

Determinants of Farmer Satisfaction with the First Open Pollinated Tomato Varieties Developed in Ghana

Stephen John Ayeh

s.john.ayeh@gmail.com

Council for Scientific and Industrial Research

Michael Kwabena Osei

Council for Scientific and Industrial Research

Natson Eyrar Amengor

Council for Scientific and Industrial Research

Akwasi Antwi Adjei

Council for Scientific and Industrial Research

James Nakoh

Council for Scientific and Industrial Research

Young Jin Kim

Korea Partnership for Innovation of Agriculture (KOPIA), RDA

Research Article

Keywords: tomato varieties, open-pollinated varieties, farmer satisfaction, technology adoption, Ghana, ordered logit regression

Posted Date: May 30th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-9683437/v1>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Determinants of Farmer Satisfaction with the First Open Pollinated Tomato Varieties Developed in Ghana

Stephen John Ayeh^{1,2}, Michael Kwabena Osei¹, Natson Eyram Amengor¹, Akwasi Antwi Adjei¹, James Nakoh¹, Young Jin Kim³

*¹CSIR-Crops Research Institute, Kumasi, P.O. Box 3785, Ghana Fumesua
P.O. Box 3785, Ghana*

*²Department of Agricultural Economics, Agribusiness and Extension, KNUST-Kumasi,
Ghana*

³Korea Partnership for Innovation of Agriculture (KOPIA), RDA, Accra, Ghana

Email of Corresponding Author: sjohn.ayeh@gmail.com

Abstract

Tomato production plays a critical role in Ghana's rural economy and household nutrition, yet domestic supply remains constrained by low productivity, pest pressures, and heavy dependence on imported varieties. To address these challenges, the Korea Partnership for Innovation of Agriculture (KOPIA), in collaboration with the CSIR-Crops Research Institute, developed and released the first locally bred open-pollinated tomato varieties aimed at improving adaptability, farmer income, and national tomato self-sufficiency. This study evaluates farmers' perceptions and satisfaction with the newly released varieties using cross-sectional survey data collected from 120 smallholder tomato farmers. Exploratory factor analysis was employed to identify latent perception dimensions, namely performance perception, marketability perception, pest and disease resistance perception, and management ease perception, which were subsequently incorporated into an ordered logistic regression model to examine determinants of farmer satisfaction levels. The results show that performance and marketability perceptions significantly increase the likelihood of higher satisfaction, highlighting the importance of market-orientated traits alongside agronomic productivity. Management ease also positively influences satisfaction, while pest and disease resistance perceptions show no independent effect once economic outcomes are considered. Extension contact and farmer experience further shape satisfaction outcomes. The results indicate that effective varietal development programs must combine agronomic performance with marketability and ease of management in order to achieve long-term adoption. Locally developed, open-pollinated varieties demonstrate strong potential to support Ghana's tomato sector industrialisation and reduce dependence on imports when complemented by effective extension services and seed system strengthening.

Keywords: tomato varieties; open-pollinated varieties; farmer satisfaction; technology adoption; Ghana; ordered logit regression.

1.0 Introduction

Tomato production plays an important role in food security, rural livelihoods, and income generation across many developing countries. As one of the most widely consumed vegetables globally, tomatoes contribute significantly to household nutrition through the provision of vitamins and micronutrients while also serving as a high-value cash crop for smallholder farmers (FAOSTAT 2022; Tiwari et al., 2022; Melomey et al., 2022). Despite increasing demand, many African countries continue to struggle with unstable domestic tomato supply, low productivity, and strong dependence on imports, reflecting persistent technological and institutional constraints within the sector (FAOSTAT 2022; Melomey et al., 2022).

In Ghana, tomato is a staple ingredient in daily diets and a major source of employment along the horticultural value chain. However, the domestic tomato industry faces longstanding challenges, including susceptibility to pests and diseases, seasonal production fluctuations, limited access to locally adapted varieties, and reliance on imported seeds (Bandanaa et al., 2023; Aidoo-Mensah, 2023; MOFA-IFPRI 2020). These constraints have contributed to a growing tomato import bill despite Ghana's favourable agroecological conditions for tomato cultivation (MoFA, 2022; MOFA-IFPRI 2020). Strengthening domestic production therefore remains a key policy priority, with particular emphasis on improving seed systems and promoting adoption of locally developed varieties.

In response, the Korea Partnership for Innovation of Agriculture (KOPIA), in collaboration with the CSIR–Crops Research Institute, implemented an intervention aimed at developing and disseminating improved tomato varieties suited to Ghanaian conditions. This initiative led to the release of two open-pollinated varieties (OPVs), CRI KOPIA and CRI-Kwabena Kwabena, representing a significant milestone in domestic varietal development. Beyond breeding, the intervention incorporated farmer training, seed distribution, and private-sector engagement to facilitate scaling and commercialization.

While varietal development and agronomic trials provide important evidence on technical performance, the sustained success of such technologies depends largely on farmers' perceptions and post-adoption experiences. Agricultural technology adoption is increasingly recognized as a dynamic process rather than a one-time decision, shaped by learning, expectations, and realized outcomes over time (Amina et al., 2025; Adnan et al., 2025; Ayeh et al., 2025; Zhang, et al., 2024; Adams and Jumpah, 2021). Empirical studies show that farmers evaluate technologies not only based on yield performance but also on attributes such as marketability, input requirements, and profitability (Shafiwu and Cobbinah, 2022; Akomodo et al., 2023). Technologies that fail to meet these expectations often face disadoption, even when experimental results appear promising (Karbo et al., 2024).

