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Improved quality signaling boosts farmers' willingness to pay for quality assured cassava planting materials: evidence from experimental auctions in the Lake Zone of Tanzania

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Cassava (*Manihot esculenta* Crantz) is a key staple food in the Lake Zone of northwestern Tanzania and a critical food security crop in Sub-Saharan Africa. However, rather than purchasing quality assured cuttings of improved varieties from trusted sources, many farmers rely on free or almost free cassava cuttings from unregulated sources to establish their plots. This study uses Vickrey's method to examine farmers' willingness to pay for cassava cuttings by exploring two aspects in two rounds of experimental auctions: Round 1, the impact of asymmetric information between buyers and sellers, and Round 2, the influence of enhanced quality signaling using quality assurance labels. Cassava farmers (n=200) placed bids on three products: P1, a farmer-sourced landrace; P2, an improved variety called TARICASS4 sourced from a quality declared seed (QDS) producer; P3, the TARICASS4 variety, also sourced from a QDS producer, but with a quality assurance label. In Round 1, the mean bids per cutting did not differ between treatments, and were TSh 24.5 (USD 0.0091) for P1, TSh 23.4 (USD 0.0087) for P2 and TSh 24.6 (USD 0.0091) for P3. This changed in Round 2, where the mean bids per cutting were TSh 11.5 (USD 0.0043) for P1, TSh 20.0 (USD 0.0074) for P2, and TSh 32.7 (USD 0.012) for P3. Despite P2 and P3 being the same variety and sourced from QDS producers, bidders in Round 2 placed a premium price on P3 because of the added quality assurance label. Relative to bids for the local landrace in Round 2, bids were almost double for the improved variety, and almost triple for the improved variety with certification labeling. These results confirm that providing product information and enhancing quality signaling can significantly boost farmers' willingness to pay for cassava seed, thereby increasing demand. This will have the important consequence of enhancing the commercial viability and therefore sustainability of the cassava seed system.

KEYWORDS

cassava, willingness to pay, seed system, Vickrey method, gender

Introduction

Cassava (*Manihot esculenta* Crantz.) is an important crop for food security and income generation in the tropical belt of Sub-Saharan Africa, and one of the crops best adapted to the anticipated future environmental shocks associated with anthropogenic climate change (Jarvis et al., 2012). However, average yields in Africa of 8.2 h/ha (FAOSTAT, 2023) are far below the estimated potential of 25–30 t/ha (Lebot, 2019). Some of the key factors causing this deficit include an overreliance on informal sources for cassava planting materials among smallholder farmers (Kilwinger et al., 2021) coupled with high disease pressure (Legg et al., 2006; Mbanzibwa et al., 2009; Winter et al., 2010; Legg et al., 2011; Ndyetabula et al., 2016) and the minimal use of agro-inputs like fertilizers (Nweke, 1994; Kelly, 2006; Fermont et al., 2010). The most important cassava diseases in Africa are the viral diseases—cassava mosaic disease (CMD) and cassava brown streak disease (CBSD). Both diseases have the greatest impact on seed quality, as the causal viruses are readily propagated from one crop cycle to the next through infected cassava cuttings (Legg et al., 2015).

The traditional reliance on informal planting material (= seed) sources hinders farmers' access to quality planting materials of improved varieties, preventing them from benefiting from the potential genetic gain of new improved varieties developed by existing cassava breeding programs in Sub-Saharan Africa. To address this bottleneck and increase farmer access to high quality seed, formal cassava seed systems have been established in several countries, most notably Nigeria and Tanzania (Legg et al., 2022). These systems are made up of networks of cassava seed entrepreneurs (CSEs) who are producing near disease-free seeds of high-yielding improved varieties whose quality is assured through regular inspection by seed regulators. In Tanzania, the CSE network includes > 600 seed producers at pre-basic, basic, certified and Quality Declared Seed (QDS) levels and delivers high quality seed of improved varieties from breeders to farmers (MEDA, 2022; Legg et al., 2022; Liani et al., 2023). Currently, the Tanzania Official Seed Certification Institute (TOSCI) regulates seed quality across all seed classes (Msami et al., 2025). However, efforts are being made to empower QDS producers to declare the quality of their seed using guidelines from TOSCI. Like most vegetatively propagated crops (VPCs), cassava has botanical seeds, however, in the context of this paper we refer to cassava cuttings as "seed" because they are used as planting materials instead of the botanical seeds as is the norm for grain crops.

Currently, the cassava seed business is constrained by imperfect markets characterized by a relatively low volume of buyers (root producing farmers) of quality planting materials of the improved varieties coupled with a low frequency of "seed" replacement in cassava farming (MEDA, 2022; Delaquis et al., 2018; Wossen et al., 2020). This is probably due to a general lack of awareness amongst many smallholder farmers of the availability of cassava planting materials from quality and regulatory-compliant sources and the potential benefits of planting improved varieties (Abdoulaye et al., 2014; Wossen et al., 2017; Yabeja et al., 2025). These characteristics are at least partly attributable to the predominance of informal seed exchanges and the nature of cassava being a vegetatively propagated crop (Delaquis et al., 2018; Almekinders et al., 2019; Wossen et al., 2020).

