DETERMINANTS OF MARKET ACCESS AMONG SMALLHOLDER FARMERS

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ABSTRACT: *This study examined the determinants of market access among smallholder farmers using Structural Equation Modeling–Partial Least Squares (SEM-PLS). The method was employed due to its suitability in analyzing complex causal relationships among latent variables, accommodating small sample sizes, and managing data that deviate from normal distribution. Purposive sampling was used to select smallholder farmers from a state-supported agricultural community. Data were collected through a structured questionnaire containing two parts: the first covering demographic and farm profile information, and the second consisting of measures related to education level, farming experience, farm size, production linkages, agricultural extension training, market information access, distance to market, and market access level. Findings revealed that education level and distance to market exert significant indirect effects on market access through agricultural extension training. Specifically, the paths Education Level (EL) ⇒ Agricultural Extension Training (AET) ⇒ Market Access Level (MAL) ($\beta = 0.406$, $p = 0.000$) and Distance to Market (DM) ⇒ Agricultural Extension Training (AET) ⇒ Market Access Level (MAL) ($\beta = 0.092$, $p = 0.029$) were statistically significant, highlighting the mediating role of training in enhancing farmers' market participation. Agricultural extension training exhibited the largest effect size ($f^2 = 0.209$), confirming its practical importance in strengthening the farmers' market access capabilities. Conversely, farming experience and farm size demonstrated limited and non-significant effects, indicating that structural and traditional factors are less influential compared to education and institutional support. Overall, the study concludes that agricultural extension training serves as a critical mechanism linking farmers' education and geographic accessibility to improved market integration. Strengthening education-oriented and extension-based programs is essential for promoting sustainable and inclusive agricultural growth among smallholder farmers.*

Keywords: smallholder farmers, market access, agricultural extension training, education level, distance to market, market information access.

1. INTRODUCTION

Agriculture continues to be a cornerstone of the Philippine economy, contributing approximately 9% to the national Gross Domestic Product (GDP) in 2023 and providing livelihood to nearly 25% of the country's labor force [1]. Despite its declining share in GDP compared to the services and industry sectors, the agricultural sector remains indispensable in sustaining food security and rural development. Within this context, smallholder farmers play a vital role as the primary producers of staple crops and high-value commodities. However, their economic potential is often constrained by barriers to market access, which limit their ability to sell produce at fair prices, connect with value chains, and achieve sustainable livelihoods. This study, therefore, seeks to examine the factors influencing market access among smallholder farmers, focusing on socio-demographic characteristics such as education level, farming experience, and farm size, as well as institutional and structural variables like production linkages, agricultural extension training, access to market information, and distance to the nearest market.

Robust recent data underscores the dynamic role of agriculture in driving economic performance, though structural constraints persist for smallholder farmers. In the second quarter of 2025, the agricultural sector expanded by 7%, contributing significantly to the country's overall GDP growth of 5.5%, the strongest annual growth in a year [2]. Complementing this, the Philippine Statistics Authority (PSA) reported that palay (rice) production increased by 13.2%, reaching 4.35 million metric tons, while corn output rose by 26.7% in the same period [3]. Similarly, the U.S. Department of Agriculture's Foreign Agricultural Service projected that milled rice production for the 2025–26 marketing year will reach 12.25 million tons, an increase from the previous year, due to favorable weather conditions and government support through the Rice Competitiveness Enhancement Fund (RCEF) [4, 5]. These trends reflect the potential of policy interventions and favorable agronomic conditions in boosting production; however, many smallholder farmers remain excluded from these gains due to limited access to markets, training, and agricultural information systems, underscoring the importance of examining the factors that determine market access.

Despite the evidence from prior research, there remain critical gaps in understanding the comprehensive set of factors that shape smallholder farmers' market access in the Philippines. While existing studies have examined agricultural productivity and food security, few have integrated socio-demographic, institutional, and infrastructural factors into a single analytical framework. In particular, the relative importance of education, farming experience, farm size, extension services, and market information in influencing market access remains underexplored. Moreover, limited research has been conducted to determine whether differences in demographic characteristics, such as age, gender, and ethnicity, result in significant variations in market access opportunities. These knowledge gaps restrict policymakers' ability to design targeted interventions that address the root causes of market exclusion among smallholder farmers.