Despite extensive literature on adoption of improved crop varieties, limited attention has been given to farmer satisfaction as an outcome of adoption, particularly in the context of newly released, locally developed vegetable varieties. Existing studies in Ghana and similar contexts have largely focused on adoption determinants and welfare impacts, with less emphasis on how farmers perceive and evaluate technologies after use (Wongnaa et al., 2023; Osei et al., 2018). This represents an important gap, as satisfaction plays a critical role in continued use, scaling, and long-term impact of agricultural innovations (Amina et al., 2025; Wale & Mkuna, 2023).

The release of locally developed OPV tomato varieties under the KOPIA initiative provides a unique opportunity to address this gap. Understanding how farmers perceive these varieties

and what drives their satisfaction is essential for improving farmer-centered breeding strategies, strengthening seed systems, and enhancing the effectiveness of agricultural development interventions.

This study therefore examines farmers' perceptions and determinants of satisfaction with newly released tomato varieties in Ghana. Specifically, it (i) identifies key perception dimensions influencing farmer evaluations using exploratory factor analysis, and (ii) analyzes the effects of these perceptions and farmer characteristics on satisfaction using an ordered logistic regression model. By shifting focus from adoption decisions to post-adoption evaluation, the study contributes to the literature on agricultural technology adoption and provides policy-relevant insights for sustainable transformation of the horticultural sector.

2.0 Methodology

2.1 Study Area

The study was conducted in seven major tomato-producing municipalities in Ghana, namely Ashanti Akyem North Municipal, Mampong Municipal, and Offinso North Municipal in the Ashanti Region, Techiman North Municipal in the Bono East Region, as well as Berekum West District, Dormaa East District, and Jaman South Municipal in the Bono Region. These municipalities were purposively selected because they formed part of the operational zones of the KOPIA Tomato Project, which distributed improved tomato seed varieties to farmers. The study area is characterised by favourable agroecological conditions for tomato production and represents important hubs within Ghana's tomato value chain. Tomato production is a major income-generating activity across farming communities in these municipalities.

2.1 Source of Plant Material

The study focused on two open-pollinated tomato varieties, CRI KOPIA and CRI-Kwabena Kwabena, which were developed and bred by the CSIR–Crops Research Institute (CSIR-CRI), Ghana, under the Korea Partnership for Innovation of Agriculture (KOPIA) intervention. Seeds of the varieties were distributed to participating farmers through the KOPIA Ghana project as part of varietal dissemination and scaling activities in selected tomato-producing municipalities in Ghana.

2.3 Research Design and Sampling Procedure

The study employed a cross-sectional survey design integrating both quantitative and qualitative approaches to collect data from tomato farmers. This design enabled data collection at a single point in time to assess farmers' experiences and perceptions following the dissemination of improved tomato varieties under the KOPIA intervention. A total of 160 tomato farmers across seven municipalities benefited from the intervention, with an average of 20 farmers selected from five communities within each municipality; this group constituted the study population.

A multistage sampling technique was adopted. First, the seven municipalities involved in the KOPIA Tomato Project were purposively selected. Second, beneficiary communities within each municipality were identified, and seeds were identified with the assistance of agricultural

extension officers. At the community level, respondents were identified using a snowball sampling technique to locate dispersed beneficiaries and ensure adequate coverage. This approach was particularly useful in reaching farmers who were not easily identifiable through official records. In total, 120 smallholder tomato farmers were interviewed across the selected municipalities.

2.4 Data Collection and Analysis

Primary data were collected through a structured questionnaire administered via face-to-face interviews. The questionnaire captured information focused on farmer-reported outcomes, including varietal performance, perceptions of key attributes, and satisfaction with the improved tomato varieties. The questionnaire consisted of both closed-ended and open-ended questions, as well as Likert-scale items designed to capture perception variables. Enumerators were trained prior to data collection to ensure consistency in administering the questionnaire and to improve data quality.

The collected data were analysed using Stata version 16. Descriptive statistics, including means, standard deviations, frequencies, and percentages, were used to summarise the socioeconomic characteristics of respondents and key study variables.

Farmers' perceptions of the OPV tomato varieties were measured using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

The mean perception index for each attribute was computed as:
The mean perception index for each attribute was estimated as:

$$Mean\ Index = \frac{\sum_{i=1}^n R_i \cdot f_i}{\sum_{i=1}^n f_i} \quad (1)$$

Where;

- R_i = the i th Likert scale score
- f_i = the number of respondents who selected the i th response
- n = the total number of response categories.

Because individual perception indicators may capture similar latent concepts, to identify the underlying perception dimensions associated with OPV tomato varieties an Exploratory Factor Analysis (EFA) was conducted using principal factor extraction with varimax rotation.

2.5 Analytical Framework and Model Specification

Farmers' satisfaction with OPV tomato varieties was measured using an ordered categorical variable ranging from low (1) to high satisfaction (5) levels. Because the dependent variable is ordinal rather than continuous, an ordered logistic regression (ordered logit) model was employed. The ordered logit model is appropriate when the dependent variable is ordinal in nature, as it accounts for the inherent ranking of response categories while estimating the effects of explanatory variables (Fullerton, 2009; Chiphang and Singh, 2020; Yano et al.,

2021). In this study, the dependent variable, overall satisfaction with the varieties (satisfied *performance*), was measured on a five-point Likert scale, ranging from 1 (very dissatisfied) to 5 (very satisfied). Given the ordered structure of this variable, the ordered logistic regression model was preferred over linear or multinomial models, as it preserves the ordinal information and ensures efficient estimation (Fullerton, 2009; Brant, 1990). The ordered logit model estimates the probability that a farmer falls into a given satisfaction category based on explanatory variables. The model uses threshold parameters (cut points) to divide the latent satisfaction scale into observed categories. The predicted probabilities are computed using the logistic cumulative distribution function.