Previous estimations of willingness to pay (WTP) for cassava seeds in Tanzania were done using contingent valuation theory (Maggidi, 2019), which is an approach that relies on the hypothetical nature of non-market products (Bamwesigye et al., 2020). While measures of stated WTP obtained from approaches such as survey questionnaires, key informant interviews, and focus group discussions remain popular (Borghi et al., 2007; Hite et al., 2008; Maggidi, 2019), their results are often viewed as unreliable. Alternatively, revealed preference methods, such as auctions, can be employed to reliably mimic purchasing decisions and scenarios to determine consumer demand for products or their attributes and reveal their WTP for a product (Vecchio, 2013; Banerji et al., 2016; Delaquis et al., 2024; Wossen et al., 2024). While experimental auctions are somewhat complex, they are trusted to prompt bidders to disclose their true willingness to pay for a product (Lusk and Shogren, 2007).

Therefore, for the first time in Tanzania, we used the Vickrey Second Price Auction (SPA) sealed-bid experimental auction method (Vickrey, 1961) to elicit farmers' willingness to pay for cassava seed and investigated how asymmetric information and enhanced quality signaling through TOSCI quality assurance labels influence farmers' willingness to pay for cassava cuttings in the Lake Zone of Tanzania. Additionally, we performed group comparisons of bidders from male-headed households (MHH) vs. female-headed households (FHH) and male bidders vs. female bidders to assess the gender implications in willingness to pay for cassava seed. Our study presents the first evidence of farmers' willingness to pay for quality cassava seeds in Tanzania using experimental auctions. The results of the study will be useful in improving marketing strategies of the CSEs involved in the cassava seed business in Tanzania, and the results will be relevant more broadly for cassava seed business development elsewhere in Sub-Saharan Africa.

Methodology

Study area and sampling procedures

The study was conducted in 10 villages spanning six districts from four regions of the Lake Zone of Tanzania, including Mara (Bunda District), Geita (Chato and Bukombe Districts), Kagera (Muleba and Biharamulo Districts) and Kigoma (Kakonko District) (Table 1, Figure 1). Pre-testing of the pre-auction tool and optimisation of the auction protocol were done in Magu District, Mwanza Region. The study locations were purposively selected in consultation with the regional and district agricultural officers, based on the presence of CSEs and/or historical dissemination of improved cassava varieties by cassava seed system actors.

Using simple random techniques, 20 cassava farmers representing the heads of households in each village were selected by their local Village Agriculture Extension Officers (VAEOs) to participate in the interviews and auctions. However, we encountered challenges in achieving equal representation of female-headed households (FHHs) compared to male-headed households (MHHs) given the apparent patriarchal nature of societies in the Lake Zone. Nonetheless, by expanding participation beyond just the heads of households, some MHHs chose to send

female representatives to the auctions, which consequently led to an increase in the number of female bidders.

Cassava is typically planted in the short rainy season, which usually starts in October in the Lake Zone. To leverage the strong demand for cassava planting materials at the start of the planting season, all auctions were conducted in October 2024 in all 10 villages, each involving the selected 20 cassava farmers. All auctions were conducted in Swahili—the most widely spoken language in Tanzania, ensuring clear communication and engagement.

TABLE 1 Study area.

Region	District	Ward	Village
Mara	Bunda	Salama	Salama Kati
Geita	Chato	Iparamasa	Imarabupina
Geita	Chato	Iparamasa	Kinsabe
Geita	Bukombe	Busonzo	Busonzo
Geita	Bukombe	Busonzo	Nampalahala
Kagera	Muleba	Ngenge	Ngenge
Kagera	Muleba	Ngenge	Rwigembe
Kagera	Biharamulo	Kabindi	Chebitoke
Kigoma	Kakonko	Nyabibuye	Nyabibuye
Kigoma	Kakonko	Nyabibuye	Rumashi

Experimental design

The auction experiment consisted of three parts (i) a pre-auction interview, (ii) two rounds of cassava cutting auctions preceded by a practice round involving bars of soap instead of cassava cuttings, and (iii) post-auction phone interviews. In the pre-auction interviews, we collected demographic, household, and farm characteristics data, as well as information on farmers' usage of quality seeds. The auctioned cassava cuttings were presented as P1, a farmer-sourced local landrace; P2, an improved variety called TARICASS4 sourced from a Quality Declared Seed (QDS) producer; P3, the "TARICASS4" variety, also sourced from a QDS producer but with a quality assurance label as shown in Table 2. In post-auction phone interviews, we contacted farmers who had zero bids for any of the products in either round of auction and asked why they were not willing to pay for any of the products.

The Vickrey Second Price (SPA) auction method (Vickrey, 1961; Barrot et al., 2010; Delaquis et al., 2024; Wossen et al., 2024)

TABLE 2 Attributes of the auctioned cassava cuttings (planting materials).

Attribute	P1	P2	P3
Variety	Local landrace	TARICASS4	TARICASS4
Source	FSS	QDS	QDS
Quality Signaling	No TOSCI label	No TOSCI label	TOSCI label

TARICASS4 is an improved disease-resistant variety.
QDS, Quality Declared Seed; FSS, Farmer Saved Seed.