Thus, this study is significant for both academic and practical reasons. Academically, it contributes to the growing discourse on agricultural economics and rural development by providing empirical evidence on the determinants of market access within a developing-country context. Practically, the study has the potential to guide policy directions and development initiatives that support smallholder farmers. By identifying which factors exert the greatest influence on market access, the research can guide

the design of capacity-building programs and encourage investment in rural infrastructure, enhancement of extension services, and development of reliable market information systems. These findings can also aid government agencies, non-government organizations, and cooperatives in crafting more inclusive interventions that reduce rural poverty and promote food security. Ultimately, the study's significance lies in its ability to highlight pathways for integrating smallholder farmers into profitable and sustainable market systems, thereby contributing to inclusive economic growth and resilience in Philippine agriculture.

2. METHODS AND MATERIALS

This study used quantitative research design using Structural Equation Modeling (SEM) with Partial Least Squares (PLS) to examine the determinants of market access among smallholder farmers. SEM-PLS was chosen for its ability to estimate complex models with multiple constructs, its suitability for prediction-oriented research, and its robustness with smaller sample sizes and non-normal data [6, 7].

The respondents were purposively selected smallholder farmers from a state-supported agricultural community, ensuring that participants were actively engaged in farming and market transactions, making them relevant to the study's objectives [8].

Data were collected through a structured survey questionnaire consisting of two sections. The first section gathered demographic information, while the second section measured variables hypothesized to influence market access. These included education level, farming experience, and farm size as resource-based characteristics; production linkages with cooperatives or traders; participation in agricultural extension training; access to market information; and distance to market. The dependent construct, market access, was operationalized as the extent to which farmers were able to sell produce, connect with buyers, and obtain fair prices (Barrett, 2008) [9]. Perceptual variables such as production linkages, extension training, access to market information, and market access were assessed using a five-point Likert scale, while education, experience, farm size, and distance were collected as quantitative values.

Instrument reliability was evaluated using Cronbach's alpha and composite reliability, while construct validity was examined through factor analysis. Convergent validity was assessed using Average Variance Extracted (AVE), and discriminant validity was confirmed through the Fornell-Larcker criterion and the heterotrait-monotrait (HTMT) ratio [6, 7].

The SEM-PLS analysis followed the two-step approach of assessing the measurement model and then the structural model (Hair et al., 2019). The measurement model was evaluated using indicator reliability, internal consistency, and validity indices. On the other hand, the structural model was assessed through path coefficients, coefficients of determination (R^2), effect sizes (f^2), and predictive relevance (Q^2). Model fit was further confirmed using the Standardized Root Mean Square Residual (SRMR), Normed Fit Index (NFI), Comparative Fit Index (CFI), and Tucker-Lewis Index (TLI). Variance Inflation Factor (VIF) values were checked to verify the absence of multicollinearity [10].

Ethical standards were strictly observed. Farmers were informed of the study's objectives, voluntary consent was obtained, and responses were anonymized to ensure rotconfidentiality, consistent with institutional research p others [11].

3. DISCUSSION AND RESULTS

Assessment of Measurement Model

Table 1. Fit indices of the model.

X^2	$-p$ value	SRMR	NFI	CFI	TLI
1396	0.000	0.098	0.806	0.895	0.886

The model presents moderately acceptable results, as the model fit shows a high chi-square (1396) value. Furthermore, the model deviates significantly from a perfect fit when the p-value is 0.000. It should be interpreted in conjunction with other indices, though, as this is a typical occurrence in large samples. The overall structure appears statistically strong despite SRMR (0.098) and NFI (0.806) indicating areas that could be improved. This is especially true if there is a solid theoretical justification and significant path coefficients. The model suggests a moderate to acceptable fit, with CFI (0.895) and TLI (0.886) approaching the conventional threshold of 0.90.

Subsequently, the study also explores the significant influence of the distribution of loadings of education level, farming experience, farm size, and distance to market, as presented in Table 2.

Table 2. Loadings distribution of education level, farming experience, farm size, and distance to market

Education Level (EL)		Farming Experience (FE)		Farm Size (FS)		Distance to Market (DM)	
Items	FL	Items	FL	Items	FL	Items	FL
EL1	0.861	FE1	0.846	FS1	0.862	DM1	0.802
EL2	0.905	FE2	0.820	FS2	0.690	DM2	0.919
EL3	0.892	FE3	0.857	FS3	0.872	DM3	0.906
EL4	0.879	FE4	0.818	FS4	0.823	DM4	0.837
EL5	0.901	FE5	0.857	FS5	0.876	DM5	0.909

The factor loadings (FL) of the indicators for each latent variable are shown in Table 2. Distance to Market (DM), Farm Size (FS), Farming Experience (FE), and Educational Level (EL) are the considered variables. The construct's internal consistency is confirmed by the excellent factor loadings of EL, which range from 0.861 to 0.905. This shows that educational attainment is consistently and effectively captured by the measurement items, highlighting

its crucial role in shaping farmers' capacity to engage in market dynamics. High loadings imply that education significantly influences decision-making processes and access to market information, thereby reinforcing its importance in agricultural economic studies. Moreover, this aligns with human capital theory which states that education enhances farmers' skills to process market information and improve production decisions, thereby positively affecting market participation according to WJARR, 2024 and Scribbr,[12,13]. This factor loading of Educational Level (EL) is implicated and likely makes a meaningful contribution to market access dynamics.

