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Drivers of market-related considerations among small-scale cassava farmers in South Africa

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Cassava (*Manihot esculenta*), a climate-resilient crop critical to food security in sub-Saharan Africa, remains underutilized in South Africa due to the fragmented value chain and limited market participation among small-scale farmers. This study examines the determinants of market-related considerations among 240 cassava farmers in the three provinces, i.e., Limpopo, Mpumalanga, and KwaZulu-Natal, comparing those who sell cassava with those who do not. Employing probit models grounded in the utility theory, the analysis evaluates how market-related considerations are influenced by socioeconomic and institutional factors among cassava farmers. Results reveal that female farmers are more likely to consider market prices, while male farmers exhibit greater susceptibility to peer influence. Larger farm sizes increase responsiveness to market demand, and education raises the likelihood of emergency harvesting. Membership in farmers' groups reduces reliance on informal peer networks, highlighting the role of collective action. Recommendations include gender-sensitive policies to empower women in value chains, land reform to enhance surplus production, and institutional support for farmers' groups to improve market access.

KEYWORDS

cassava, gender, market participation, probit model, small-scale farmers, South Africa

1 Introduction

Cassava (*Manihot esculenta*), a climate-smart crop renowned for its resilience and adaptability, has emerged as a cornerstone of food security and rural livelihoods in sub-Saharan Africa. Its ability to thrive in diverse agroecological conditions, including marginal soils and harsh climates, making it an indispensable crop for small-scale farmers in regions prone to drought and food insecurity (Amelework et al., 2021; Nderitu, 2020). Globally, cassava production reached 330 million metric tons in 2022, with Africa contributing over 56% of this output (FAOSTAT, 2022). Despite its potential, cassava remains underutilized in South Africa, where production is largely confined to small-scale farming systems in frost-free provinces such as Limpopo, Mpumalanga, and KwaZulu-Natal (Amelework et al., 2021; Lukhele et al., 2023).

The Department of Science and Innovation (DSI) in South Africa, through its Bio-economy Strategy, has identified cassava as a multi-purpose, climate-smart crop with the potential to address multiple national priorities, including food security, rural development, and industrial innovation (Lubinga et al., 2024; Amelework et al., 2023). Cassava's versatility extends beyond its role as a staple food; it is increasingly being utilized in the food industry for products such as biodegradable packaging films, bread, soups, and bioethanol (Immanuel et al., 2024;

Senanayake et al., 2024). In the non-food sector, cassava-derived starches are used in innovative applications, including adhesives, textiles, and pharmaceuticals, highlighting its potential to drive a sustainable bio-economy (Hierro-Iglesias et al., 2022; Hierro-Iglesias, 2023).

However, despite these promising applications, the cassava value chain in South Africa remains underdeveloped and poorly coordinated, limiting its contribution to the broader agricultural economy (Lubinga et al., 2024). Small-scale farmers, who form the backbone of cassava production in South Africa, primarily grow the crop for household consumption, with only occasional surpluses sold in informal markets (Lubinga et al., 2024). This limited market participation is attributed to many factors, including the lack of an organized value chain, inadequate infrastructure, misperceptions about the crop, and limited access to processing facilities. Unlike other staple crops such as maize and wheat, cassava lacks a structured marketing framework, leaving farmers to navigate a fragmented and often unprofitable market landscape (Manganyi et al., 2023).

Within this context, farmers' interactions with cassava markets are shaped not only by production capacity but also by market-related considerations they take into account before selling. In this study, market related considerations refer to the set of factors that small-scale cassava farmers consciously consider before engaging in the market. Factors such as prevailing market prices, perceived market demand, emergency harvesting needs, and influence obtained from peers or farmers' groups. These considerations represent the decision criteria before selling rather than the actual market participation outcomes. They play a role in shaping whether, when, and under what conditions farmers sell cassava. Previous studies have shown that factors such as price fluctuations, demand variability, transportation costs, and access to timely market information influence farmers' market behavior (Mugonola et al., 2017; Donkor et al., 2018). However, there remains a limited understanding of how these market-related considerations vary across small-scale cassava farmers, and how socioeconomic and institutional factors shape these considerations, particularly in the South African context. This gap is significant, as examining what farmers consider before selling provides insight into the underlying decision-making processes that precede market engagement, especially in settings characterized by weak value chains and imperfect information.

Recent efforts by the Agricultural Research Council (ARC) have aimed to address some of these challenges by breeding and promoting high-yielding cassava varieties, coupled with creating awareness about improved agronomic practices (Amelework et al., 2021, 2023). Nonetheless, these initiatives are yet to overcome systemic barriers such as poor infrastructure and limited farmer training, which continue to hinder the establishment of a robust domestic market for cassava and its derivatives. Therefore, this study examines the determinants of market-related considerations among small-scale cassava farmers in South Africa. Findings from this study are anticipated to lay a strong basis for well-informed policy interventions and strategies to enhance market participation among small-scale farmers and unlock the crop's full economic potential.

2 Literature review

Market participation among small-scale cassava farmers is determined by a complex interplay of market-related parameters,

socio-economic characteristics, and institutional support that collectively drive the decision to sell cassava or retain it for household use. Existing literature indicates that factors such as market price, market demand, market access, emergency harvest, and influence by other farmers or cooperatives serve as critical determinants influencing a farmer's decision-making process (Onya et al., 2016; Masamha et al., 2019; Mutyaba et al., 2016). For instance, the market price not only facilitates efficient resource allocation but also reflects product scarcity and surplus availability. However, the inherent perishability of cassava, coupled with external challenges such as adverse weather and pest outbreaks, often leads to significant price volatility (Brownson et al., 2014; Nguyen et al., 2023). Studies have shown that higher and more stable prices encourage market participation, especially when contractual arrangements offer guaranteed prices that mitigate market risks (Enete and Igbokwe, 2009; Tirra et al., 2019). Similarly, market demand is shaped by both local consumption patterns and industrial requirements for products like flour, chips, starch, and biofuels play a pivotal role in influencing farmers' marketing decisions (Ikueomonisan et al., 2020). When farmers perceive robust demand, they are more inclined to allocate surplus produce to the market, whereas fluctuating demand or competition from substitute crops may discourage market engagement (Aku, 2017; Bennett et al., 2019).

