to reduce rural poverty in Papua should not focus solely on increasing agricultural production. More effective poverty reduction strategies should combine support for farm productivity with improved market connectivity, access to infrastructure and public services, and the strengthening of local social institutions. Investments in roads, transportation, extension services, market information systems, and community-based organizations are likely to enhance the capacity of rural households to convert agricultural participation into sustainable welfare gains. In this regard, an integrated and place-based rural development strategy is essential for addressing the complex realities of poverty in Papua.

Several limitations of the study should be acknowledged. First, the study is based on cross-sectional data, which limits the ability to draw strong causal conclusions about the relationships among variables over time. Second, the use of self-reported survey responses may not fully capture the dynamic and multidimensional nature of constructs such as market access, social capital, and poverty. Third, the findings are context-specific and therefore may not be fully generalizable to other regions with different socioeconomic and institutional conditions.
Future research may extend this study in several ways. Longitudinal or panel-data approaches would be valuable for examining how the effects of agricultural participation on poverty evolve over time. Further studies could also incorporate spatial variables, market distance, commodity-specific analysis, or gender-based perspectives to better understand heterogeneous development outcomes. In addition, comparative studies across rural regions would help clarify whether the mechanisms identified in Papua are also applicable in other geographically remote and economically vulnerable contexts.

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