Let S_i^* denote the unobserved latent satisfaction level of farmer i , defined as:

$$S_i^* = \beta X_i + \varepsilon_i \quad (2)$$

where:

- S_i^* is the latent satisfaction level
- X_i represents a vector of explanatory variables including perception factors and farmer characteristics,
- β denotes vector of parameters to be estimated,
- ε_i is the error term assumed to follow a logistic distribution.

The observed satisfaction category S_i is determined by threshold parameters such that:

$$S_i = \begin{cases} 1, & \text{if } S_i^* \leq \mu_1 \\ 2, & \text{if } \mu_1^* < S_i^* \leq \mu_2 \\ 3, & \text{if } \mu_2^* < S_i^* \leq \mu_3 \\ 4, & \text{if } \mu_3^* < S_i^* \leq \mu_4 \\ 5, & \text{if } S_i^* > \mu_4 \end{cases} \quad (3)$$

where $\mu_1, \mu_2, \mu_3, \mu_4$ are threshold parameters to be estimated.

The probability of observing a particular satisfaction level is given by:

$$P(S \leq j) = F(\mu_j - \beta X) \quad (4)$$

Ordered logit uses the logistic cumulative distribution function (CDF):

$$F(z) = \frac{1}{1 + e^{-z}} \quad (5)$$

where $F(\cdot)$ is the logistic cumulative distribution function.

3. Results

3.1 Farmers' Perception of OPV Tomato Varieties

Table 1 presents descriptive statistics of farmers' responses to perception statements regarding locally bred OPV tomato varieties. Overall, the results indicate that farmers held generally positive perceptions of most varietal attributes. High mean scores were recorded for germination vigour (4.71), fruit colour and appearance (4.35), and profitability (4.08), suggesting that these attributes are highly valued by farmers. Similarly, fruit firmness and storage ability (4.04) and disease tolerance (4.01) were positively rated. However, relatively lower mean values were observed for market acceptance (3.39), labour requirements (3.33), and pest tolerance (3.51), indicating some variability in farmers' experiences with these attributes. These variations suggest that while the locally bred OPV tomato varieties are generally well perceived, certain production and market-related challenges persist.

Table 1: Descriptive Statistics of Perception Statements

Variable Name	Perception statement	Mean	Std. Dev.	Min	Max
f1	The seed had good germination vigor.	4.71	0.4745	3	5
f2	The variety showed strong plant growth and vigor in the field.	4.22	0.4525	3	5
f3	The variety matured early enough for my cropping schedule	3.93	0.6880	3	5
f4	The yield from this variety was satisfactory.	4.14	0.8023	1	5
f5	The variety performed well under my field conditions.	3.97	0.7326	1	5
f6	The variety was tolerant to common pests in my area.	3.51	0.6481	1	5
f7	The variety was tolerant to major diseases affecting production	4.01	0.8044	2	5
f8	I had to use fewer pesticides on this variety compared to others	3.80	0.5439	2	5
f9	The fruits had a good size and shape for my target market.	3.64	1.0191	1	5
f10	The fruits had good color and appearance.	4.35	0.9317	1	5
f11	The fruits were firm and stored well after harvest.	4.04	0.8925	1	5
f12	The flavor/taste of the fruits was good for home use	3.93	0.6373	1	5
f13	The fruits transported well without too much loss or damage.	4.10	0.9019	1	5
f14	Buyers in the market accepted this variety well.	3.39	0.7136	1	5
f15	I was able to sell this variety at a good price.	3.65	0.7631	1	5
f16	The variety reduced post-harvest losses compared to others.	3.53	0.7093	1	5
f17	The variety was profitable to grow under rain-fed condition.	4.08	0.8360	1	5
f18	This variety was easy to manage in the field	3.66	0.6011	2	5
f19	The amount of fertilizer and spraying required was reasonable.	3.73	0.6477	3	5
f20	The variety did not require too much labor compared to others	3.33	0.8903	1	5

3.2 Factor Analysis and Construct Development

The suitability of the data for factor analysis (Table 2) was confirmed using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett’s test of sphericity. The KMO value of 0.748 indicates good sampling adequacy, while Bartlett’s test was statistically significant ($\chi^2 = 2243.60$, $p < 0.001$), confirming sufficient correlations among variables.

Using principal factor analysis with varimax rotation, four factors were extracted based on the Kaiser criterion (eigenvalues greater than one) together with inspection of the scree plot. Figure 1 shows the scree plot having eigenvalues on the vertical (y-axis) and the number of constructs extracted on the horizontal (x-axis). The rotated factor solution revealed four distinct perception constructs: performance perception, marketability perception, pest and disease resistance perception, and management ease perception, collectively explaining over 90% of the total variance, suggesting a strong underlying factor structure.

All retained items exhibited factor loadings greater than 0.40, indicating strong associations with their respective constructs. The performance perception construct captured attributes related to production performance and product quality. The marketability perception construct comprised traits associated with price, consumer preference, and postharvest handling. The pest and disease resistance construct reflected farmers’ assessments of varietal resilience, while the management ease construct captured labour and input requirements. Reliability analysis showed strong internal consistency across constructs, with Cronbach’s alpha values ranging from 0.79 to 0.92, indicating that the items reliably measure the underlying perception dimensions.