A study done by Okoye et al. (2016) provided early evidence from Central Madagascar that transaction costs play a pivotal role in market participation decisions. They employed a multistage random sampling approach and a structured questionnaire. Okoye et al. (2016) demonstrate that factors such as longer distances to the nearest town and market, as well as higher transportation costs, significantly reduced the likelihood of market participation. In contrast, membership in cooperatives, local affiliation, and greater farming experience were found to enhance the propensity to engage in the market. These findings underscore the centrality of logistical and social capital considerations in determining market behavior. Complementing these insights, research conducted in Ghana by Abunyuwah (2024) and in Kenya by Tirra et al. (2019) further elucidated the complex interplay between household dynamics and market engagement. Abunyuwah (2024) classified farmers into distinct categories (including net sellers, autarkic producers, and net buyers) and revealed that factors such as household size, access to market information, and off-farm income critically shape market participation levels. Similarly, Tirra et al. (2019) applied advanced econometric models to demonstrate that both socioeconomic and market structural factors, including education, market access, and transaction costs, significantly influence the extent of cassava commercialization.

Socioeconomic factors play a critical role in shaping the market participation decisions of small-scale cassava farmers. Empirical evidence suggests that the effect of age on market behavior is multifaceted. For instance, a study done by Okoye et al. (2016) demonstrated that older farmers benefit from accumulated market knowledge and well-established networks, which can enhance their ability to navigate market conditions. In contrast, a study by Tirra et al. (2019) indicates that advanced age is often associated with reduced mobility and increased risk aversion, discouraging active market engagement. Consequently, although experience and local connections are valuable, the limitations imposed by aging may counterbalance these benefits.

Gender dynamics further influence market-related decisions. Studies consistently show that female-headed households tend to be more actively involved in market transactions, an observation

supported by [Osakue et al. \(2023\)](#) and [Masamha et al. \(2019\)](#). The scholars attribute this to the limited alternative livelihood options and a stronger reliance on agricultural income for household sustenance. However, higher educational attainment enhances a farmer's capacity to access, interpret, and apply market information effectively, which in turn improves market participation ([Obisesan, 2018](#)). Younger farmers, who are generally more adaptable and receptive to innovative market practices, often record higher sales volumes ([Ozioma-Eleodinmuo and Edeoga, 2015](#); [Mbarga Evouna et al., 2024](#)). Extensive experience typically improves a farmer's ability to manage market uncertainties. However, as [Donkor et al. \(2018\)](#) note, prolonged exposure to market risks can lead to a more conservative selling approach. Farm size, serving as an indicator of production capacity, exhibits a dual effect. Larger farms may generate greater surpluses that could boost market participation. However, they may also encourage farmers to diversify into other crops that promise higher returns, thereby reducing the focus on cassava ([Onya et al., 2016](#); [Tirra et al., 2019](#)). Moreover, the study done by [Mbarga Evouna et al. \(2024\)](#) and [Mugonola et al. \(2017\)](#) reported that married farmers often bearing greater financial responsibilities, tend to participate more in market activities to supplement household income, whereas larger households might consume a greater proportion of production, reducing the volume available for sale.

Institutional factors play a critical role in mitigating market barriers and enhancing market participation among small-scale cassava farmers. One of the most vital institutional supports is access to extension services, which bridge the gap between research institutions and farmers. These services provide essential guidance on improved agronomic practices, pest management, and post-harvest handling, all crucial for producing market-ready cassava ([Suvedi et al., 2017](#); [Chikuni and Kilima, 2019](#)). Notably, [Donkor et al. \(2018\)](#) and [Ozioma-Eleodinmuo and Edeoga \(2015\)](#) demonstrate that farmers receiving robust extension support benefit from timely and relevant market intelligence, which in turn significantly increases their likelihood of engaging in formal markets.

Additionally, cooperatives enable farmers to pool resources, access shared inputs, and collectively bargain for better prices. Studies by [Bizikova et al. \(2020\)](#), [Okoye et al. \(2016\)](#), and [Zamanti and Jaderka \(2016\)](#) noted that such collective action reduces individual risks and improves overall market access. The social capital generated through these groups further helps farmers overcome the information asymmetries that often impede market participation. According to [Awotide et al. \(2019\)](#) and [Isaga \(2018\)](#), adequate credit facilities allow farmers to invest in quality inputs, storage facilities, and transportation infrastructure, which are all essential to overcoming production and marketing constraints. However, many farmers face structural challenges such as the lack of collateral and high interest rates that limit their access to formal credit, often forcing them to rely on informal sources that may not offer favorable terms ([Antwi-Boateng, 2020](#)).

In the marketplace, price plays an essential role in determining how efficiently resources are distributed; it also acts as a measure of surpluses and product scarcity, enabling farmers to adapt to the shift in market conditions ([Naruetharadhol et al., 2022](#)). Cassava markets are susceptible to price volatility due to various factors, such as the lifespan of fresh cassava, adverse weather conditions, pest outbreaks, and changes in global commodity prices ([Nguyen et al., 2023](#)). Effective risk management strategies are essential to mitigate the impact of price volatility on farmers' incomes and food security ([Ndem and Osondu, 2018](#)). The study by [Odongo and Etany \(2018\)](#)

on cassava's value chain and marketing margins reported that because cassava is particularly perishable, farmers were obliged to drastically reduce their prices if their tubers reached the market 2 or 3 days after harvest. The study also revealed that dried cassava chips can be stored for a few months and sold at a higher price during periods of high market demand. Several studies have found a positive correlation between the market price of cassava produce and small-scale farmers' participation in the market ([Enete and Igbokwe, 2009](#); [Mugonola et al., 2017](#); [Tirra et al., 2019](#)). Farmers are more inclined to enter the cassava market when prices increase. The availability of favorable prices for cassava products also plays a crucial role in influencing farmers' decisions to sell produce at the farm's gate or transport it to the market ([Tirra et al., 2019](#)). However, it has been noted that pricing gaps between urban markets and farm gates lead to reduced marketing incentives and decreased participation of farmers in the market ([Mugonola et al., 2017](#)). Nevertheless, contract arrangements that provide guaranteed markets and better prices have increased small-scale farmers' market participation ([Enete and Igbokwe, 2009](#)). Moreover, such contract arrangements motivate farmers to exert more effort to meet the required output, as they are assured of a stable price and market.