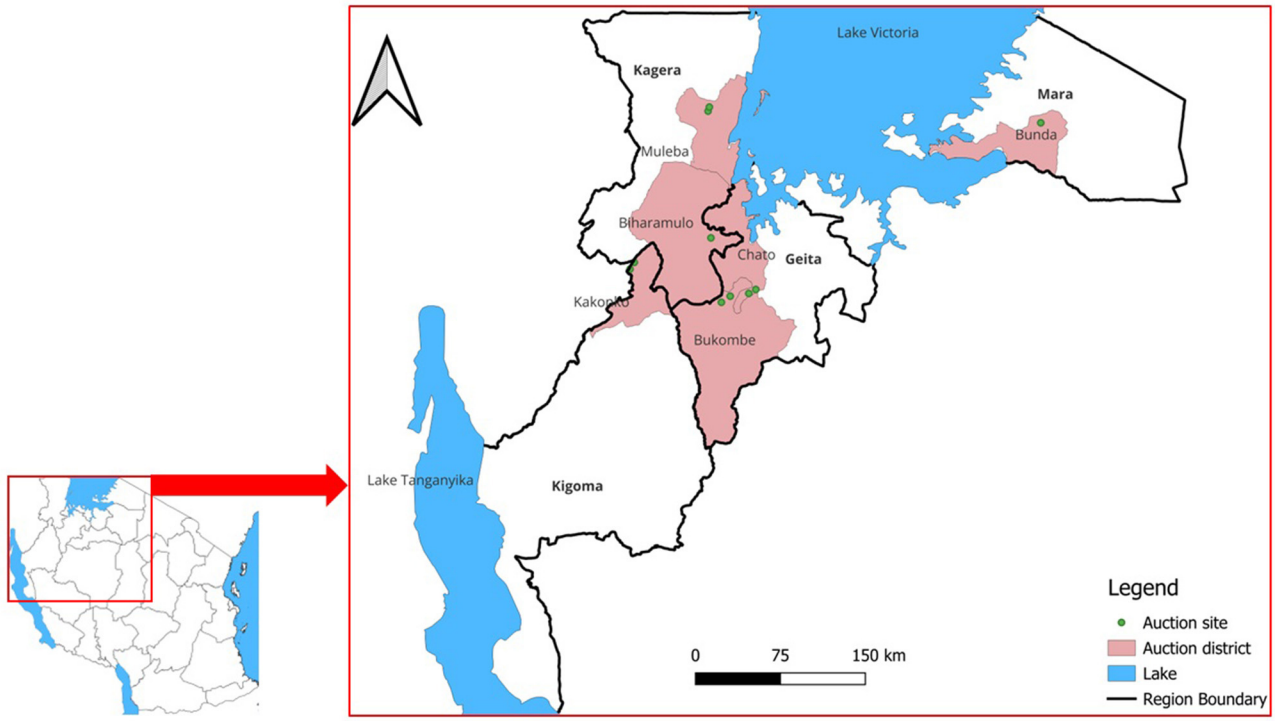

FIGURE 1
Map of the Lake Zone of Tanzania showing auction sites.

was used to simulate cassava seed purchasing decisions in two scenarios: first, mimicking a situation in which there is information asymmetry between the buyer and the seller; and a second situation in which we provided information and used improved quality signaling in the form of quality assurance labels placed on the auctioned cassava cuttings. In all scenarios, the farmer who placed the highest bid was selected as the winner of the auction and would buy the seed at the second highest price.

To prevent the windfall effect that could distort participants' willingness to pay (Banerji et al., 2016; Delaquis et al., 2024), we did not offer endowments or participation fees. Instead, participants were asked to bring their own money to purchase cassava seeds. Participation was not hindered because cassava cuttings are relatively inexpensive, and this was a high-demand planting season. However, light refreshments such as snacks and drinks were provided during the auctions. Auction venues were selected for their central locations within the village, either in village office meeting rooms or schools, to ensure easy access for all participants.

Before conducting auctions for cassava cuttings, a practice auction round was done using three slightly different soap bars to explain the general principle of the experimental auction method used to elicit farmers' willingness to pay for cassava cuttings of different attributes (Lusk and Shogren, 2007, p. 62; Briz et al., 2017; Delaquis et al., 2024). Although the soap bars presented did not have equivalents in the attributes of the cassava seed to be auctioned, they proved to be a useful tool to describe the auction process to farmers who were mostly unfamiliar with second price sealed-bid auctions.

To test for the effect of seed quality misperceptions resulting from information asymmetry and the absence of proper quality signaling (quality assurance labels), two rounds of auctions were conducted. The first round of the cassava seed auction, termed the "*Pre-reveal auction*", was conducted without revealing information about the sources of cassava cuttings, or names of the varieties and without presenting the quality signal (TOSCI quality assurance label) to the farmers. They were allowed to inspect the 20 cassava stem cuttings from each product type (P1, P2, and P3) displayed on the table and then they were asked to bid on the cuttings based on what they could physically observe, mimicking the prevalent situation in the informal cassava seed exchanges in the Lake Zone of Tanzania. Bids for each product were discreetly placed and recorded by the bid recorder who ensured no farmer knew what the other was bidding until the results were presented at the end of the round. This was done to make sure that farmers wrote down what they actually were willing to pay for the products and to reduce the chance of farmers trying to haphazardly bid higher than everyone else just to win the round–a behavior which would have distorted the real price that the farmers were willing to pay under normal circumstances.