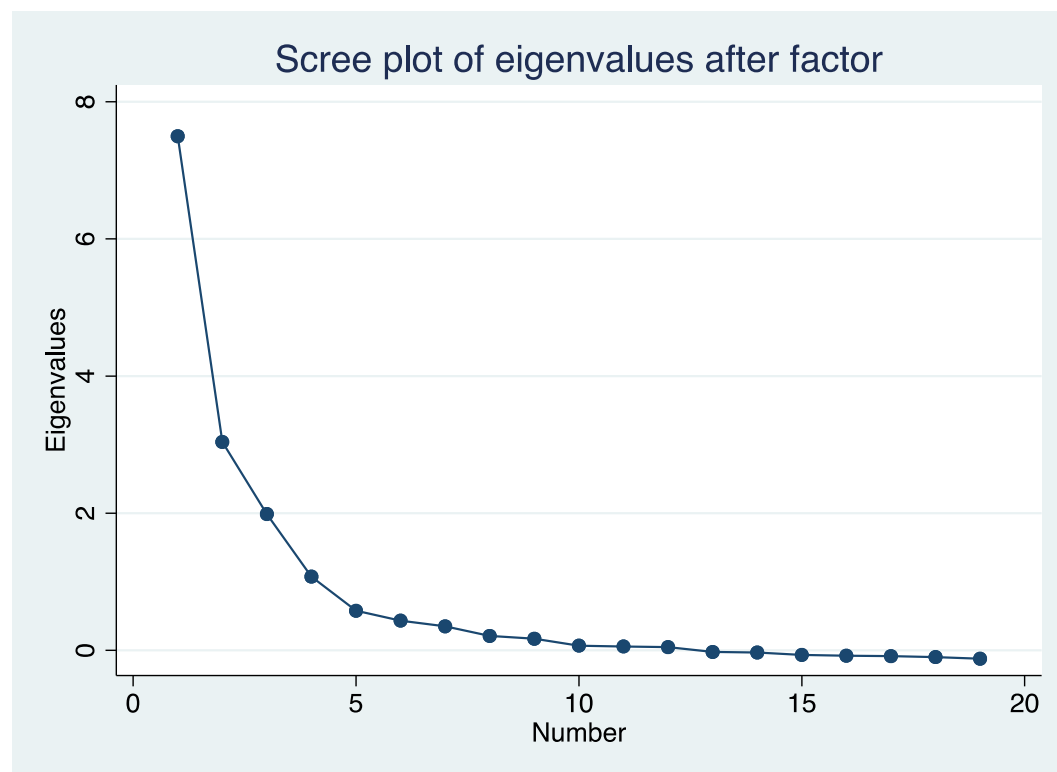


Fig. 1

Table 2: Rotated Factor Analysis and Reliability Statistics

Construct	Item	Factor Loading	No. of items	Cronbach alpha
Performance Perception	The seed had good germination vigor.	0.6701	8	0.9155
	The amount of fertilizer and spraying required was reasonable.	0.7103		
	The variety matured early enough for my cropping schedule	0.8481		
	The fruits were firm and stored well after harvest.	0.8974		
	The yield from this variety was satisfactory	0.6138		
	The fruits transported well without too much loss or damage.	0.9065		
	The variety was profitable to grow under rain-fed condition.	0.6983		
	The variety performed well under my field conditions	0.8503		
Marketability Perception	The fruits had good color and appearance.	0.7465	6	0.8772
	The flavor/taste of the fruits was good for home use.	0.6387		
	The fruits had a good size and shape for my target market.	0.7292		
	Buyers in the market accepted this variety well.	0.7711		
	I was able to sell this variety at a good price.	0.7278		
	The variety reduced post-harvest losses compared to others.	0.7954		
Pest and Disease Resistance Perception	The variety was tolerant to common pests in my area.	0.8014	3	0.7886
	The variety was tolerant to major diseases affecting tomatoes here.	0.8946		
	I had to use fewer pesticides on this variety compared to others	0.4949		
Management Ease Perception	This variety was easy to manage in the field	0.6374	2	0.7974
	The variety did not require too much labor compared to others	0.7627		
<i>Kaiser-Meyer-Olkin Measure of Sampling Adequacy.</i>		0.748		
<i>Bartlett's Test of Sphericity χ^2</i>		2243.595		
<i>Degrees of freedom</i>		171		
<i>p-value</i>		0.000		

3.3 Descriptive Statistics of Model Variables

Table 3 presents descriptive statistics of the variables used in the ordered logistic regression analysis. The average overall satisfaction level among farmers was 2.91, indicating moderate satisfaction with locally bred OPV tomato varieties. The perception constructs exhibit notably elevated mean values, with performance perception at 4.02, marketability perception at 3.61, pest and disease perception at 3.77, and management perception at 3.97. This suggests that farmers generally have positive perceptions of the varieties. Regarding socioeconomic characteristics, the average age of farmers was 38.9 years, with an average of 10.9 years of schooling and 14.1 years of farming experience. The majority of respondents were male (82%). Farmers reported an average of five (5) extension visits and cultivated approximately 2.4 acres of tomato, with an average household size of six (6) members.

Table 3: Descriptive Statistics of Model Variables

Variable	Mean	Std. Dev.	Min	Max
Satisfied Performance	2.91	0.889	1	5
Performance perception	4.02	0.619	1.9	5
Market perception	3.61	0.559	2.6	5
Pest and disease perception	3.77	0.565	2	5
Management perception	3.97	0.733	1	5
Age	38.86	8.614	22	68
Years of schooling	10.90	3.479	0	16
Sex (<i>Male=1</i>)	0.82	0.389	0	1
Years of farming	14.08	9.993	3	48
Extension visit	4.97	4.788	0	20
Farm size	2.36	1.760	0	15
Household size	6.0	2.763	1	15

3.4 Determinants of Farmers' Satisfaction

The results of the ordered logistic regression model are presented in Table 4. The model is statistically significant (LR $\chi^2 = 93.33$, $p < 0.001$), which means that the explanatory variables have a combined effect on how satisfied farmers are. The *pseudo R*² value of 0.3405 suggests a substantial explanatory power of the model.