The decision-making process of small-scale cassava farmers is significantly influenced by market demand. This demand is multifaceted and driven by the need for various cassava products, such as high-quality flour, chips, starch, industrial raw materials, and animal feeds. Farmers' ability to negotiate prices and their willingness to sell their produce are directly affected by demand. In regions where cassava is a staple food, such as many parts of sub-Saharan Africa, demand is typically stable, owing to its crucial role in food security ([Ikuemonisan et al., 2020](#)). Nonetheless, demand may fluctuate due to seasonal factors, population growth, and shifts in consumer preferences ([Nweke et al., 2019](#)). In South Africa, cassava is gaining recognition as a food crop and a raw material for industrial purposes such as biofuels and starch production ([Amelework et al., 2021](#)). This broadening demand can stabilize prices and create new market opportunities for small-scale farmers ([Graffham et al., 2019](#)). However, small-scale farmers' ability to access these markets depends on their capability to meet industrial buyers' quality and quantity requirements ([Amelework et al., 2021](#)). Small-scale farmers often encounter difficulties meeting market needs because of their limited production capacity and access to market information ([Jouzi et al., 2017](#)). According to [de Janvry and Sadoulet \(2020\)](#), inadequate infrastructure, restricted access to inputs, and insufficient investment in agricultural technology often constrains small-scale farmers' ability to respond to market demands. Consequently, these limitations can result in supply shortages, particularly during periods of high demand, thus restricting farmers' capacity to capitalize on market opportunities. Global economic conditions and trade regulations also influence the demand for cassava ([Ikuemonisan and Akinbola, 2021](#)). The international demand for cassava products has opened export prospects for African nations ([Parmar et al., 2017](#)). Currently, the global demand for cassava is approximately 284 million tons and is projected to reach 368 million tons by 2032. Furthermore, the local demand for cassava is often affected by alternative crops such as maize, potatoes, and other staple foods ([Amelework et al., 2021](#)). The demand for cassava may decrease in regions with numerous substitute crops, consequently influencing the sales prospects. This dynamic is particularly pertinent in South Africa, where cassava competes with other staples more deeply ingrained in the national

food system (Amelework et al., 2021). Aku (2017) found that awareness and perception of market demand among farmers significantly impacts their decision to engage with the market. When farmers believe there is intense market demand for their products, they are more likely to invest resources in producing goods for sale. This is particularly relevant for small-scale farmers, who often work with limited profit margins and depend on market demand to ensure profitability (Bennett et al., 2019). Conversely, suppose farmers do not perceive sufficient market demand. In that case, they may limit their market involvement by storing their produce or using it for other purposes, such as household consumption or local barter systems, as noted by Onya et al. (2016).

Market information promotes competition and prevents individuals from becoming monopolies. Additionally, market information is essential for all parties involved in production, buying, and selling since agricultural commodities see more significant price fluctuations than other sectors (Sadiq et al., 2017). The study done by Odongo and Etany (2018) found that 46% of small-scale farmers experienced challenges in accessing market information. Enete and Igbokwe (2009) conducted a study to assess the influence of market information on farm households' decisions to engage in the cassava market. Study findings demonstrated that access to market information improved the market involvement of cassava-producing households in African countries. Adejobi and Adeyemo (2012) also performed research that found that having access to market information increased farmers' likelihood of participating in the Nigerian cassava market. Similarly, Donkor et al. (2018) stated that appropriate market information was critical in allowing farmers to make educated decisions. The study discovered that having access to market information enabled farmers to improve their amount of trade with processors. In addition to this, access to market information significantly influenced farmers' engagement in cassava markets, resulting in greater participation in the direct market. Furthermore, access to market information increased farmers' bargaining power, allowing them to bargain with buyers for better terms.

Market access is a crucial factor affecting market participation and is critical in enhancing the income of small-scale producers in developing countries (Mbarga Evouna et al., 2024). However, participation rates among smallholder farmers in sub-Saharan African countries remain minimal because of various barriers and minimal market access (Otegunrin et al., 2022). Small-scale farmers typically sell their port it to the marketplace using the available means to gain access to the market. According to a study by Otegunrin et al. (2022), market entry and participation decisions are hindered by high transaction

costs, inadequate infrastructure, and poor access to reliable market information. Market access is a crucial factor affecting market participation and significantly enhances the income of small-scale farmers in developing countries (Okoye et al., 2016).

3 Methodology

3.1 Study area and data collection

This study was conducted in key cassava-producing regions across three provinces in South Africa: KwaZulu-Natal, Limpopo, and Mpumalanga. These provinces were purposively selected due to their significance in cassava production, as well as their distinct geographical, climatic, and socio-economic characteristics (Manganyi et al., 2023). Notably, these provinces are also the sites where the Agricultural Research Council (ARC) conducted cassava experimental trials (Amelework et al., 2021, 2023). In KwaZulu-Natal, data were collected from the uMkhanyakude and King Cetshwayo district municipalities. In Limpopo, the study focused on the Mopani district, encompassing the local municipalities of Giyani, Tzaneen, Greater Letaba, and Ba-Phalaborwa. Meanwhile, in Mpumalanga, data were gathered from farmers in the Bushbuckridge local municipality within the Ehlanzeni district. These district municipalities represent the major cassava-producing areas within their respective provinces.

A multi-stage purposive sampling approach was employed to select study respondents. Initially, the provinces were chosen based on their prominence in cassava production and the occurrence of cassava trials by the ARC. Within these provinces, districts known for high cassava output were identified with the assistance of the local agricultural advisors, and then farmers actively involved in cassava cultivation were purposively selected. Within each local municipality, a simple random sampling technique was used, with the assistance of the agricultural advisors who work within the local municipalities. When saturation was reached, the research team progressed to look for cassava farmers in the next local municipality. In this study, we did not calculate the sample size before the data collection phase as guided by Lakens (2022), since there was no concrete background information on cassava production in the country (Lubinga et al., 2024). Hence, we used a simple random exploration approach. In total, 240 cassava farmers participated in the study, ensuring representation of various districts across the three provinces, as shown in Table 1.

TABLE 1 Number of respondents sampled per local municipality in the major cassava producing districts per province.

Province	District	Local Municipality	Number of respondents
Limpopo (LIMP)	Mopani	Tzaneen	18
		Giyani	21
		Letaba	1
		Ba-Phalaborwa	7
Kwa-Zulu Natal (KZN)	uMkhanyakude	uMhlabyalingana	100
	KingCetshwayo	uMhlathuze	55
Mpumalanga (MPUM)	Ehlanzeni	Bushbuckridge	37
		Ehlanzeni	1

Data were collected using a semi-structured questionnaire designed to capture both qualitative and quantitative information. The questionnaire comprised a mix of open-ended and closed-ended questions, facilitating in-depth responses while ensuring the standardization of data. The key aspects of the research included socio-economic characteristics and demographic details of the farmers, as well as various characteristics of their involvement in the cassava value chain such as cultivation practices, marketing strategies, processing methods, and income generation. Local enumerators were recruited and rigorously trained in questionnaire administration and interview techniques to ensure clarity and consistency in data collection. Face-to-face interviews were conducted in the field, allowing enumerators to clarify responses and build rapport with the respondents. Ethical considerations, including informed consent and confidentiality protocols, were strictly adhered to throughout the data collection process.

To ensure data accuracy and consistency, several quality control measures were implemented. Field supervisors conducted regular check-ins and spot-checked during data collection, and re-interviews were carried out in select cases to cross-validate responses (Lubinga et al., 2024). To externally validate the data collected, in total four stakeholder engagements were held across the districts from where the data were collected. These engagements included not only cassava farmers, but also government officials, traders, and other value chain actors (e.g., processors and transporters) with keen interest in participating in the cassava value chain. During the stakeholder engagements, a checklist was used to validate responses received from the individual farmers. However, in this paper, the information sought during the stakeholder engagements was used to enrich the discussion of empirical findings.

