Smallholder Farmers' Willingness to Pay for Certified Improved Maize Seed in Morogoro

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Jacqueline P. Majuva[1*], Joseph P. Hella[2], Nicetus Seluhinga[2], Martin Komba[3] and Gasper G. Mapunda[4]

[1] Mbeya University of Science and Technology, [2] Sokoine University of Agriculture, [3] Tanzania Agricultural Research Institute, [4] Hofstra University

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Correspondence email: jacquelinemajuva@gmail.com

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Abstract

Agriculture is critical to Tanzania's economy, with maize as a staple crop vital for both food security and income in both rural and urban communities. Despite its importance, maize yields lag behind potential due to limited use of productivity enhancing technologies like fertilizers and certified improved seeds. This study estimates willingness to pay and investigates the factors affecting smallholder farmers' willingness to pay (WTP) for improved maize seeds, offering data driven insights to support policies that promote sustainable farming and food security. Household surveys and field experiments with 208 maize-producing households revealed that high seed costs averaging Tshs 13492 and 13521 in Kilosa and Mvomero respectively deter adoption, with 94% of farmers citing price as a barrier. Using the Becker-DeGroot-Marschak (BDM) method, farmers were willing to pay Tshs 5377 and 4853 for certified and non-certified seeds, respectively; the Take-It-or-Leave-It (TIOLI) method showed higher WTP at a price of Tshs 5000, with 59% for certified and 50% for non-certified seeds. Factors influencing WTP include sex, formal group membership, and slope of the land. The study recommends seed adoption enhancing initiatives including government subsidies, farmer education, and cooperative promotion to improve productivity and smallholder livelihoods.

Key words: *Certified, BDM, Experiment, Maize seeds, TIOLI, Willingness to pay*

JEL codes: C93, D13, D90, Q16

Introduction

Agriculture remains the foundation of Tanzania's economy, employing about two-thirds of the labour force, contributing roughly a quarter of national gross domestic product, and supplying most of the country's food (World Bank, 2023). Within this sector, maize is the most important staple crop, dominating cultivated land and serving as the principal source of both food and income for rural households (Jayne *et al.,* 2020; Santalucia *et al.,* 2024).

Despite this importance, maize productivity in Tanzania has stagnated and remains below both its agronomic potential and the regional average. This gap is driven by climate variability, rising input prices, and the limited use of yield-enhancing technologies such as inorganic fertiliser and certified improved seed (Santalucia *et al.,* 2024; Rweyemamu et al., 2024). The fragility of the system became evident between 2021 and 2022, when maize yields fell and prices rose sharply, pushing a substantial share of the population into food insecurity (Rweyemamu et al., 2024). Improved seed is widely recognised as one of the most cost-effective entry points for closing this yield gap, yet its uptake among smallholder farmers remains persistently low (Mastenbroek *et al.,* 2021; Natogmah *et al.,* 2023).

Certified improved seed is expected to raise productivity through higher and more stable yields, better germination, and greater tolerance to drought, pests and disease. However, seed quality is a credence attribute: farmers cannot observe it at the point of purchase and only learn whether the seed is genuine after it has germinated (Mastenbroek et al., 2021). In Tanzania this uncertainty is heightened by the circulation of counterfeit and substandard seed, which undermines farmers' trust in the certified label (Ronald & Mulemia, 2023). Where farmers cannot reliably distinguish genuine from fake seed, their willingness to invest in certified varieties and in complementary inputs declines (Gharib *et al.,* 2021). Price reinforces this hesitation: in the present study, the average retail price of a 2 kg pack of improved maize seed reached Tshs 13,492 in Kilosa and Tshs 13,521 in Mvomero, and 94% of surveyed farmers cited cost as the main reason for not purchasing improved seed.