Performance perception has a positive and statistically significant effect on farmer satisfaction ($\beta = 1.7727$, $p < 0.01$), indicating that improvements in production and product quality attributes increase the likelihood of higher satisfaction levels. Similarly, marketability perception is positive and significant ($\beta = 1.8741$, $p < 0.01$), suggesting that favourable market-related attributes enhance farmer satisfaction. Management perception also shows a positive and significant effect ($\beta = 0.8979$, $p < 0.05$), indicating that ease of production and lower labour requirements contribute to greater satisfaction. In contrast, pest and disease perception is not statistically significant, suggesting that this factor plays a minor role in determining satisfaction in this context.

Among socioeconomic variables, age has a positive and significant effect ($\beta = 0.0976$, $p < 0.05$), indicating that older farmers are more likely to report higher satisfaction. Years of schooling show a negative and significant effect ($\beta = -0.1702$, $p < 0.05$), suggesting that more

educated farmers may have higher expectations regarding varietal performance. Sex has a negative and significant coefficient ($\beta = -1.9918$, $p < 0.01$), indicating differences in satisfaction levels between male and female farmers. Farming experience also has a negative and significant effect ($\beta = -0.1419$, $p < 0.01$), suggesting that more experienced farmers may be more critical in their evaluations. Extension visits positively influence satisfaction ($\beta = 0.1182$, $p < 0.05$), highlighting the importance of access to information and advisory services. Farm size has a negative and significant effect ($\beta = -0.4585$, $p < 0.01$), while household size has a positive and significant effect ($\beta = 0.4667$, $p < 0.01$).

Table 4: Ordered Logit Results

Satisfied performance	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Performance perception	1.7727	0.5209	3.40	0.001***	0.7517	2.7937
Market perception	1.8741	0.6865	2.73	0.006***	0.5286	3.2196
Pest-disease perception	-0.4820	0.4359	-1.11	0.269	-1.3363	0.3724
Management perception	0.8979	0.3809	2.36	0.018**	0.1513	1.6444
Age	0.0976	0.0397	2.46	0.014**	0.0198	0.1754
Education (<i>Years</i>)	-0.1702	0.0846	-2.01	0.044**	-0.3359	-0.0044
Sex (<i>Male=1</i>)	-1.9918	0.6183	-3.22	0.001***	-3.2037	-0.7798
Farming experience	-0.1419	0.0422	-3.36	0.001***	-0.2246	-0.0592
Extension visit	0.1182	0.0500	2.37	0.018**	0.0203	0.2162
Farm size (<i>Acre</i>)	-0.4585	0.1418	-3.23	0.001***	-0.7364	-0.1807
Household size	0.4667	0.1317	3.55	0.000***	0.2087	0.7248
/cut1	12.1227	3.0141			6.2151	18.0303
/cut2	14.1186	3.1326			7.9789	20.2584
/cut3	19.3244	3.4629			12.5373	26.1116
/cut4	21.1691	3.5090			14.2916	28.0466
Number of obs	120					
LR chi2(11)	93.33					
Prob > chi2	0.000					
Pseudo R2	0.3405					
Log likelihood =	-90.993483					

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

3.5 Marginal Effects of Explanatory Variables

Table 5 shows how the explanatory variables affect the chances of farmers being in different satisfaction groups. An increase in performance perception significantly reduces the probability of being very dissatisfied and dissatisfied, while increasing the probability of being satisfied and very satisfied. A similar pattern is observed for marketability perception, indicating that improvements in market-related attributes enhance positive satisfaction outcomes. Management perception also significantly increases the likelihood of higher satisfaction levels while reducing dissatisfaction probabilities. In contrast, pest and disease perception does not significantly affect the probability distribution across satisfaction categories. Among socioeconomic variables, increases in age and extension visits are associated with a higher probability of satisfaction, while increases in farming experience and farm size reduce the likelihood of higher satisfaction levels. Household size increases the probability of satisfaction, suggesting that family labour or support shapes perceptions.

Table 5: Ordered logit model Marginal Effects results for Satisfied Performance

Satisfied Performance	Very Dissatisfied		Dissatisfied		Somehow Satisfied		Satisfied		Very Satisfied	
	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z	dy/dx	P>z
Perform perception	-0.0845	0.001***	-0.0850	0.005***	0.0382	0.226	0.0761	0.006***	0.0552	0.015**
Market perception	-0.0894	0.018**	-0.0898	0.009***	0.0403	0.271	0.0805	0.017**	0.0584	0.020**
Pestdisease percept	0.0230	0.287	0.0231	0.298	-0.0104	0.472	-0.0207	0.263	-0.0150	0.272
Management percep	-0.0428	0.018**	-0.0430	0.035**	0.0193	0.253	0.0386	0.042**	0.0280	0.046**
Age	-0.0047	0.020**	-0.0047	0.034**	0.0021	0.290	0.0042	0.027**	0.0030	0.033**
Years of schooling	0.0081	0.063*	0.0082	0.068*	-0.0037	0.338	-0.0073	0.066*	-0.0053	0.04**
Sex	0.0950	0.005***	0.0955	0.003***	-0.0429	0.244	-0.0855	0.008***	-0.0621	0.011**
Years of farming	0.0068	0.003***	0.0068	0.005***	-0.0031	0.254	-0.0061	0.009***	-0.0044	0.006***
Extension visit	-0.0056	0.028**	-0.0057	0.028**	0.0025	0.275	0.0051	0.042**	0.0037	0.031**
Farm size	0.0219	0.004***	0.0220	0.001***	-0.0099	0.221	-0.0197	0.015**	-0.0143	0.007***
Household size	-0.0223	0.001***	-0.0224	0.004***	0.0100	0.237	0.0200	0.008***	0.0145	0.005***

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.10.