3.2 Empirical framework and data analysis

This study employs the theory of utility as its theoretical foundation to examine the determinants of market-related considerations among small-scale cassava farmers in South Africa. Utility theory posits that individuals make decisions by selecting the option that maximizes their perceived satisfaction or benefit, subject to available choices and constraints (Lubinga et al., 2024; Tirra et al., 2019). In this context, small-scale cassava farmers do not solely base the selling of their produce on production, but also consider a set of factors, including market price, market demand, emergency harvesting needs and influence from peers or farmer groups. A farmer decides whether to consider a given market-related factor before selling their cassava or retain the cassava for household consumption based on the maximization of their perceived utility. For instance, a farmer is assumed to consider market demand before selling cassava if the utility (U_s) derived from the consideration exceeds the utility (U_n) of not considering market demand. The same is applicable to the other three market-related considerations, i.e., market price, emergency harvesting, and influence by other farmers. That is, if $U_s > U_n$. Therefore, it is assumed that for each market-related factor, a farmer derives latent utility from considering that factor before selling cassava. A farmer is therefore more likely to consider a given market-related factor when the perceived utility associated with that consideration is positive.

To model this decision-making process, we adopt a binary choice framework illustrated in Equation 1. The decision to consider a specific market-related consideration is represented by the dependent variable Y_i , where:

$$Y_i = \begin{cases} 1 & \text{if } U_s > U_n \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

Since the utility difference ($U_s - U_n$) is not directly observable, it is modeled as a latent variable (Y_i), influenced by a set of explanatory variables which include socioeconomic and institutional factors. The latent utility difference is specified as follows in Equation 2:

$$\begin{aligned} Y_i = & \beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Gender}) + \beta_3(\text{Experience}) \\ & + \beta_4(\text{FarmSize}) + \beta_5(\text{MaritalStatus}) \\ & + \beta_6(\text{Education}) + \beta_7(\text{HouseholdSize}) \\ & + \beta_8(\text{ExtensionService}) + \beta_9(\text{CreditAccess}) \\ & + \beta_{10}(\text{FarmersGroup}) + \beta_{11}(\text{KZN}) + \beta_{12}(\text{LIMP}) \\ & + \beta_{13}(\text{MPUM}) + \varepsilon_i \end{aligned} \quad (2)$$

where β_0 is the intercept, $\beta_1, \beta_2, \dots, \beta_k$ are the coefficients associated with each explanatory variable, and ε_i is the error term, and it is assumed to follow a standard normal distribution. The observed decision is then linked to the latent variable by in Equation 3:

$$Y_i = \begin{cases} 1 & \text{if } Y_i > 0 \\ 0 & \text{otherwise} \end{cases} \quad (3)$$

To estimate the probability of the determinants of market-related considerations among small-scale cassava farmers, we used a probit model (see Equation 4), which is well-suited for binary outcomes. The probability that $Y_i = 1$ given the explanatory variables is expressed as:

$$\begin{aligned} P(Y_i = 1) = & \Phi(\beta_0 + \beta_1(\text{Age}) + \beta_2(\text{Gender}) \\ & + \beta_3(\text{Experience}) + \beta_4(\text{FarmSize}) \\ & + \beta_5(\text{MaritalStatus}) + \beta_6(\text{Education}) \\ & + \beta_7(\text{HouseholdSize}) + \beta_8(\text{ExtensionService}) \\ & + \beta_9(\text{CreditAccess}) + \beta_{10}(\text{FarmersGroup}) \\ & + \beta_{11}(\text{KZN}) + \beta_{12}(\text{LIMP}) + \beta_{13}(\text{MPUM}), \dots \end{aligned} \quad (4)$$

where $\Phi(\cdot)$ denotes the cumulative distribution function (CDF) of the standard normal distribution. This specification allows us to assess how changes in the explanatory variables affect the likelihood that a farmer considers a specific market-related parameter before deciding to sell. Four separate Probit models were estimated each corresponding to one market-related consideration, i.e., *market price*, *market demand*, *emergency harvesting* and *influence from other farmers/group(s)*. This approach allows the effect of socioeconomic and institutional characteristics to differ across considerations, recognizing that the recognizing that the factors influencing price consideration may not be the same as those shaping market demand, emergency harvesting behavior, or peer influence from other farmers/groups. Marginal effects were also computed to

facilitate interpretation and reflect the interpretation of the results. Marginal results are interpreted as a change in the probability of considering a given market factor associated with changes in the explanatory variables.

The set of explanatory variables comprises both socioeconomic factors (such as age, gender, farming experience, education level, farm size, marital status, and household size) and institutional factors (access to extension services, access to credit, and membership in farmers' groups). These variables are hypothesized to influence the utility derived from selling cassava and, consequently, the probability of market participation. The empirical model is inspired by earlier studies (e.g., Tirra et al., 2019; Udoh and Kormawa, 2009) and builds on the framework discussed in Lubinga et al. (2024). Due to spatial heterogeneity across the three provinces, dummy variables (KZN, LIMP & MPUM) were introduced in the model as a control for regional fixed effects (Klein and Tchuente, 2024). Conceptually, adding the dummy shifts the intercept for each province, thereby absorbing any unmeasured factors such as administrative space. This inherently reduces the omitted-variable bias (Gartaula et al., 2024; Bonuedi et al., 2025) and may influence a farmer's consideration of any of the market-related considerations.

3.3 Description of variables

Table 2 provides the summary of dependent and independent variables used in this study, along with their definitions and the

expected direction of their influence based on previous empirical research on small-scale cassava farming (Mugonola et al., 2017; Sebatta et al., 2014). The expected signs indicate whether an increase in a particular variable is hypothesized to increase (+), decrease (−), or have a mixed (+/−) effect on the market-related parameters that small-scale cassava farmers consider before selling their produce.

Following Tabe-Ojong et al. (2022) and Tam and Grimes (2023), we applied the Ordinary Least Squares (OLS) linear probability model (LPM) to assess the robustness of results for each probit model, with the same variables so that substantive comparison could be made in relation to the signs of the coefficients, the relative magnitude and statistical significance of the variables. Unlike the probit model, LPM coefficients are interpreted as changes in the probability of the event when a covariate changes (Lee et al., 2025). Furthermore, the probit model assumes that a variable generates the observed binary outcome through a normal cumulative distribution (Abanum and Isaac, 2022). On the other hand, LPM is treated as a quick linear approximation, which is too simplistic (Mendes et al., 2024). A well-specified LPM can effectively approximate average partial effects of nonlinear models, even if many fitted values are outside the 0–1 range. A study conducted by Chatla and Shmueli (2016) on the LPM suggests that, under certain assumptions, the linear projection parameters from LPM can provide a good approximation of average partial effects. Additionally, using trimming techniques or more advanced nonlinear least squares methods can make LPM-type estimators competitive with probit models for estimating these effects.