In the second round of the auction ("*post-reveal auction*"), farmers were provided with complete information about the auctioned cassava cuttings, including names of the varieties presented, sources of the cuttings, and the TOSCI quality assurance label was displayed on the appropriate bundle of cuttings. The second round of the auction was run immediately after the pre-reveal auction. The farmers' bidding behavior in this round assumes that farmers are now acting on the "*objective quality information*" provided. In this round too, bids for each product were discreetly placed and recorded by the bid recorder who ensured none of the farmers knew what the other was bidding until results were revealed at the end of the round. This was done to make sure that farmers wrote down what they were truly willing to pay for the products and to reduce the chance of farmers engaging in haphazard bidding just to win, as described above.

Data collection and analysis

Data collection was done using Microsoft Excel. The data collected at the village and district levels proved insufficient for analysis. Each auction included only 20 farmers to ensure maximum engagement, however, this number is below the minimum sample size of 30 recommended by the Central Limit Theorem (CLT) for achieving accurate and generalisable results. To address this limitation, data from all districts were aggregated at the zonal level, resulting in a combined sample size of 200 farmers. This larger sample size was considered adequate for ensuring reliability and generalizability of the findings (Kwak and Kim, 2017; Zhang et al., 2023). A descriptive analysis of pre-auction information and analysis of bidding data was done using the SPSS and R statistical packages. WTP estimates were calculated for each round, and comparisons were made.

Results

Socio-demographics of cassava farmers involved in the study

Two hundred farmers participated in the experimental auctions from the four regions where the study was conducted. Among them 151 were men and 49 were women. However, considering the gender of the heads of households represented, 188 were male-headed households (94%) and 12 were female-headed households (6%). The majority (72%) of the farmers were adults aged 36–50 and mature adults aged 51–65 (Table 3). Most had only received primary education (82.0%), with only 4.5% having received tertiary education. Most farmers had more than six years of experience in cassava cultivation. More than 95% of farmers had cassava farms of <2 ha (Table 4).

Auction bidding

In the first round (pre-reveal of information), the mean bids per cutting were TSh 24.5 (USD 0.0094) for P1, TSh 23.4 (USD 0.0089) for P2, and TSh 24.6 (USD 0.0094) for P3, however there was no statistically significant difference in the mean bids among the products ($p = 0.92$). This changed in the second round (post-reveal of information), in which mean bids per cutting were TSh 11.5 (USD 0.0044) for P1, TSh 20.0 (USD 0.0076) for P2, and TSh 32.7 (USD 0.013) for P3 (Figure 2) which varied significantly between products ($p = 1.97\times10^{-7}$). Results show that in the first

TABLE 3 Socio-demographics of cassava farmers involved in the study.

Age			Farming Experience			Education		
Age	Frequency	Percent	Years	Frequency	Percent	Level	Frequency	Percent
18–35	43	21.5%	<3	16	8.0%	Illiterate	10	5.0%
36–50	85	42.5%	3–5	35	17.5%	Primary	164	82.0%
51–65	60	30.0%	6–10	35	17.5%	Secondary	17	8.5%
>65	12	6.0%	>10	114	57.0%	Tertiary	9	4.5%
Total	200	100.0%	Total	200	100.0%	Total	200	100.0%

TABLE 4 Cassava farm size among farmers involved in the study.

Land size (ha)	All farms		Cassava farm	
	Frequency	Percent	Frequency	Percent
Very small farms (<1.0)	26	13%	142	71%
Small farms (>1.0-2.0)	83	41.5%	49	24.5%
Medium farms (>2.0-4.0)	58	29%	6	3%
Large farms (>4.0)	33	16.5%	3	1.5%
Total	200	100%	200	100%

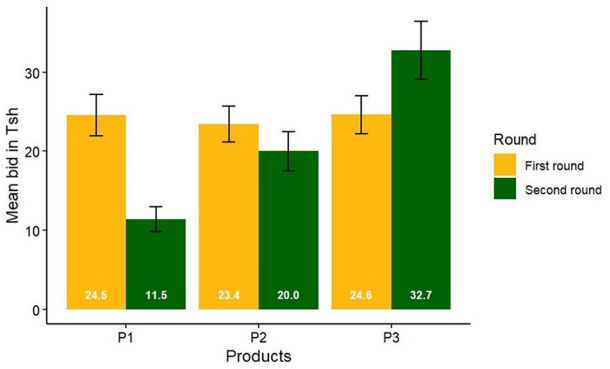

FIGURE 2
Mean bids before information sharing in the first round (Round 1) and after information sharing in the second round (Round 2).