4.0 Discussion

The generally high ratings for most perception attributes suggest that farmers have a positive outlook on the two locally bred OPV (CRI KOPIA and CRI-Kwabena Kwabena) tomato varieties. They particularly prioritise traits such as germination, vigour, fruit appearance, and profitability, reflecting their focus on factors that contribute to successful production and market value. These findings demonstrate that farmers are concerned with both the agronomic performance and the market-orientated characteristics of improved crop varieties. This aligns with previous research, which indicates that farmers assess improved crop varieties not solely based on yield performance but also by considering attributes that merge agronomic efficiency with desirable market traits such as yield, quality, and profitability (Asante et al., 2023; Shafiwu and Cobbinah., 2022; Akomdo et al., 2023).

Both perception-related factors and socioeconomic characteristics strongly influence farmers' satisfaction with the locally bred OPV tomato varieties. Among the perception constructs, performance perception and marketability perception significantly increased the likelihood of higher satisfaction. This suggests that farmers primarily evaluate OPV tomato varieties based on their agronomic productivity, as well as their ability to generate favourable market outcomes. Similar findings have been reported in studies examining farmers' preferences for tomato varieties in Ghana, where traits such as high yield, fruit quality, market acceptance, and post-harvest performance were identified as key determinants of varietal choice and satisfaction (Melomey et al., 2022; Asante et al., 2020). These results highlight the growing importance of market-orientated traits in horticultural production systems, where farmers often prioritise attributes that enhance income opportunities and reduce post-harvest losses.

Management ease perception also showed a positive and significant effect on satisfaction, indicating that varieties requiring less labour and simpler management practices are more likely to generate favourable farmer experiences. This finding aligns with technological adoption studies that show that farmers tend to favour innovations that reduce operational complexity and labour requirements (Vecchio et al., 2020; Shafiwu and Cobbinah., 2022; Kule et al., 2025). Once we controlled for other factors, pest and disease resistance perception did not significantly influence satisfaction. Although resistance traits are generally important in varietal selection, farmers may evaluate these attributes indirectly through yield performance and economic outcomes rather than as standalone characteristics.

Socioeconomic characteristics also played an important part in determining farmer satisfaction. Age positively influenced satisfaction, suggesting that older farmers may rely on accumulated experience when evaluating new technologies, a finding consistent with studies indicating that experience can enhance farmers' ability to assess technology reliability under local conditions (Shafiwu et al., 2025; Baffour-Ata et al., 2025). However, other studies report that younger farmers tend to adopt innovations more readily because they are more willing to experiment with new technologies (Asante et al., 2023; Vecchio et al., 2020), indicating that the role of age may vary across contexts. Years of schooling exhibited a negative relationship with satisfaction, which may reflect the tendency of more educated farmers to hold higher expectations regarding technology performance and economic returns (Ayeh et al., 2025; Baffour-Ata et al., 2025).

Gender differences were also observed, with male farmers reporting lower satisfaction levels compared with female farmers, possibly reflecting differences in production roles and

perceptions of varietal attributes in vegetable farming systems. Extension visits significantly improved farmer satisfaction, confirming the critical role of extension services in facilitating technology use and improving farmers' understanding of recommended management practices (Shafiwu and Cobbinah, 2022). Farm size showed a negative relationship with satisfaction, suggesting that managing larger plots may increase production complexity and associated risks, which could lead to feelings of overwhelm and dissatisfaction among farmers. Finally, household size positively influenced satisfaction, likely reflecting the importance of family labour in labour-intensive crops, such as tomato production. Larger households may provide additional labour, which improves farm management efficiency and enhances production outcomes.

5.0 Conclusions and Policy Implications

This study examined farmers' perceptions and satisfaction with locally developed open-pollinated tomato varieties under the KOPIA intervention in Ghana. The results show that performance, marketability, and management ease significantly enhance farmer satisfaction, while pest and disease resistance does not independently influence satisfaction outcomes. Socioeconomic factors, including age, education, farming experience, extension access, and farm size, also play important roles in shaping farmer evaluations.

The findings provide important policy insights for reducing Ghana's dependence on tomato imports. The CRI KOPIA tomato and CRI -Kwabena Kwabena tomato varieties demonstrate strong potential as locally adapted alternatives capable of improving domestic production and market competitiveness. However, achieving import substitution requires more than varietal availability. A coordinated approach that integrates market-orientated breeding, strengthened extension services, and improved seed systems is essential. Framing the promotion of these open-pollinated varieties as part of a broader strategy for enhancing agricultural productivity and reducing import dependence can contribute to building a more resilient and self-sufficient tomato sector in Ghana.

Author Contributions:

Conceptualization, S.J.A. and M.K.O., methodology, S.J.A. and N.E.A.; software, S.J.A.; validation, M.K.O., Y.J.K., and N.E.A.; formal analysis, S.J.A. and N.E.A.; investigation, S.J.A., A.A.A., J.N.; curation, A.A.A. and J.N.; writing—original draft preparation, S.J.A., and N.E.A., writing— review and editing, S.J.A., M.K.O, and N.E.A.; supervision, M.K.O., and Y.J.K.; All authors have read and agreed to the published version of the manuscript.