TABLE 2 Description of variables and expected sign.

Variable	Description	Expected sign (+/− or Both)
Dependent variables		
Market price	Whether the farmer considers market prices as a key factor in deciding to sell cassava (dummy, yes = 1)	
Market demand	Whether the farmer considers market demand as a key factor in deciding to sell cassava (dummy, yes = 1)	
Emergency harvest	Whether the farmer considers emergency harvests as a factor in deciding to sell cassava (dummy, yes = 1)	
Influence by other farmers	Whether the farmer is influenced by other farmers or cooperatives in deciding to sell cassava (dummy, yes = 1)	
Independent variables		
Age	Age (years)	+/−
Gender	Gender (Male = 1; Female = 0)	+/−
Experience	Experience in farming cassava (years)	+
Farm size	Farm size (hectares of land under cassava production)	+
Marital status	Marital status (Single = 0; Married = 1; Divorced = 2; Widowed = 3)	+/−
Education level	Education level (No formal education = 0; Primary = 1; Secondary = 2; Tertiary = 3)	+
Household size	Household size (number of members in the household)	+/−
Market access	Access to credit (Access = 1; No access = 0)	+/−
Access to extension services	Access to extension service support (Access = 1; No access = 0)	+/−
Farmers' group member	Farmers' group member (Yes = 1; No = 0)	+/−
KZN	KwaZulu-Natal province (dummy, yes = 1)	+/−
LIMP	Limpopo province (dummy, yes = 1)	+/−
MPUM	Mpumalanga province (dummy, yes = 1)	+/−

According to Gomila (2021), the LPM is advantageous due to its interpretability and transparency. LPM coefficients map directly to probability changes, thereby avoiding the extra step of converting log odds or latent index slopes into marginal probabilities. Furthermore, Rios-Avila and Maroto (2024) argue that LPM regressions provide unbiased treatment effect estimates for binary outcomes and is preferable in cases with fixed effects, where nonlinear models may be misleading. The second advantage of LPM is that it can retain observations that certain nonlinear estimators drop. LPM maintains observations that influence the estimates produced, helping to preserve information that might otherwise be lost (Chatla and Shmueli, 2016). As a precaution, it is important to note that LPM specifications can lead to predicted probabilities falling outside the 0–1 interval, and heteroskedastic errors are inherent. This, therefore, requires robust inference and careful interpretation (Timoneda, 2021).

4 Results and discussion

4.1 Descriptive statistics

Table 3 presents a summary of descriptive statistics of socioeconomic, institutional, and market-related factors of small-scale cassava farmers in South Africa. The average age of the farmers was 57.53 years, with a standard deviation of 12.73 years, indicating a relatively older farming population. This demographic trend raises concerns about the sustainability of cassava production, since younger generations are less involved in agriculture. The observed trend is attributable to urbanization and possibly the more attractive alternative livelihood opportunities. The average education level of 0.74 (on a scale of 0 to 3) suggests that most farmers only attained primary level

education, which may limit their ability to adopt improved farming practices and access market information. On average, household size was 7 members, reflecting large family structures typical of rural farming communities. However, only 33% of the farmers were male, highlighting the significant role of women in cassava production. The average farm size was 0.62 hectares, indicating that most farmers operate on small plots of land.

The limited access to land constrains the ability of farmers to produce surplus cassava for the market, particularly in the face of competing household consumption needs. However, farmers had an average of 14.79 years of experience in cassava farming, reflecting a high level of familiarity with the crop. This experience could be leveraged to improve productivity through targeted training and the adoption of improved farming practices.

Institutional factors such as access to extension services and credit were found to be critically low, with only 11 and 7% of farmers reporting access, respectively. This lack of institutional support poses a significant barrier to productivity and market participation, as farmers are unable to access the knowledge, resources, and financial services needed to improve their farming operations. In contrast, 62% of farmers reported being members of a farmers' group or cooperative, indicating that collective action plays a vital role in cassava farming. These groups can facilitate collective marketing, reduce transaction costs, and enhance bargaining power, thereby improving market access for small-scale farmers (Manganyi et al., 2023).

With regards to market-related factors, only 36% of farmers considered market price as a key factor in their decision to sell cassava, while 58% reported market demand as a more significant consideration. This suggests that farmers may lack reliable and timely market information, limiting their ability to make informed decisions. Additionally, emergency harvests and influence by other farmers were reported by only 3 and 8% of farmers, respectively. This suggests that

TABLE 3 General summary of demographic characteristics of respondents.

Variables	Mean	Standard deviation	Minimum	Maximum
Age	57.53	12.73	24	96
Education level	0.74	0.92	0	3
Household size	7.00	3.51	1	27
Farm size	0.62	1.35	0	17.13
Experience	14.79	13.59	0.17	61
Gender	0.33	0.47	0	1
Marital status	1.02	1.11	0	3
Access to extension services	0.11	0.32	0	1
Access to credit	0.07	0.26	0	1
Farmers' group member	0.62	0.49	0	1
Market price	0.36	0.48	0	1
Market demand	0.58	0.50	0	1
Emergency harvest	0.03	0.18	0	1
Influenced by other farmers	0.08	0.27	0	1
KZN	0.610	0.489	0	1
LIMP	0.191	0.394	0	1
MPUM	0.154	0.362	0	1

these factors play a minimal role in shaping small-scale cassava farmers' market participation decisions in the study areas. The low consideration of emergency harvests may reflect the resilience of cassava as a crop, while the limited influence of other farmers suggests that peer networks and cooperatives may not be fully utilized to enhance market access.

Regarding the provincial distribution of farmers, the largest share (61%) was from KwaZulu-Natal province (KZN), followed by 19.1% from Limpopo province, while Mpumalanga accounted for 15.4%. It is important to note that some questionnaires were incomplete, hence not included in the analysis.

4.2 Empirical results

4.2.1 Factors influencing farmers' consideration of market price

Empirical results presented in Table 4 show factors influencing farmers' consideration of market prices before selling cassava. The diagnostic indicators of the probit model provided a log-likelihood value of -103.960 and a Wald chi-squared statistic of 680.29 . A p -value of 0.000 indicates that the model was statistically significant at all levels. The Chi-squared test confirms that the model was

TABLE 4 Factors influencing farmers' consideration of market price.