Meanwhile, factor loadings for Farming Experience (FE) vary from 0.818 to 0.857 which suggest that all items show strong loadings, indicating a coherent and reliable construct. The consistency across items suggests that farming experience is a well-defined latent variable. This stability underscores the importance of accumulated practical knowledge and skills in influencing farming productivity and market participation. Thus, Farming Experience (FE) is a stable predictor and is well-captured by the instrument. However, unlike, Farming Experience (FE), Farm Size (FS) ranges from 0.690 to 0.876, marking only four strong items. One item, FS2 (0.690), has a marginally acceptable mean. Although FS2 might benefit from improvement or theoretical support, this data indicates that the construct is generally reliable. The variance in loadings may reflect heterogeneity in farm scale measurement or differences in farmers' reporting that should be considered for future scale refinement. Finally, the factor loadings for Distance to Market (DM) vary from 0.802 to 0.919, indicating that all items are strong to excellent, with DM2 and DM3 exceeding 0.90. These results confirm that the distance factor is precisely captured, reflecting its significant influence on farmers' market access challenges. The strong loadings emphasize the physical accessibility dimension and its implications on transaction costs, transportation feasibility, and timely market participation. Increased distance raises transaction costs and limits farmer engagement [14]. This concept is highly credible and makes a significant contribution to explaining market access restrictions.

The study also examines the distribution of loadings for production linkages, agricultural extension training, market information access, and market access level. Factor loading indicates the strength of association between each observed variable and a latent factor.

Table 3. Loadings distribution of production linkages, agricultural extension training, market information access, and market access level

Production Linkages (PL)		Agricultural Extension Training (AET)		Market Information Access (MIA)		Market Access Level (MAL)	
Items	**FL**	**Items**	**FL**	**Items**	**FL**	**Items**	**FL**
PL1	0.732	AET1	0.941	MIA1	0.903	MAL1	0.729
PL2	0.799	AET2	0.950	MIA2	0.889	MAL2	0.754
PL3	0.870	AET3	0.933	MIA3	0.935	MAL3	0.738
PL4	0.837	AET4	0.932	MIA4	0.939	MAL4	0.822
PL5	0.834	AET5	0.953	MIA5	0.911	MAL5	0.817

The factor loadings (FL) of Market Information Access (MIA), Market Access Level (MAL), Agricultural Extension Training (AET), and Production Linkages (PL) are displayed in Table 3. The factor loadings of Production Linkages (PL), which range from 0.732 to 0.870, show all items exceed the 0.70 threshold, suggesting that PL is a strong and reliable construct that likely plays a significant role in market access dynamics. Indicators effectively measure the level of production connectivity among farmers, buyers, suppliers, and other market factors. This implies that production linkages play a crucial role in facilitating the flow of goods, services, and information across the agricultural value chain which directly supports market participation and competitiveness.

Meanwhile, all items regarding Agricultural Extension Training (AET) exhibit exceptional loadings, confirming excellent internal consistency, as indicated by the factor loadings which range from 0.932 to 0.953. AET is a very dependable concept that could play a significant role in opening up markets. The high loading values reflect the vital role of extension services in empowering farmers with technical knowledge, innovative farming practices, and market-oriented skills which ultimately improve their readiness to engage effectively in competitive markets. In terms of Market Information Access (MIA), the results show that all items present strong to excellent factor loadings, which range from 0.889 to 0.939. This indicates that a vital measurement model suggests that MIA is a critical factor in facilitating informed market participation. Findings imply that timely and accurate access to market information such as prices, demand trends, and buyer requirements significantly enhances farmers' ability to make informed marketing decisions. This also confirms that MIA serves as a critical enabler of market participation, bridging the information gap that often limits smallholder farmers' integration into broader market systems.

Lastly, the factor loadings of Market Access Level (MAL) range from 0.729 to 0.822, and all items meet the strong loading criteria, with MAL4 and MAL5 approaching 0.82, which indicates that the construct is reliably measured, supporting its role as a dependent variable in the proposed model. Results support that market access is a well-measured dependent construct in the structural model, effectively capturing farmer's ability to reach, negotiate, and sustain linkages with their target markets.