Declaration

Ethical consent and approval

The study protocol adhered to the standard ethical principles for research involving human participants, as outlined in the Declaration of Helsinki (WMA, 1964). This commitment prioritises the rights, safety, and well-being of all participants. Ethical consent was reviewed and approved by the CSIR–Crops Research Institute in Ghana, ensuring compliance with ethical research standards.

Consent to Participate

Informed consent was obtained from all participants before data collection commenced. Participants were made aware that their involvement was voluntary and that they had the right to withdraw at any time. They were assured of confidentiality and anonymity, and all the data collected was used exclusively for research purposes.

Consent for publication

All the data collected was handled with confidentiality and used solely for academic purposes, in accordance with the principles of privacy and data protection outlined in the declaration. The manuscript does not contain any identifiable personal data. Verbal consent for the publication of information derived from participants was also obtained.

Field Permission

Permission to conduct the field survey was obtained from the municipal agricultural offices in all seven selected study municipalities. Additionally, consent was secured from extension agents and lead farmers within the local community prior to data collection. Interviews were carried out with the consent of the participating farmers.

Plant Guidelines

The CSIR–Crops Research Institute officially developed and bred the tomato varieties used in the study under the KOPIA Ghana intervention. The plant materials were cultivated varieties distributed through the project to participating farmers. All activities involving plant materials complied with relevant institutional and national agricultural research guidelines in Ghana. No wild plant collection was undertaken, and therefore no special collection permits or licences were required.

Permission to Collect Plant Material

The seeds used in the study were obtained through the official distribution system for the KOPIA Ghana project implemented by the CSIR–Crops Research Institute. No wild plant collection was undertaken, and no special collection permits were required.

Conflict of interest

The authors declare that there is no known conflict of interest associated with this submission.

Data availability statement

The data from which the study was conducted is available from corresponding author upon request.

Acknowledgment

We thank the Korea Partnership for Innovation of Agriculture (KOPIA) Ghana Center for technical guidance and logistical support during data collection for this impact assessment. The cooperation of KOPIA staff and partner farmers was invaluable to the success of the survey.

Funding

This study was conducted as part of activities under the KOPIA programme; however, no direct funding was received for this specific research.

Reference

1. A FAOSTAT (2022) Online Statistical Database of the Food and Agriculture Organization of the United Nations. Available online: <http://www.fao.org/faostat/en/#data/TP> (accessed on 11 January 2026).
2. Adams, A., and Jumpah, E. T. (2021). Agricultural technologies adoption and smallholder farmers' welfare: Evidence from Northern Ghana. *Cogent Economics & Finance*, 9(1). <https://doi.org/10.1080/23322039.2021.2006905>
3. Adnan, N., Rehman, H. M., & Alam, M. N. (2025). Exploring agricultural innovation: Factors influencing adoption and non-adoption of smart fertilizer technology among farmers in developing countries. *Agriculture & Food Security*, 14(11). <https://doi.org/10.1186/s40066-025-00529-0>
4. Aidoo-Mensah, D. (2023). *Determinants of savings frequency among tomato farmers in Ghana*. *Cogent Economics & Finance*, 11(1), 2196862. <https://doi.org/10.1080/23322039.2023.2196862>
5. Akomdo, C., Bakang, J.-E. A., Tham-Agyekum, E. K., Akese, I., Oye, S., Yankyerah, O. K., & Prah, S. (2023). *Adoption of good agronomic practices by tomato farmers in rural Ghana: An application of the unified theory of acceptance and use of technology*. *Agricultural Socio-Economics Journal*, 23(2), 185–197. <http://dx.doi.org/10.21776/ub.agrise.2023.023.2.8>
6. Amina, W., Warraich, N. F., & Rafiq, M. (2025). Factors influencing farmers' satisfaction and adoption of mobile phone applications for agricultural purposes: A systematic review. *Journal of Agricultural Research*, 63(2), 171–186 <https://doi.org/10.58475/2025.63.2.1145>
7. Asante, B. O., Frimpong, B. N., Asante, M. D., Prah, S., Ayeh, S. J., Sakyiamah, B., Zenna, N., Mujawamariya, G., & Tufan, H. A. (2023). *Exploring gender differences in the role of trait preferences among stakeholders in the rice value chain in Ghana*. *Sustainability*, 15(7), 6026. <https://doi.org/10.3390/su15076026>
8. Asante, B. O., Osei-Adu, J., Bonsu, K. O., Osei, M. K., Adabah, R., Ayeh, S. J., Okyere, J., Gyoungrae, C., Hakyung, J., & Soonsung, H. (2020). *Farmers' perceptions and preferences for improved varietal traits in the Wenchi and Offinso North municipalities of Ghana*. *Journal of the Korean Society of International Agriculture*, 32(2), 81–91. <https://doi.org/10.12719/KSIA.2020.32.2.81>
9. Ayeh, S. J., Asante, B. O., Tham-Agyekum, E. K., Sakyiamah, B., Bakang, J.-E. A., Asante, M. D., & Nartey, E. N. (2025). Rice farming in Ghana: Exploring varietal choices, perceptions, and production constraints in Ejura-Sekyeredumase, Atwima Nwabiegya, and Kedjebi districts. *International Journal of Research and Innovation in Social Science (IJRISS)*, 9(15), Special Issue on Economics. <https://doi.org/10.47772/IJRISS.2025.915EC0036>
10. Baffour-Ata, F., Mensah, S. C., Kuutiero, R. P., Opoku, D. A., Agboto-Seguin, C. S., Sonful, E. A., Darkoh, C. A. P., Oteng, N. D., & Darkwah, E. (2025). *Assessing climate-smart agricultural practices and socioeconomic determinants in Atwima Kwanwoma District, Ghana*. *Scientific African*, 29, e02916. <https://doi.org/10.1016/j.sciaf.2025.e02916>
11. Bandanaa, J., Bosomtwe, A., Danson-Anokye, A., Adjei, E., Bissah, M., & Kotey, D. A. (2024). Determinants of pesticide use among tomato farmers in the Bono and Ahafo regions of Ghana. *Scientific Reports*. <https://doi.org/10.1038/s41598-024-55169-4>
12. Brant, R. (1990). Assessing proportionality in the proportional odds model for ordinal logistic regression. *Biometrics*, 46(4), 1171–1178. JSTOR. <https://doi.org/10.2307/2532457>