round one participant bid 0 for P1 and another person bid 0 for P3; none bid 0 for P2. In the second round 38 participants (19%) bid 0 for P1 and 22 (11%) bid 0 for P2; none bid 0 for P3. Considering the results from both rounds, only P3 in round 2 resulted in significantly higher bids than P2 in round 2 or all of the treatments in round 1. The demand curve (Figure 3) shows an increase from 30% (round 1) to about 40% (round 2) of farmers willing to pay at least TSh 25 (USD 0.0096) for the premium product P3. The vertical distance among the three curves, evident from the round 2 results, illustrates the discount or premium farmers are willing to pay for various products of differing quality. The difference encompasses the unobservable and observable quality premiums. In round two, the vertical distance of the demand curve for P3 was greater compared to round one, signifying farmers were acting on the objective information provided when placing their bids.

Bidding behavior by the gender of the head of household (HH)

In the first round, the mean bids per cutting for bidders from female-headed households (FHH) ($n = 12$) were TSh 9.0 (USD 0.0034) for P1, TSh 9.3 (USD 0.0036) for P2, and TSh 13.4 (USD 0.0051) for P3 while the mean bids per cutting for bidders from male-headed households (MHH) ($n = 188$) were TSh 25.5 (USD 0.0098) for P1, TSh 24.3 (USD 0.0093) for P2 and TSh 25.3 (USD 0.0097) for P3 (Figure 4). In the second round, the mean bids per cutting for bidders from FHH were TSh 3.5 (USD 0.0013) for P1, TSh 7.2 (USD 0.0028) for P2 and TSh 11.8 (USD 0.0045) for P3 while the mean bids per cutting for bidders from MHH were TSh 12.0 (USD 0.0046) for P1, TSh 20.8 (USD 0.008) for P2, and TSh 34.1 (0.013) for P3. Bids were significantly higher among bidders from MHH compared to the bidders from FHH across all products in round 1 ($p = 0.03$) and round 2 ($p = 0.02$).

Bidding behavior by the gender of the bidder

The mean bids per cutting for female bidders ($n = 49$) in the first round were Tsh 20.9 (USD 0.0077) for P1, Tsh 19.7 (USD 0.0073) for P2, Tsh 22.7 (USD 0.0084) for P3 while in the second round the mean bids were Tsh 8.3 (USD 0.0031) for P1, Tsh 18.1 (USD 0.0067) for P2, Tsh 29.5 (USD 0.0110) for P3. On the other hand, the mean bids per cutting for male bidders ($n = 151$) in the first round were Tsh 25.8 (USD 0.0095) for P1, Tsh 24.6 (USD 0.0091) for P2, Tsh 25.3 (USD 0.0093) for P3 whereas in the second round the mean bids were Tsh 12.5 (USD 0.0046) for P1, Tsh 20.6 (USD 0.0076) for P2, Tsh 33.8 (USD 0.012) for P3 (Figure 5). While mean bids for male bidders were higher than those of female bidders across all products and rounds, the observed differences were not statistically significant ($p > 0.05$).

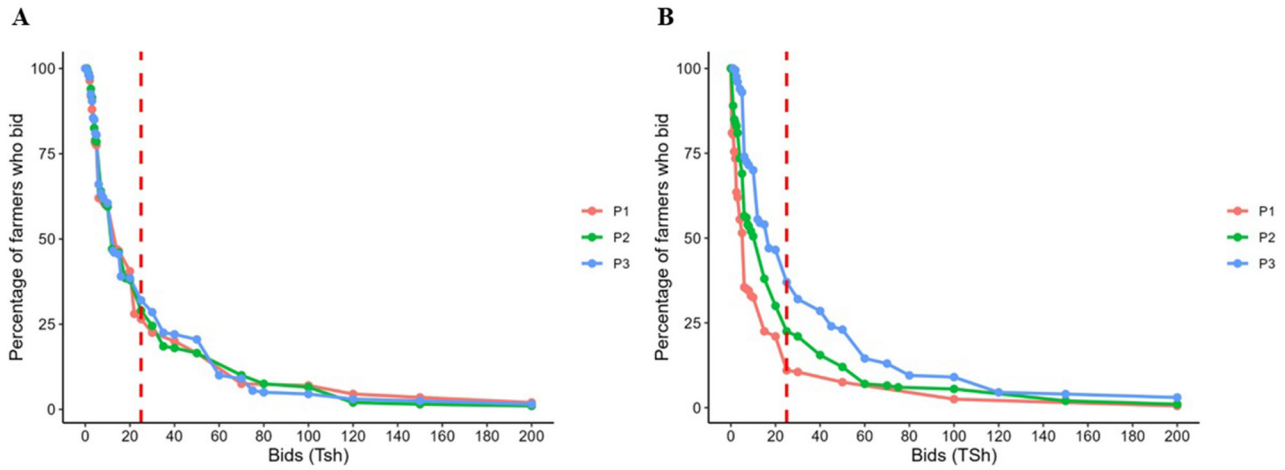

FIGURE 3
Demand curve for products P1, P2, and P3 in **(A)** first round and **(B)** second round auctions [note that in **(B)** the x-axis was adjusted to exclude one farmer who bid TSh 300 for P2 and one former who bid TSh 500 for P3].