Aside from factor loading, which indicates the strength of association between each observed variable and a latent factor, the study also analyzed Cronbach's alpha, composite reliability, and Average Variance Extracted (AVE) for Education Level, Farming Experience, Farming Size,

Distance to Market, Production Linkages, Agricultural Extension Training, Market Information Access, and Market Access Level.

Across all constructs, the measurement model shows excellent convergent validity and reliability. Individual and structural factors are well-represented in the model, as evidenced by the strong reliability and validity of Education Level (EL) (AVE = 0.788), Farming Experience (FE) (AVE = 0.705), Farming Size (FS) (AVE = 0.685), and Distance to Market (DM) (AVE = 0.767). Likewise, acceptable to excellent internal consistency is indicated by the Cronbach's alpha values for Market Access Level (MAL) (0.831) and Agricultural Extension Training (AET) (0.968).

For all constructs, composite reliability (CR) scores are higher than the suggested cutoff of 0.70, with Agricultural Extension Training (AET) and Market Information Access MIA) gaining the top two scores of 0.969 and 0.956) respectively, confirming the instrument's strength. Each ariance from its indicators, as construct captures sufficient v evidenced by AVE values that exceed the 0.50 benchmark and range from 0.597 to 0.887. These findings support the use of the instrument in structural modeling and affirm its oth CR psychometric validity. The top two constructs for b and AVE are agricultural extension training and market information access, which are closely associated with institutional support and play a significant role in enabling smallholder farmers to participate in the market. The ss level into the framework model inclusion of market acce $\alpha = 0.831$))is justified based on its satisfactory reliability and convergent validity (AVE = 0.597) as a dependent .variable

While the measurement model demonstrates reliability and validity for all constructs, the Heterotrait-Monotrait Ratio of Correlations (HTMT) compares the average correlations between indicators of different constructs.

Distance to Market (DM) reveals the same weaknesses in between constructs particularly with Agricultural Extension Training (AET) (r = 0.221) and Market Access Level (MAL) (r = 0.136). This result indicates that geographical information is less influential than informational and organizational support. On the other hand, the Farming Size (FS) correlation values are moderate with both Market Access Level (MAL) (r = 0.355) and Market Information Access (MIA) (r = 0.356). Meanwhile, FS to Product Linkages (PL) shows a weak correlation (r = 0.148), indicating a limited association between farm size and production coordination. This suggests that farm size has a limited impact on the production coordination and market integration.

Agricultural Extension Training (AET) strongly positively correlates with Market Information Access (MIA) (r = 0.710), Market Access Level (MAL) (r = 0.628), and Product Linkages (PL) (r = 0.626) implying that training has increased farmers' access to market information, facilitating stronger linkages among producers, and ultimately enhancing overall market participation. This indicates that extension training significantly enhances market access and suggests that training facilitates production linkages. Institutional support mechanisms are essential for improving farmers' access to markets.

Likewise, Education Level (EL) exhibits higher correlation values with Market Information Access (MIA) (r = 0.483). This suggests that educated farmers are more efficient in accessing market information. The more education one attains, the closer one is to a closer interaction with the market mechanism. There are also moderate correlations with Market Access Level (MAL) (r = 0.367) and Product Linkages (PL) (r = 0.376). Farmers who are educated are likely more capable of interpreting market signals, adopting innovations, and engaging effectively with value chains.

In summary, HTMT results reinforce that while constructs are statistically diverse, the interrelations of constructs show the critical role of knowledge-based and institutional supports in improving smallholder farmers' market access.

Table 4. Assessment of Structural Model (Direct effects)

Structure	β	f^2	Standard Error (SE)	value-p	Remarks
EL => PL	0.346	0.103	0.059	0.000	**Significant**
FE => PL	0.176	0.033	0.070	0.023	**Significant**
FS => PL	-0.083	0.001	0.044	0.263	Not Significant
DM => PL	0.224	0.041	0.052	0.004	**Significant**
EL => AET	0.630	0.464	0.093	0.000	**Significant**
FE => AET	0.070	0.002	0.100	0.263	Not Significant
FS => AET	0.061	0.015	0.065	0.312	Not Significant
DM => AET	0.142	0.018	0.075	0.022	**Significant**
EL => MIA	0.490	0.201	0.102	0.000	**Significant**
FE => MIA	0.054	0.004	0.116	0.418	Not Significant
FS => MIA	0.173	0.057	0.075	0.009	**Significant**
DM => MIA	0.248	0.054	0.088	0.000	**Significant**
PL => MAL	0.030	0.002	0.072	0.685	Not Significant
AET => MAL	0.644	0.209	0.052	0.000	**Significant**
MIA => MAL	-0.071	0.004	0.038	0.346	Not Significant

$f^2 \geq 0.02$ –small effect, $f^2 \geq 0.15$ –medium effect, $f^2 \geq 0.35$ -large effect
Education Level (EL) => Production Linkages (PL).