Variable	Coefficient	Average Marginal Effects (dy/dx)
Access credit	0.000	0.000
	(0.342)	(0.120)
Age	0.193	0.068
	(0.124)	(0.043)
Education level	0.176	0.062
	(0.151)	(0.052)
Experience	-0.036	-0.013
	(0.069)	(0.024)
Extension service	0.017	0.006
	(0.355)	(0.125)
Farmers' group member	-0.264	-0.093
	(0.272)	(0.095)
Farm size	0.15	0.053
	(0.212)	(0.074)
Gender	-0.413^*	-0.145
	(0.235)	(0.080)
Household size	-0.19	-0.067
	(0.125)	(0.043)
Marital status	-0.013	-0.004
	(0.117)	(0.041)
KZN	4.829^{***}	1.701
	(0.311)	(0.139)
LIMP	4.258^{***}	1.500
	(0.503)	(0.214)
MPUM	4.399^{***}	1.550
	(0.545)	(0.222)
Constant	-5.211^{***}	
	(0.54)	
Log-likelihood	-103.960	
Wald Chi ² (13)	680.29	
Prob>Chi ²	0.000	
Pseudo R ²	0.064	
Observations	169	

Robust standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively. dy/dx for factor levels is the discrete change from the base level.

a good fit, as the null hypothesis (all coefficients were zero) was rejected.

Results reveal that gender was the only significant factor influencing farmers' consideration of market prices before deciding to sell cassava. Gender had a significant negative marginal effect (-0.413) at a 10% level of significance. The marginal effect coefficient indicates that male farmers are associated with a 14.5% decrease in the likelihood of considering the market price before selling cassava. Thus, making females more likely to consider the market price in their decision-making. Female farmers have more influence over price negotiations and are involved in

different market activities where they can secure better prices. Our findings are similar to those of [Masamha et al. \(2019\)](#) and [Ozioma-Eleodinmuo and Edeoga \(2015\)](#), who observed that women are more likely to participate in the cassava market than men. Conversely, a study done by [Udoh and Kormawa \(2009\)](#) emphasized women's challenges in market participation, such as limited access to resources and market networks. The marginal effects of other variables, such as age, farm size, and household size, were not statistically significant despite their positive or negative influences and thus were not discussed further.

TABLE 5 Factors influencing smallholder farmers' consideration of market demand before selling cassava.

Variable	Coefficient	Average marginal effects (dy/dx)
Access credit	0.347	0.117
	(0.376)	(0.127)
Age	0.002	0.001
	(0.122)	(0.041)
Education level	0.059	0.020
	(0.149)	(0.050)
Experience	-0.154^{**}	-0.052
	(0.070)	(0.023)
Extension service	-0.186	-0.063
	(0.326)	(0.109)
Farmers' group member	-0.437	-0.148
	(0.276)	(0.092)
Farm size	0.446^{***}	0.151
	(0.223)	(0.073)
Gender	-0.486^{***}	-0.164
	(0.225)	(0.073)
Household size	-0.138	-0.047
	(0.100)	(0.033)
Marital status	0.028	0.009
	(0.114)	(0.038)
KZN	-0.067	-0.023
	(0.741)	(0.250)
LIMP	-0.398	-0.134
	(0.824)	(0.278)
MPUM	-1.500^{*}	-0.506
	(0.862)	(0.284)
Constant	1.100	
	(0.903)	
Log-likelihood	-100.307	
Wald χ^2 (13)	27.65	
Prob> χ^2	0.010	
Pseudo R^2	0.128	
Observations	169	

Robust standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively. dy/dx for factor levels is the discrete change from the base level.

4.2.2 Factors influencing farmers' consideration of market demand

Table 5 presents model estimates of the factors influencing farmers' consideration of the market demand before deciding to sell cassava. The model's diagnostics indicate that the model is a good fit, with a Wald chi-squared value of 27.65 ($p < 0.05$), demonstrating that the overall model was statistically significant at the 5% level. Therefore, the null hypothesis that the independent variables have no statistically significant effect on farmers' consideration of market demand is rejected. The results show that experience, farm size, and gender have a statistically significant influence on farmers' consideration of market demand for cassava before they embark on selling.

At a 5% level of significance, experience has a significant negative impact on how farmers consider market demand for cassava before selling. The negative marginal value (0.052) implies that farmers with more years of experience were less likely to rely on market demand before selling their cassava by 5.2%. This is attributable to the fact that cassava is highly perishable, and experienced farmers often leverage their market participation decisions on timeliness and logistics, including transport availability, labor to harvest, and buyer reliability, among others (Bosompem et al., 2024). Conversely, the study done by Okoye et al. (2016) reported that greater experience is often linked to better market knowledge and more robust market participation. Furthermore, experienced farmers may have developed long-term relationships with buyers, allowing them to avoid short-term market fluctuations in demand.

Farm size was found to be positive and significant at the 5% level ($p < 0.05$). The results imply that farmers with larger farms were more likely to consider market demand by 15.1% as compared to those with small farms. The desire to consider market demand can be attributed to the higher output volumes, which require good marketing strategies. This finding is consistent with work by Enete and Igbokwe (2009), who reported that larger farm sizes are associated with increased production capacity, enabling farmers to meet higher demand levels. Furthermore, larger farms can produce higher quantities of cassava, making it more attractive to buyers, particularly in larger or more competitive markets. Gender had a significant but negative coefficient, which suggests that male cassava farmers were less likely to consider market demand for cassava when compared to their female counterparts by 16.4%. This was statistically significant at the 5% level. Traditionally, women have been more involved in local trading activities, so they may have benefited from better local market connections and consumer demand for cassava. These results are consistent with the work of Masamha et al. (2019), who reported that female farmers sell more cassava than their male counterparts. The significant influence of gender highlights the importance of considering gender-based market dynamics, particularly for smallholder farmers.

Due to spatial heterogeneity, the negative and statistically significant results (1.50, $p < 0.1$) reveal that farmers in Mpumalanga were less likely to consider the market demand for cassava by 50.6%, unlike in other provinces. This is attributed to cross-border trade with Mozambique, whereby informal cross-border traders do not necessarily track demand. Practically, farmers supply traders as and when they come if they have the required quantities and payment terms are in form of immediate cash. This finding corroborates the view of Kahiya (2025), who explains the entrepreneurial ecosystem among informal cross-border traders. The other variables, including age, education

level, extension services, farmer group membership and access to credit, were not statistically significant in explaining farmers' consideration of market demand before selling their cassava. Thus, no further discussion is given about the insignificant variables.

4.2.3 Factors influencing smallholder farmers' consideration of emergency harvesting before selling

Results for factors influencing the consideration of emergency harvesting before selling among smallholder cassava farmers are presented in Table 6. The Wald chi-squared test statistic is 205.22 and the model was found to be statistically significant at all levels. Therefore, the null hypothesis was rejected, and it is worthwhile to note that gender and the provincial dummies were found to positively influence farmers' consideration of emergency harvesting.