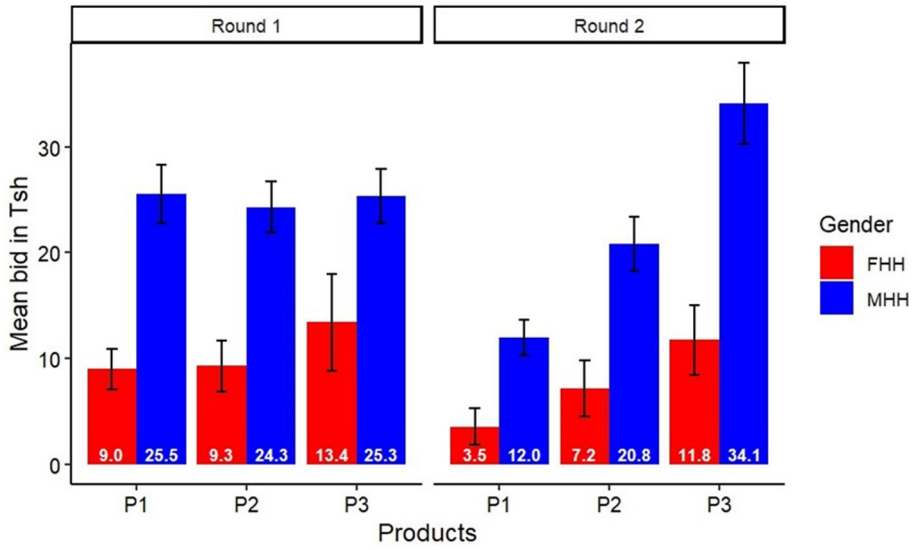

FIGURE 4
Mean bids by the gender of household head (HH) before information provision (Round 1) and after information provision (Round 2).

Post-auction phone interviews

Post-auction interviews with 39 farmers who had not made bids for at least one of the products in either auction round showed that for P1, the main factor was that this product could be obtained elsewhere for free (Table 5). One of the two next reasons for non-bidding was the lack of money to spend on cuttings, and this was the most important non-bidding factor overall for all three product types. For P2, a lack of familiarity with the improved variety was the most common reason for failure to offer a bid, although the next most common explanation was an expressed need to save money for higher quality material. The only response farmers provided for failure to bid for P3 was that they did not have any more money.

Discussion

Are farmers willing to pay for cassava seed?

Seeds are a crucial agricultural input that determines crop productivity and resilience to environmental stresses such as diseases and pests. The use of high-quality seeds of improved varieties is highly emphasized for enhancing resilient agrifood systems under the current conditions of changing climates and threats from biotic and abiotic stresses (Atlin et al., 2017). The benefits of using quality seeds of resilient crop varieties by smallholder farmers in Tanzania and Malawi are estimated to rise from 984 million USD in 2020 to 2.1 billion USD in

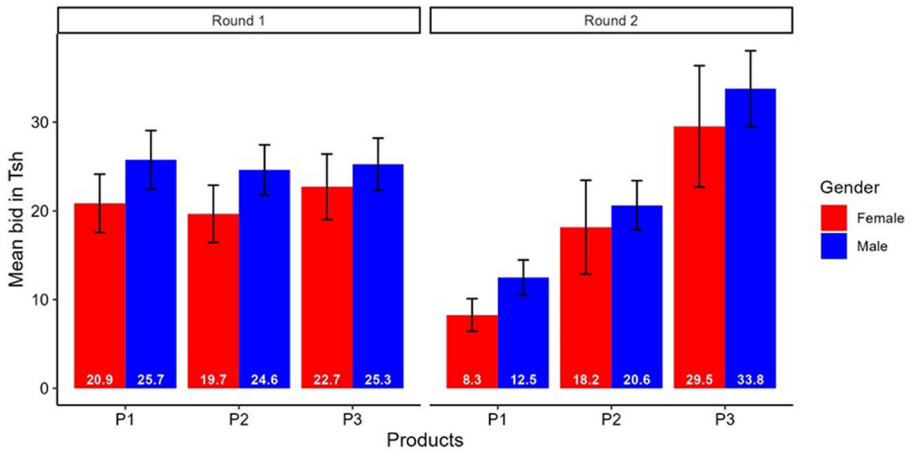

FIGURE 5
Mean bids of female vs. male bidders before information provision (Round 1) and after information provision (Round 2).

TABLE 5 Post-auction phone interview.

Why did you not bid for any of the products?	*n*	P1	*n*	P2	*n*	P3
I had no more money to spend on cassava planting materials	8	21.1%	4	18.2%	1	100%
I cannot pay for the product because I can obtain it for free from other sources	15	39.5%	0	0.0%	0	0%
I am not familiar with the variety traits such as yield, disease resistance, etc.	4	10.5%	9	40.9%	0	0%
I have already satisfied my demand for planting materials this season	4	10.5%	2	9.1%	0	0%
I am saving money to pay for higher quality cuttings	8	21.1%	7	31.8%	0	0%

2050 (Cacho et al., 2020). In Ghana, using certified seeds of rice provided an additional income of GH¢2.65 (USD 0.83) for every GH¢1.00 (USD 0.31) invested, whereas investing GH¢1.00 (USD 0.31) in farmer-saved seed yielded a comparatively lower additional income of GH¢1.98 (USD 0.61) (Dogbe et al., 2014). For cassava in Tanzania, Yabeja et al. (2025) noted an 81% increase in fresh yield when high quality seeds of improved cassava varieties were planted instead of farmer-saved seeds of the same varieties.