The path for EL => PL represents that Education Level (EL) has a moderately strong positive effect on Production Linkages (PL), with the path coefficient value of 0.346, indicating the strength and direction of the relationship between EL and PL. However, the medium-sized effect (f^2 = 0.103) indicates that educational attainment implicitly contributes to farmers' capability to coordinate production and engage in collaborative linkages. Farmers who are

educated are more likely to be strategic and informed in creating production relationships, highlighting the important role of education in the enhancement of production coordination. A statistically significant p-value of 0.000 also suggests the statistical significance between the pairwise variables, and the result turns out to be highly substantial against the null hypothesis. *Farming Experience (FE) => Production linkages (PL).* FE has a significant positive effect on PL (FE => PL) with a path coefficient value of $\beta = 0.176$ and a significant p-value at 0.023. This indicates that farming experience contributes slightly to production coordination. In addition, SE = 0.070 and $f^2 = 0.033$ explain variance in production coordinates to a lesser extent. The small effect size ($f^2 = 0.033$) illustrates that experience helps farmers coordinate with others. Compared to education, the impact of experience is modest. Experience may provide practical knowledge, but this may not fully be interpreted into formal linkages without complementary support mechanisms.

Farm Size (FS) => Production linkages (PL). The path from FS to PL ($\beta = -0.083$) indicates a negligible influence and a statistically insignificant relationship ($p = 0.263$), i.e., FS does not meaningfully influence farmers' ability to coordinate production activities. Moreover, its SE = 0.044 and $f^2 = 0.001$ indicate a limited explanatory power of this variable in the model. The negligible effect $f^2 = 0.001$implies that both small and large farm operators exhibit similar levels of production linkage engagement, suggesting that coordination is driven more by institutional and informal support than by landholding size.

Distance to Market (DM) => Production linkages (PL). Taking a glance at the association between DM and PL, the path coefficient value of 0.224 indicates a moderate positive relationship between DM and PL. As DM increases, PL also increases. The SE = 0.052, which is relatively high, suggests some variability in the estimate. Moreover, the p-value of 0.004 indicates a statistically significant result. Thus, substantial evidence supports DM as a predictor of PL. The small size effect ($f^2 = 0.041$) suggests that nearness to markets is a key that slightly increases coordination efforts of farmers. Farmers nearer to market centers can more easily engage in collective marketing and input sharing.

Educational Level (EL) => Agricultural Extension Training (AET). Similarly, the path from EL to AET, with a path coefficient value of $\beta = 0.630$ and a p-value of 0.000, indicates a substantial and statistically significant positive effect. Additionally, its important contribution to explaining variance in training access is confirmed by SE = 0.093 with a large effect size ($f^2 = 0.464$). This translates that education significantly enhances farmers' access to and involvement in extension training. Farmers who are educated recognize the value of technical training and will adopt improved practices which in return elevates their integration into extension networks.

Farming Experience (FE) => Agricultural Extension Training (AET). On the other hand, FE => AET yields different results; the path displays a low coefficient with minimal effect ($f^2 = 0.002$) and a negligible effect ($\beta = 0.070$). Furthermore, it shows a statistically non-significant effect ($p = 0.263$, SE = 0.100), indicating that experience is not a significant factor in determining access to extension services. Experienced farmers rely more on traditional methods than on formal agricultural extension trainings.

Farm Size (FS) => Agricultural Extension Training (AET). Similarly, the path of FS => AET shows a negligible ($\beta = 0.061$), low coefficient with a limited effect $f^2 = 0.015$. Additionally, the p-value of 0.312 indicates a non-significant effect on AET. In contrast, SE = 0.065 signifies a relatively small but stable value; however, the effect is still statistically insignificant since the p-value is high.

Distance to Market (DM) => Agricultural Extension Training (AET). Another mediating variable included in the analysis was the DM =>AET, whose direct effect has a path coefficient of $\beta = 0.142$ and a p-value of 0.022, resulting in an ambiguous, although weak and statistically significant positive influence. This may imply that farmers who live closer to market centers are slightly more likely to adopt extension services. However, the small effect size ($f^2 = 0.018$) and SE = 0.075 suggest a tolerable contribution to explaining variance in training access.