Designing policies that can raise certified-seed uptake whether through subsidies, pricing, or quality-assurance schemes requires credible evidence on how much farmers are genuinely willing to pay (WTP) for these seeds, and on the factors that shape this valuation (Natogmah *et al.,* 2023; Miao et al., 2026). Such evidence is, however, limited for the Tanzanian maize seed sector. Most existing WTP estimates rely on hypothetical methods such as contingent valuation, which are prone to

hypothetical and social-desirability bias and tend to overstate real demand (Brzozowicz & Krawczyk, 2022). Non-hypothetical, incentive-compatible field experiments that involve real purchase decisions remain scarce in this context, and direct comparisons of competing elicitation mechanisms for the same good are rarer still (Berry *et al.,* 2020; Cole *et al.,* 2020). This study addresses that gap.

To elicit WTP under real purchasing conditions, the study applies two incentive-compatible mechanisms: the Take-It-or-Leave-It (TIOLI) method, in which farmers face a randomly drawn price and decide whether to buy at that price, and the Becker–DeGroot–Marschak (BDM) method, in which farmers state their maximum bid and transact only if a randomly drawn price falls at or below it (Berry et al., 2020; Cole et al., 2020). Both methods give respondents an incentive to reveal their true valuation, reduce hypothetical bias, and are well suited to single-respondent field settings (Mastenbroek *et al.,* 2021). Comparing the two also allows the study to examine whether estimated WTP depends on the elicitation method used, an issue of methodological importance in agricultural economics (Miao et al., 2026).

Against this background, the study pursued two specific objectives: (i) to estimate smallholder farmers' willingness to pay for certified and non-certified improved maize seed using the BDM and TIOLI methods; and (ii) to identify the household, geographical, institutional, and economic factors that influence farmers' willingness to pay for certified improved maize seed. By applying and comparing the two elicitation mechanisms in a real seed-purchase experiment, the study further contributes methodological evidence on the suitability of incentive-compatible approaches for valuing agricultural inputs, and provides data-driven insights to inform seed pricing, subsidy, and cooperative-development policies aimed at improving productivity and food security.

Literature Review

Seed certification process in Tanzania is a critical component of the agricultural sector, aimed at ensuring that farmers have access to high-quality seeds that meet specific standards of purity, viability and performance (AECF, 2017). Seed certification is managed by the Tanzania Official Seed Certification Institute (TOSCI), a government body responsible for regulating and supervising seed production, processing, and marketing across the country. This process involves several stages, including field inspections, laboratory testing, and final approval, to confirm that seeds comply with national and international standards (Rajesh, 2022).

Seed certification is part of the ongoing intervention by the seed regulatory organ to ensure the indigenous farmers are adopting the use of certified improved seeds for better yields. Certified seed production is estimated to cover 15-25 of the national seed requirements (USAID, 2013). According to TOSCI Director General interviewed by Farmers review Africa, he reported that "a total of 482 plant varieties has been certified with 160 maize varieties have been certified and registered of the period between January and November 2021".

Maize seed certification ensures farmers receive seeds with known qualities, improve their yields, better disease and drought tolerance, reduce the risk of low germination or poor performance. Buying certified seeds is one thing and should go in hand with proper agronomic practices and management techniques to maximize the benefit of using certified seeds (Xiong and Tarnavsky, 2020).

However, despite the benefit that are expected to be obtained by farmers from using certified maize seeds, the use of these seeds is lower than expected. It has been put forward that limited growth of private seed sector in central, southern and western part of Tanzania, long process of certification, high costs in certification, direct competition with government agricultural seed agency and presence of fake or counterfeit seeds in the market. For example, it is estimated that 25-30 of certified seeds used is fake seeds in the market (USAID, 2013; Ronald & Mulemia, 2023). These factors lead to high prices of seeds and hesitance to farmers regarding the quality of seeds to use in their production. To overcome these challenges, efforts are being made by the Tanzanian government, in collaboration with international organizations, to enhance the seed certification process and address the issues surrounding it. These efforts include demand led breeding by Tanzania Agricultural Research Institute (TARI), improving the capacity of TOSCI, raising awareness among farmers about the benefits of certified seeds, and developing more efficient distribution channels to ensure that certified seeds reach all farmers, regardless of their location (AECF, 2017).