Despite the noted benefits of using certified seeds, many believe that farmers in Sub-Saharan Africa are not willing to pay for certified planting materials of vegetatively propagated crops, as they can recycle their own planting stock instead. In the study described here, we set out to examine this topic with farmers in Tanzania, with key questions being: (i) are farmers willing to pay for cassava seed? and (ii) do they place a premium on improved varieties, with or without quality certification? Results indicate that farmers are willing to pay for cassava seed, particularly the cassava seed of improved varieties that offer better yields and resistance to diseases. They are also ready to pay a premium for the seeds of improved varieties if they come with a quality assurance label. As well as obtaining qualitative (yes/no) answers to these questions, we also aimed to quantify any added value expressed by farmers for improved varieties and quality certification. The specific auction approach taken proved to be an appropriate mechanism for assessing farmers' willingness to pay for cassava seed in Tanzania, generating important insights.

Role of information asymmetry

Information asymmetry—where one side has lots of information and the other side has little or none—is a critical challenge that affects farmers' willingness to pay for and adopt new agricultural technologies, including improved cassava varieties (Bai, 2021; Michelson et al., 2023; Wossen et al., 2024). When the quality of planting materials is not explicitly specified, there exists a significant likelihood of information asymmetry between the buyer and the seller of such materials. The first round of auctions was designed to mimic this situation. Results in this round showed no significant variation in the mean bids for P1, P2, and P3.

Furthermore, the unusually high willingness to pay for P1, a local landrace, was most likely an outcome of quality misperception resulting from information asymmetry between bidders and auctioneers of the cassava seed. It could also mean farmers assigned the same level of quality to all three products because they thought cassava cuttings brought by auctioneers (researchers from a government agency and IITA) would be of a similar higher quality compared to what is available in their local market. This has important implications for the cassava seed system in the real market situation.

Suppose CSEs fail to effectively communicate the quality of the improved planting materials they offer, and do not strengthen their value proposition strategies, then farmers are likely to assign the same price as low quality local landrace cuttings available in the market to the high quality cuttings of improved varieties produced by CSEs. If that happens, the CSEs' business

model will ultimately collapse because the cost of production of quality assured planting materials of improved cassava varieties is higher than that of the unregulated planting materials of local landraces. Akerlof's theory of asymmetric information describes how information asymmetry between buyers and sellers can lead to products of poor quality ultimately flooding the market in a phenomenon termed as a *"market for lemons"* (Akerlof, 1978). In such a market, lower prices are applied to both poor-quality products (lemons) and higher-quality products, ultimately leading to the exit of higher-quality product sellers due to reduced returns (Giannakas and Fulton, 2020).

In contrast, when bidders received adequate information about seed quality in the second round of auctions, the bids for P1 and P2 decreased by 53.3% and 14.5%, respectively, while bids for P3 increased by 32.9%. The bids for P2 and P3 were significantly higher than those for P1 (local landrace), suggesting that bidders are willing to pay a premium for the improved variety products (TARICASS4). These results align with Delaquis et al. (2024) study, which found that farmers in Laos and Cambodia were willing to pay a higher price for clean stem cuttings of the improved cassava variety (KU50) from sources that are subject to routine PCR-based testing and visual inspection. Wossen et al. (2024) similarly found that smallholder farmers in Nigeria demonstrated a higher willingness to pay for certified cassava stems of the officially registered variety TME 419.

Effect of improved quality signaling

Quality signaling through seed certification and labeling has been noted to effectively change the "*credence attributes*" of marketed certified seeds into "*search attributes*" (Auriol and Schilizzi, 2015). This process is facilitated by labeling systems, in which certified seeds are accompanied by quality assurance labels that provide essential information regarding quality attributes. Quality assurance labels in Tanzania are provided by TOSCI and have only recently been piloted for cassava seed and are yet to be fully adopted by CSEs.

The application of the TOSCI label on P3 in the second round of auctions led to a significantly higher mean bid for P3 compared to P2, indicating that farmers are willing to pay a premium for TARICASS4 cuttings with quality assurance labels. This finding demonstrates that the issue of information asymmetry in the VPCs' seed markets can be addressed by enhancing quality signaling through a labeling system by regulators such as TOSCI in Tanzania. The willingness of bidders to pay 63.5% more for the premium product P3 (TARICASS4 with the added TOSCI quality assurance label) compared to the price of P2 (TARICASS4) makes a strong case to mandate the inclusion of such labels on certified cassava planting materials within the formal seed system.