Educational Level (EL) => Market Information Access (MIA). For the path of EL => MIA, the coefficient value of $\beta = 0.490$, the p-value of 0.000, and the SE=0.102 indicate that EL has a statistically significant and moderately strong positive effect on MIA. EL explains a meaningful portion of the variance in MIA, reinforcing its practical importance in the model, as shown in the effect size of 0.201, which means a moderate range.

Farming Experience (FE) => Market Information Access (MIA). Based on the data, FE has a low coefficient value, meaning that it has a minimal effect size and a negligible and statistically non-significant effect on MIA ($\beta = 0.054$, SE = 0.116, $p = 0.418$, $f^2 = 0.004$). The small effect size shows that farming experience alone does not guarantee better access to market information.

Farm Size (FS) => Market Information Access (MIA). However, this is not the case for the path of FS => MIA, with the $\beta = 0.173$, the SE = 0.075, the $p = 0.009$, and the $f^2 = 0.057$, indicating a statistically significant but weak positive effect on MIA. The results suggest that farmers who own larger farms have more resources and opportunities in attaining market information compared to smaller farmers.

Distance to Market (DM) => Market Information Access (MIA). DM => MIA has a coefficient value of $\beta = 0.248$, SE = 0.088, p=0.000, and $f^2 = 0.054$, which means DM is statistically significant and has a moderately positive effect on MIA, and a modest yet meaningful contribution to explaining variance in information access. This implies that easy access to markets enhances the ability of farmers to gain timely and important market information. This may be possibly due to increased exposure to networks and agents.

Production Linkages (PL) => Market Access Level (MAL). PL => MAL shows a negligible effect ($\beta = 0.030$) and is statistically non-significant (p=0.685). Furthermore, the SE = 0.072 and the $f^2 = 0.002$ reinforce that the path from PL to MAL is imprecise. Production Linkages alone do not directly translate into improved market access. The very small effect size demonstrates that production linkages can influence

market access indirectly by other mediating factors like training or information access.

Agricultural Extension Training (AET) => Market Access Level (MAL). The path of AET => MAL shows a strong (β = 0.644) and statistically significant (p = 0.000) positive effect. This means that involvement in extension trainings has a considerable positive influence on the ability to access markets. This equips farmers with the needed modernized techniques in production, handling skills in harvest and post-harvest, quality standards, and knowledge in marketing which enhances their competitiveness. The moderate-to-large effect size (SE = 0.052, f^2 = 0.209) confirms its practical importance in the model in influencing market access level. Farmers who participate in trainings consistently enhance their capabilities. Furthermore, the effect size suggests that agricultural extension training serves as a strategic channel that links farmers to viable markets emphasizing the important role in elevating rural livelihood and economic empowerment. Thus, agricultural extension training is a statistically significant and impactful factor in strengthening farmers' competitiveness and long-term market participation.

Market Information Access (MIA) => Market Access Level (MAL). Lastly, this path shows a negligible (β =-0.071) and statistically non-significant effect (p=0.346), and the negative coefficient suggests a weak inverse relationship. This suggests that access to information alone does not guarantee increased market participation. Farmers who lack the necessary resources, networks, or transportation to act on it even if they have access to information still receive limited benefit. However, due to the small effect size (f^2 =0.004), this path does not contribute meaningfully to market linkage formation. The small effect emphasized that there is a need to incorporate information with trainings in order to attain the desired market outcomes.

The assessment of indirect effects in the structural model reveals that there are only two variables linking Agricultural Extension Training (AET) and Market Access Level (MAL). Specifically, Education Level (EL) and Distance to Market (DM) show as the only significant mediators which exert meaningful indirect influence on Markert Access Level (MAL) through Agricultural Extension Training (AET) with EL ⇒ AET ⇒ MAL (β = 0.406, SE = 0.052, p = 0.000) and DM ⇒ AET ⇒ MAL (β = 0.092, SE = 0.027, p = 0.029), respectively. Findings highlight the critical role of Agricultural Extension Training (AET) as a mediating mechanism that enables the translation of farmers' educational attainment and locational characteristics into enhanced market participation

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Table 5. Assessment of Structural Model (Indirect effects)