At 5% level, the significant positive marginal effect for gender suggests that male farmers are associated with a 6.1% higher likelihood of considering harvesting cassava during an emergency. With a sociological and gender-relations perspective, this finding is attributable to the fact that men are noted to be able to provide for their families during periods of hardship, and failure in this undermines household stability and male legitimacy (Quisumbing et al., 2015; Doss et al., 2018).

For the provincial dummies, the positive and significant marginal values imply that farmers in Mpumalanga (MPUM) are the most likely to consider emergency harvesting (21.8%) before selling, followed by those from Limpopo (LIMP) with a 20.6% likelihood and then a 12.5% likelihood among KZN farmers. The slight variation across provinces might be due to other factors like cultural differences and infrastructure.

Household size was a significant factor negatively affecting farmers' consideration of emergency harvesting at the 5% significance level. The negative marginal effects value (−0.070) implies that larger households are less likely to consider emergency harvesting before selling their produce by 7%. Larger households may provide more labor and flexibility, potentially reducing the need for emergency decisions, as they can adjust labor to stabilize harvest timelines. This finding is consistent with the studies conducted by Mugonola et al. (2017) who reported that larger households have more labor and resources to support better planning and resilience, thereby reducing the need for emergency measures. Moreover, households with more members may also have alternative income sources, which may lessen the need for immediate cash flows through early harvests.

4.2.4 Factors influencing the consideration of other farmers/farmers' groups

Empirical results presented in Table 7 show that the Wald chi-squared value is highly significant with a p -value of 0.000. This implies that the specified probit model was a good fit and it is significant at all levels. Thus, the independent variables collectively have a statistically significant effect on the probability of a farmer being influenced by other farmers or membership in a farmers' group before selling cassava. Table 7 illustrates the estimated coefficients and marginal effects for factors that influence farmers' consideration of other farmers or farmer groups before selling cassava. The statistically significant factors were age, gender, marital status, and provincial dummies.

Age had a significant negative influence at the 10% level among respondents who were influenced by other farmers. The marginal effect

TABLE 6 Probit model results for farmers' consideration of harvest emergency.

Variable	Coefficient	Average Marginal Effects (dy/dx)
Age	0.368	0.020
	(0.383)	(0.021)
Education level	0.127	0.007
	(0.314)	(0.017)
Experience	0.222	0.012
	(0.187)	(0.010)
Farmers' group member	0.301	0.016
	(0.456)	(0.023)
Farm size	−0.322	−0.017
	(0.696)	(0.036)
Gender	1.163**	0.061
	(0.561)	(0.031)
Household size	−1.341**	−0.070
	(0.562)	(0.031)
Marital status	−0.341	−0.018
	(0.286)	(0.014)
KZN	2.379**	0.125
	(1.031)	(0.073)
LIMP	3.917***	0.206
	(1.056)	(0.085)
MPUM	4.157***	0.218
	(0.955)	(0.079)
Constant	−6.62***	
	(1.767)	
Log-likelihood	−13.401	
Wald Chi ² (11)	205.22	
Prob>Chi ²	0.000	
Pseudo R ²	0.456	
Observations	137	

Robust standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively. dy/dx for factor levels is the discrete change from the base level.

coefficient of −0.046 indicates that a one-year increase in farmers' age reduces the probability of being influenced by other farmers by 4.6% before selling produce. This aligns with the view that older farmers are more likely to have accumulated farming experience and have access to market information (Mugonola et al., 2017; Sebatta et al., 2014), which makes them less susceptible to being influenced by other farmers. Younger farmers are more receptive to advice and new ideas (Nwachukwu, 2020), which makes them consider the views of other farmers. Gender was also found to have a positive and significant coefficient (1.882) at the 1% level, implying that the marginal effect of male cassava farmers suggests a 17.2% higher probability of being influenced by other farmers, unlike female farmers. This might be because male farmers often network more in agricultural settings, thus fostering a higher level of information exchange and influence. Our findings are similar to those of Donkor et al. (2018) and Adejobi and Adeyemo (2012), who reported that male farmers tend to increase their cassava output more than female farmers because cassava production is labor-intensive.

Marital status had a significant positive marginal effect coefficient (0.741) on the likelihood of being influenced by other farmers at the 1% level of significance. The positive marginal effects suggest that married farmers are more likely to influence other farmers by 7.1%. This might be attributed to social support and shared decision-making processes typical of married households, where the influence of others could play a crucial role in agricultural decisions. This result is consistent with Onya et al. (2016), who found that being married significantly affected cassava farmers' involvement in the market. For the provincial dummies, the positive and significant coefficients for KZN (4.233, $p < 0.01$), LIMP (4.384, $p < 0.01$) and MPUM (5.693, $p < 0.01$) reveal that the farmer's location (by province) strongly influences their consideration of what other farmers say or do about the selling of cassava. The marginal values imply that being in KZN is associated with a 38.6% likelihood of being influenced by other farmers or farmer groups, while in Limpopo (LIMP) and in Mpumalanga (MPUM) the likelihood is 40 and 51.9%, respectively. Findings suggest that

TABLE 7 Factors influencing the consideration of other farmers/farmers' groups.

Variable	Coefficient	Average Marginal Effects (dy/dx)
Age	−0.506**	−0.046
	(0.225)	(0.022)
Education level	0.136	0.012
	(0.229)	(0.021)
Experience	−0.103	−0.009
	(0.127)	(0.012)
Extension service	0.339	0.031
	(0.614)	(0.055)
Farmers' group member	−0.623	−0.057
	(0.407)	(0.036)
Farm size	0.130	0.012
	(0.356)	(0.033)
Gender	1.882***	0.172
	(0.482)	(0.051)
Household size	0.235*	0.021
	(0.139)	(0.014)
Marital status	0.741***	0.068
	(0.231)	(0.022)
KZN	4.233***	0.386
	(0.521)	(0.099)
LIMP	4.384***	0.400
	(0.643)	(0.116)
MPUM	5.693***	0.519
	(0.625)	(0.115)
Constant	−6.429***	
	(1.088)	
Log-likelihood	−25.205	
Wald Chi ² (12)	349.36	
Prob>Chi ²	0.000	
Pseudo R ²	0.398	
Observations	151	

Robust standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively. dy/dx for factor levels is the discrete change from the base level.

irrespective of the province in which a cassava farmer is based, the consideration of what other farmers or farmer groups say or do. This is because farmer-to-farmer engagements reduce information asymmetries, directly influencing who, where, when, and whether farmers sell their produce. Moreover, farmer groups also foster collective marketing, which is known to minimize the associated transaction costs. Our findings align with [Abdul-Rahaman and Abdulai \(2020\)](#), who posit that social networks positively influence market participation in the agricultural sector.