It is crucial to note that a corollary of the increase in bids for quality assured seed of the improved variety (P3) following the information "reveal" was a significant reduction in bids for farmer saved seeds of the local landrace (P1). This observation suggests that as quality signaling for VPCs' planting materials becomes more common, the demand for low-quality, cheap planting materials from unregulated sources is likely to decline, leading to an overall improvement in the quality of planting materials being made available to farmers. The results of this study provide a strong indication that if TOSCI implements a labeling system for certified cassava seed in Tanzania, it is likely to boost sales of improved varieties by CSEs and increase adoption of improved varieties.

Gender implications in the WTP of bidders

Although there were no significant differences in mean bids between male and female bidders overall, a statistically significant difference was found when comparing the mean bids of participants from male-headed households (MHH) and female-headed households (FHH). Bids were significantly higher among bidders from MHH compared to those from FHH across all products in rounds 1 and 2, indicating that the gender of the head of the household of the bidders influenced their bidding behavior. Bidders from FHH bid lower than bidders from MHH, probably because households with female heads have comparatively lower disposable income. Women generally have less access to and control over resources than men in rural Tanzania (Liani et al., 2023); nonetheless, they are equally or even more engaged in agriculture than men. However, there is evidence that women's engagement in agriculture in central and eastern Africa increases income inequality, favoring men over women (Akpa et al., 2024). This might also be true in the Lake Zone of Tanzania. To remedy the situation, stakeholders should implement policies that strengthen women's rights in agriculture by enhancing their access to credit, land, and education. This will help narrow the income gap and boost their willingness to pay for quality assured cassava cuttings of improved cassava varieties as well as other agricultural technologies.

While bidders from FHH preferred P3 in the first round, the bid variations among products were not significant. This means they exhibited a level of quality misperception regarding the presented products due to information asymmetry. In the second round, their mean bid for P1 shifted downward by 61.1% and there was a significant difference in mean bids between P1 and P3, which shows that they valued the premium product (P3) more than the local landrace (P1). For the bidders from FHH, the provision of additional information did not lead to general increases in bid size, suggesting that their resources were restricted to a fixed amount, with no scope for increase, even though bids show they favored P3 over other products.

On the other hand, in the absence of any information about the auctioned cuttings in the first round, bidders from MHH favored P1 (local landrace), over P2 and P3 (both TARICASS4), presumably because they were familiar with P1 and were not willing to bet on the unfamiliar P2 and P3 in the absence of any information about quality attributes. Nevertheless, they changed their bids in the second round, in which we observed a large and significant decrease in the mean bid for P1 by 52.9% and an increase in the mean bid for P3 by 34.8%. Bids of participants from MHH for P3 (labeled, certified TARICASS4) were almost three times as great as those for the farmer-saved seed of a local landrace (P1).

Conclusion

This study investigated how the prevalent market conditions for cassava planting material in the Lake Zone of Tanzania affect

the willingness to pay and consequently the demand for certified cassava planting materials, a critical staple food in the region. We used two rounds of a second price sealed bid method to examine (i) how asymmetric information regarding product quality and (ii) how enhanced quality signaling using quality assurance labels issued by TOSCI influenced bids in the two rounds of the experimental auction. We demonstrated that most smallholder farmers in the surveyed areas are prone to quality misperceptions when information about products was withheld in round 1, as there was no significant variation in mean bids for auctioned products. This is unsurprising since the diseases that reduce the quality of cassava planting material are not readily recognized just from viewing stem cuttings. The overwhelming majority of farmers revised their bids upwards (P2 and P3) or downwards (P1) in response to information shared in round 2. Even though P2 and P3 were both the same variety and both produced by QDS farmers, bidders placed a premium price on P3 because it had the TOSCI quality assurance label. This implies that the provision of information about quality can improve the demand for quality cassava cuttings of improved varieties. Consequently, the enhanced quality signaling achieved by using TOSCI quality assurance labels has the potential to greatly improve farmers' willingness to pay for planting materials of improved cassava varieties and therefore increase the demand for the same. Participants from female-headed households demonstrated lower WTP compared to those from male-headed households, even lower than the reported average market price of TSh 25 (USD 0.0096) per cutting for improved cassava cuttings from CSEs. We speculate that participants from female-headed households in our study bid lower because they have marginal access to and control over resources such as land due to the prevalent gender norms and traditions in the region. Implementing policies that strengthen women's access to credit and land ownership would boost their willingness to pay for agricultural technologies including the willingness to pay for quality assured planting materials of improved cassava varieties. Overall, the results reveal that farmers are not only willing to invest in cassava seed but are also inclined to pay a higher price for improved varieties, which offer better yields and disease resistance. Furthermore, there is a notable willingness among farmers to pay a premium for improved variety seeds that come with a quality assurance label, indicating a commitment to superior standards and reliability in their farming practices. This reflects farmers' recognition of the value that enhanced seed quality brings to their agricultural productivity and overall success.

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 studies involving humans were approved by Internal Review Board of International Institute of Tropical Agriculture. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JM: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. JN: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – original draft, Writing – review & editing. HK: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Visualization, Writing – original draft, Writing – review & editing. JJN: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Visualization, Writing – original draft, Writing – review & editing. JL: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

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