Structure	*β*	SE	value-*p*	Remark
MAL ⇒ PL ⇒ EL	0.010	0.018	0.686	Not Significant
MAL ⇒ AET ⇒ EL	0.406	0.052	0.000	**Significant**
MAL ⇒ MIA ⇒ EL	0.035-	0.026	0.350	Not Significant
MAL ⇒ PL ⇒ FE	0.005	0.012	0.689	Not Significant
MAL ⇒ AET ⇒ FE	0.045	0.035	0.269	Not Significant
MAL ⇒ MIA ⇒ FE	0.004-	0.005	0.539	Not Significant
MAL ⇒ PL ⇒ FS	0.003-	0.004	0.702	Not Significant
MAL ⇒ AET ⇒ FS	0.039	0.023	0.317	Not Significant
MAL ⇒ MIA ⇒ FS	0.012-	0.008	0.374	Not Significant
MAL ⇒ PL ⇒ DM	0.007	0.011	0.687	Not Significant
MAL ⇒ AET ⇒ DM	0.092	0.027	0.029	**Significant**
MAL ⇒ MIA ⇒ DM	0.017-	0.012	0.361	Not Significant

In summary, agricultural extension training increases the capacity of farmers to use new knowledge and technologies thus building stronger market participation. In the same manner, farmers located closer to markets are more benefited from extension trainings through adopted market responsive practices. The important role of Agricultural Extension Training (AET) emphasizes the need to boost and strengthen agricultural extension programs for inclusive growth.

The figure presents the relationships among the key variables influencing Market Access Level (MAL) of smallholder farmers. The model integrates both direct and indirect path showing how latent constructs like Education Level (EL), Farming Experience (FE), Farming Size (FS), and Distance to Market (DM) influence Market Access Level (MAL) through mediating variables like Production Linkages (PL), Agricultural Extension Training (AET), and Market Information Access (MIA).

Each path indicates statistically significant effect (p=0.000) and have relatively small SE values for EL ⇒ AET ⇒ MAL(SE=0.052) and DM ⇒ AET ⇒ MAL (SE=0.027), demonstrating that the significant indirect effects are not only statistically valid but also measured with confidence. The figure above visually strengthens the empirical findings from the model, particularly the central role of Agricultural Extension Training (AET) in mediating the effects of Education Level (EL) and Distance to Market (DM) on Market Access Level (MAL). In contrast, other indirect paths are not statistically significant, such as FS and FE towards MAL. Moreover, without the mediating influence of AET, structural and informational factors alone may not be sufficient to drive market integration.

Table 6 below presents the Variance Inflation Factor (VIF) results. All items for Education Level (EL), Farming Experience (FE), Farm Size (FS), and Distance to Market (DM) recorded VIF values ranging from 1.203 to 4.960, which fall below the threshold of 5.0. This suggests that the exogenous constructs in the model are free from multicollinearity issues, meaning that each indicator contributes uniquely to measuring its respective latent variable without redundancy.

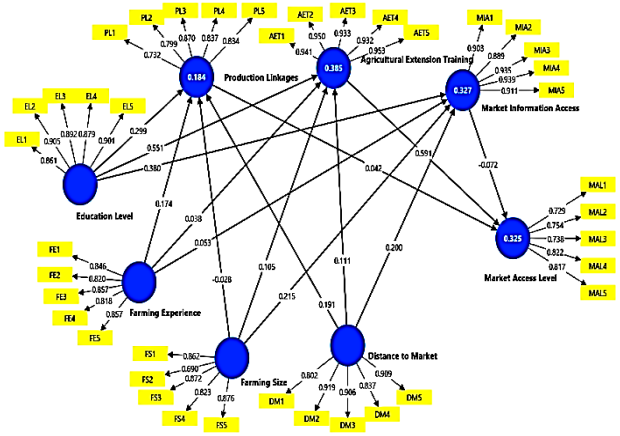

Figure1. Structural model

Table 6. Variance Inflation Factor (VIF) results.

Education Level (EL)		Farming Experience (FE)		Farm Size (FS)		Distance to Market (DM)	
Items	**VIF**	**Items**	**VIF**	**Items**	**VIF**	**Items**	**VIF**
EL1	2.841	FE1	2.143	FS1	3.757	DM1	2.121
EL2	4.116	FE2	2.475	FS2	1.203	DM2	3.853
EL3	3.157	FE3	2.981	FS3	4.049	DM3	3.483
EL4	3.941	FE4	2.248	FS4	4.178	DM4	3.101
EL5	4.633	FE5	2.267	FS5	4.960	DM5	4.440

VIF < 5.00

Table 7. Variance Inflation Factor (VIF) results.