13. Chiphang, S., & Singh, R. (2020). Livelihood security determinants of the organic farm household in Sikkim, India: Ordered logistic regression approach. *Current Journal of Applied Science and Technology*, 39(20), 138–143. <https://doi.org/10.9734/cjast/2020/v39i2030848>
14. Fullerton, A. S. (2009). A conceptual framework for ordered logistic regression models. *Sociological Methods & Research*, 38(2), 306–347. <https://doi.org/10.1177/0049124109346162>
15. International Food Policy Research Institute (IFPRI). (2020). *Ghana's tomato market* (MoFA-IFPRI Market Brief No. 3). International Food Policy Research Institute. <https://doi.org/10.2499/p15738coll2.133694>.
16. Karbo, R. T.-V., Frewer, L. J., Areal, F., Jones, G., & Nurudeen, S. (2024). A systematic review of the efficacy of theories used to understand farmers' technology adoption behavior in lower-to-middle-income countries. *Development Studies Research*, 11(1), 2294696. <https://doi.org/10.1080/21665095.2023.2294696>
17. Kule, E. K., Obia, A., Agole, D., Okello, D. M., & Odongo, W. (2025). *Farmer perceptions and their implications for adoption of sustainable agricultural intensification practices*. *Discover Sustainability*, 6, 210. <https://doi.org/10.1007/s43621-025-00929-z>
18. Melomey, L. D., Ayenan, M. A. T., Marechera, G., Abu, P., Danquah, A., Tarus, D., & Danquah, E. Y. (2022). *Pre- and post-harvest practices and varietal preferences of tomato in Ghana*. *Sustainability*, 14(3), 1436. <https://doi.org/10.3390/su14031436>
19. MoFA. (2022). Annual report for offinso district, Ministry of Food and Agriculture,
20. Osei, M. K., Danquah, A., Blay, E., Danquah, E., & Adu-Dapaah, H. (2018). *Stakeholders' perception and preferences of post-harvest quality traits of tomato in Ghana*. *Sustainable Agriculture Research*, 7(3), 93–101. <https://doi.org/10.5539/sar.v7n3p93>
21. Shafiwi, A. B. (2025). *Agricultural technology adoption in Ghana: Improved tomato seed variety adoption in perspective*. *Ghana Journal of Science, Technology and Development*, 11(2) <https://doi.org/10.47881/487.967x>
22. Shafiwi, A. B., & Cobbinah, M. T. (2022). *Assessing tomato marketing efficiency in selected agro-ecological zones of Ghana*. *Asian Journal of Agricultural Extension, Economics & Sociology*, 40(1), 78–92. <https://doi.org/10.9734/AJAEES/2022/v40i130836>
23. Tiwari, J. K., Behera, T. K., Rai, N., Yerasu, S. R., Singh, M. K., & Singh, P. M. (2022). *Tomato breeding for processing in India: Current status and prospects*. *Vegetable Science*, 49(2), 123–132.
24. Vecchio, Y., Agnusdei, G. P., Miglietta, P. P., & Capitanio, F. (2020). *Adoption of precision farming tools: The case of Italian farmers*. *International Journal of Environmental Research and Public Health*, 17(3), 869. <https://doi.org/10.3390/ijerph17030869>
25. Wale, E., & Mkuna, E. (2023). Smallholder satisfaction with the quality of agricultural information and their preferences among sources: Evidence from KwaZulu-Natal, South Africa. *Journal of Agriculture and Food Research*, 14, 100715. <https://doi.org/10.1016/j.jafr.2023.100715>.
26. Wongnaa, C. A., Ankomah, E. D., Ojo, T. O., Abokyi, E., Sienso, G., & Awunyo-Vitor, D. (2023). Valuing postharvest losses among tomato smallholder farmers:

- Evidence from Ghana. *Cogent Food & Agriculture*, 9(1), 2187183.
<https://doi.org/10.1080/23311932.2023.2187183>
27. Yano, Y., Nakamura, T., Ishitsuka, S., & Maruyama, A. (2021). Consumer attitudes toward vertically farmed produce in Russia: A study using ordered logit and Co-occurrence network analysis. *Foods*, 10(3), 638. <https://doi.org/10.3390/foods10030638>
 28. Zhang, X., Yang, Q., Al Mamun, A., Masukujjaman, M., & Masud, M.M., (2024). Acceptance of new agricultural technology among small rural farmers: Evidence using UTAUT framework. *Humanities and Social Sciences Communications*. <https://doi.org/10.1057/s41599-024-04163-2>