4.2.5 Robustness check

To ensure robustness of the results based on the probit model, [Table 8](#) presents the results of the LPM estimator. Results of the LPM corroborate with the results of the probit model, revealing corresponding signs for the different market-related considerations, as well as the

statistical significance of the gender coefficient. That is, gender negatively influences farmers' consideration of market price and market demand before selling cassava. However, the effect is positive and statistically significant when we assess the consideration based on the influence of other farmers or farmer groups. It is important to note that whereas the coefficient for the gender variable is positive and relatively comparable in magnitude for both estimators, the LPM coefficient is statistically insignificant for emergency marketing consideration. Thus, this affirms that the results for the gender variable are stable, irrespective of the estimators. Similarly, the statistically significant negative effect of experience on the consideration of market demand by farmers concurs in both models, and the magnitude of effect being the same (0.05). The positive and statistically significant effect of farm size for the market demand consideration also corroborates in both the probit and LPM. For the provincial fixed-effects dummies (KZN, LIMP, and MPUM), robustness results also corroborate the probit model findings.

TABLE 8 Robustness check of all four market-related parameters.

Consideration by farmers before selling cassava				
	Market price	Market demand	Emergency harvesting	Influenced by other farmers/groups
	Coefficient	Coefficient	Coefficient	Coefficient
Access credit	−0.001	0.097	0.022	−0.01
	(0.132)	(0.113)	(0.016)	(0.026)
Age	0.063	0.005	0.023	−0.022
	(0.042)	(0.044)	(0.015)	(0.028)
Education level	0.064	0.028	0.033	0.015
	(0.058)	(0.049)	(0.025)	(0.028)
Experience	−0.01	−0.054**	0.012	−0.001
	(0.025)	(0.025)	(0.011)	(0.013)
Extension service	0.010	−0.074	−0.032	−0.004
	(0.129)	(0.113)	(0.027)	(0.057)
Farmers' group member	−0.099	−0.133	0.007	−0.052
	(0.104)	(0.09)	(0.033)	(0.045)
Farm size	0.051	0.145*	−0.009	0.012
	(0.081)	(0.076)	(0.021)	(0.033)
Gender	−0.143*	−0.169**	0.049	0.114**
	(0.084)	(0.083)	(0.032)	(0.046)
Household size	−0.063*	−0.048	−0.009	0.016
	(0.037)	(0.037)	(0.008)	(0.013)
Marital status	−0.001	0.011	−0.02	0.033*
	(0.044)	(0.042)	(0.016)	(0.018)
KZN	0.325***	−0.012	−0.004	0.030
	(0.089)	(0.288)	(0.017)	(0.059)
LIMP	0.109	−0.117	0.105	0.021
	(0.18)	(0.314)	(0.067)	(0.084)
MPUM	0.158	−0.487	0.162	0.333**
	(0.195)	(0.31)	(0.105)	(0.131)
Constant	0.044	0.849**	−0.091	0.020
	(0.194)	(0.336)	(0.064)	(0.11)
<i>F</i> (13, 155)	2.97	3.85	0.57	1.54
Prob > <i>F</i>	0.000	0.000	0.875	0.108
Root MSE	0.0485	0.472	0.177	0.235
<i>R</i> -squared	0.073	0.160	0.163	0.231
Observations	169	169	169	169

Robust standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.

All in all, it is permissible to argue that LPM results corroborate the probit model results, a confirmation that the results are insensitive to the estimation technique used.

5 Conclusion

This study examined the determinants of market-related considerations among 240 small-scale cassava farmers in South Africa's key

cassava-producing provinces of Limpopo, Mpumalanga, and KwaZulu- Natal. Grounded in the Theory of Utility, the analysis employed probit models to assess how socioeconomic and institutional factors shape farmers' market-related parameters before selling their cassava. In this study, four market-related parameters were used as dependent variables. That is, the consideration of market price, market demand, emergency harvests, and peer influence from other farmers or farmer groups. The probit models identified gender, farm size, education, and farmers' group membership as pivotal drivers of the four market-related considerations that cassava farmers focus on

before selling their produce. Female farmers were 14.5% more likely to prioritize market prices, reflecting their active role in household food security and localized trading networks. Conversely, male farmers exhibited a 6.1% higher probability of being influenced by peer networks, underscoring gendered differences in social capital. Larger farms were strongly associated with responsiveness to market demand, emphasizing the role of surplus production in commercial engagement. Farmers with large household sizes are associated with a 7.0% reduction in the likelihood of considering emergency harvesting, likely due to labor flexibility. These findings align with studies emphasizing the interplay of resource endowments, social networks, and institutional support in smallholder agriculture.

With these results, the study recommends that policymakers prioritize gender-sensitive interventions to amplify women's roles in price negotiations and value-addition activities by explicitly targeting women farmers through market literacy training, contract negotiation support, and access to small-scale processing technologies that enable price differentiation and improved bargaining power. Expanding land access and promoting farm consolidation through land-leasing schemes, cooperative land-use arrangements, and incentives for joint production among neighboring smallholders could enable surplus-oriented production and strengthen farmers' responsiveness to market demand. Investments in education and extension services should focus on practical risk management, post-harvest planning, and market timing strategies, delivered through localized extension programs and farmer field schools, to improve farmers' capacity to manage shocks and emergency harvesting decisions. Strengthening farmers' groups with training in market intelligence and cooperative bargaining and linking these groups to formal buyers, processors, and public procurement programs can reduce reliance on informal peer influence and improve structured market engagement. Future research should adopt longitudinal designs to explore causal relationships and expand geographically to include other cassava-growing regions in South Africa. Additionally, qualitative studies could unravel the sociocultural dynamics influencing gendered decision-making and peer networks. By addressing these systemic barriers, South Africa can unlock cassava's potential as a driver of rural livelihoods, food security, and sustainable agricultural transformation.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The study involved a cross-sectional survey of adult small-scale cassava farmers and posed minimal risk to participants. Ethical approval was formally waived in accordance with institutional guidelines for social science research involving anonymized questionnaire-based data and no collection of sensitive personal identifiers. Before data collection, written informed consent was obtained from all participants. Respondents were informed about the purpose of the study. The voluntary nature of participation and the right to withdraw at any time without consequence. To ensure confidentiality and compliance with the Protection of Personal Information (POPI) Act. All data were anonymized using unique identification codes, and no personally

identifiable information was retained. The study was conducted in accordance with relevant institutional and national ethical standards for research involving human participants.

Author contributions

ZO: Conceptualization, Software, Data curation, Visualization, Formal analysis, Methodology, Writing – original draft. MH: Methodology, Conceptualization, Writing – review & editing, Supervision, Visualization, Software, Data curation, Resources. LD: Conceptualization, Writing – review & editing, Supervision, Formal analysis.

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Conflict of interest

The author(s) declared that this work was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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