Production Linkages (PL)		Agricultural Extension Training (AET)		Market Information Access (MIA)		Market Access Level (MAL)	
Items	**VIF**	**Items**	**VIF**	**Items**	**VIF**	**Items**	**VIF**
PL1	1.851	AET1	4.722	MIA1	3.968	MAL1	1.588
PL2	1.749	AET2	4.597	MIA2	3.366	MAL2	1.676
PL3	2.897	AET3	4.815	MIA3	4.307	MAL3	1.598
PL4	2.324	AET4	4.299	MIA4	4.373	MAL4	2.001
PL5	2.209	AET5	4.391	MIA5	3.897	MAL5	1.875

VIF < 5.00

Likewise, the VIF values for these constructs, which range between 1.588 and 4.815 remain below the recommended cutoff. It can be observed that the slightly higher VIF values for AET indicators (AET1–AET5) direct a strong internal consistency among the items, reflecting the construct's cohesive measurement of training-related dimensions. Nonetheless, this confirms the absence of multicollinearity because all the values are still within the acceptable range.

In general, results of the VIF analysis support that multicollinearity does not pose a concern within the proposed model. The constructs demonstrate adequate independence, allowing for strong interpretation of the direct and indirect effects as discussed in the previous data.

4. CONCLUSION AND RECOMMENDATION

Findings reveal the important role of education level and distance to market in improving the market access level of smallholder farmers through agricultural extension training. Results indicate that agricultural extension training serves as a significant mediating factor interpreting the advantages of farmers' educational level and locational accessibility into improved market participation. The indirect paths EL ⇒ AET ⇒ MAL (β = 0.406, p = 0.000) and DM ⇒ AET ⇒ MAL (β = 0.092, p = 0.029) were found to be statistically significant, emphasizing that knowledge acquisition and training participation effectively link the gap between farmers' background characteristics and their engagement in market systems.

Further, education level showed a consistent positive and significant influence on production linkages, extension training participation, and market information access. This shows that education enhances farmers' strategic, analytical, and managerial skills essential for coordination and adaptation to market demands. On the other hand, farming experience and farm size presented weak and statistically non-significant effects across most pathways signifying that traditional experience and size of land do not assure improved market integration if there is no structured institutional support.

In addition, distance to market illustrated a strong connection with production linkages, agricultural training, and market information access. This implies that geographic location promotes exposure to markets, networks and opportunities for learning. Nevertheless, direct effects of production linkages and market information access on the level of market access were minimal. Coordination and dissemination must be supplemented with active training and capacity-building activities to achieve measurable outcomes.

In general, results sustain that agricultural extension training represents the most influential path toward boosting smallholder farmers' market participation. By providing farmers with technical knowledge, skills in entrepreneurship, market-oriented competencies, agricultural extension programs increase competitiveness and contribute to inclusive agricultural growth. Thus, the study points out the indispensable role of education and training in bridging structural and information gaps within smallholder farming systems.

To enhance market participation and economic empowerment among smallholder farmers, the following recommendations are proposed:

Strengthen Agricultural Extension Programs. Agricultural extension initiatives may be expanded and institutionalized to deliver comprehensive trainings in marketing, value chain integration, and post-harvest management. Emphasis should be pointed in reaching marginalized and less-educated farmers to ensure equitable access to capacity-building opportunities.

Integrate Education and Capacity-Building Interventions. Training programs designed to address the needs of farmers may be introduced to enhance skills on analytical thinking, problem-solving and decision-making. This intensifies the indirect positive effects of education on market access.

Improve Market Infrastructure and Accessibility. Rural roads and transportation systems should be prioritized to lessen market distance barriers. Improved physical accessibility enables farmers' participation and engagement with buyers and suppliers.

Promote Synergy Between Information and Training. Dissemination system on market information should be integrated with extension training to equip farmers in translating information into actionable decisions. Knowledge acquisition combined with training interventions guarantees that information access leads to improved production and marketing outcomes.

Encourage Cooperative and Institutional Linkages. Strengthening farmers' organizations and cooperatives can increase collective marketing, input procurement, and knowledge sharing. Institutions serve as strategic platforms for delivering extension services and sustaining linkages among farmers, extension agents, and market intermediaries.

Target Experience-Based Peer Learning. Experienced farmers may be assigned as peer educators or local resource persons in extension activities. This facilitates knowledge transfer within communities and reinforces experiential learning.

Enhance Policy Support and Investment. The government may prioritize budget allocation for agricultural extension systems and market linkage programs. Public–private partnerships may also be explored to sustain training, capacity-building, and infrastructure initiatives aimed at improving farmers' competitiveness and long-term market participation.

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