There are several WTP valuation methods including contingent valuation, discrete choice experiments, conjoint analysis, single and double dichotomous choices, cheap talk script, payment cards, BDM and experimental auctions (Ngaiza, 2019). Most of these methods base their assessment on hypothetical situation (scenario) leading to selection and hypothetical bias (Caswell et al., 2007). However, in this study take it or Leave It (TIOLI) and Becker DeGroot Marschak (BDM) is used based on its advantages in revealing the willingness to pay and reducing biases.

It involves sales offer at a randomized price and there is no opportunity for bargaining (Berry et al., 2012). Hence respondents are required to draw a random price for the product. Then the respondent is asked if he accepts the offer at a drawn price. If the

respondent accepts the offer, then they are allowed to purchase the product and are told not to purchase if otherwise (Berry et al., 2020). And if the respondent initially agreed to the purchase but is ultimately unable to obtain the funds, then is coded as not purchasing but attempt to purchase is noted (Berry et al.,2019). This method has an advantage that is simple to understand and implemented in the field.

BDM is value elicitation method commonly used in developed country, however in developing countries it has recently been used (Patrick et al., 2019). Recent studies that have used BDM for preference and value elicitation in context of developing country agriculture includes farmers' WTP for adoption of agricultural best management practices (Palm-Forster et al., 2017), consumers' acceptance of biofortified foods (Birol et al., 2015) and food characteristics (Alphonce & Frode, 2017). In this method individuals are asked to state a maximum amount they would be WTP for a product. Then a binding transaction price is drawn randomly from a predetermined price distribution (Becker et al.,1964; Berry et al., 2019). Hence, if the participant's valuation exceeds the randomly selected price, transaction occurs and participant purchases the product. And if the participant selects otherwise, they will not be entitled to a product (Becker et al., 1964). Hence the advantages that BDM has over other methods been that participants have an incentive to state valuations that reveal true value they hold for the product (Becker et al., 1964). It allows the researchers to conduct the procedure in the field setting with single participant incorporating subject's decision making (Patrick et al., 2019). Further, it reduces uncertainty and limits the hypothetical biases since it involves actual purchase of a product during the experiment.

Theoretical Framework

The random utility theory (RUT), as introduced by McFadden in 1975, is a valuable tool frequently employed in studying individual willingness to pay for various alternatives, such as goods or services (Adalja et al., 2015; McFadden, 1999; Ngaiza, 2019). This theory holds substantial prominence in the field of economics due to its capacity to elucidate, clarify, and predict choices among discrete options, a prime example being the decision to pay for improved maize seeds. According to the theory, when individuals are confronted with a range of distinct and viable choices, they will opt for alternatives that are mutually exclusive. It rests upon the premise that rational individuals, adhering to consumer theory principles, will select the option offering the highest utility when faced with discrete alternatives.

This theory explicitly connects to the existing study by framing WTP as a utility-maximizing choice between certified and non-certified maize seed alternatives, where farmers select the option bringing higher expected utility (especially higher yields and stable income) net of costs.

Conceptual framework

Grounded from RUT that household, geographical, institutional, and economic factors influence the deterministic utility component, eventually shaping WTP (choice probabilities and bid values). It follows that the WTP for certified maize seed is the central focus of this framework which is driven by the aforementioned factors with linkages explained henceforth. Household characteristics with attributes specific to the farmer's household, such as age, sex, income level, education, family size, and plot size can affect the farmer's expectation on yield from certified improved maize seeds. Also, geographical factors like slope of the land are decisive as different varieties of maize seeds may perform differently in various geographical conditions. Farmers with flat and gentle slope may have a higher willingness to pay for seeds, while those in less favorable areas (steep slope) may prioritize traits such as drought resistance or pest resilience. Institutional factors are encompassing agricultural policies, regulations, and support systems. This could include government subsidies, extension services, seed certification programs, or intellectual property rights. Institutional factors can significantly influence the availability, affordability, and perceived value of improved maize seeds, thereby impacting farmers' willingness to pay. In this study land ownership, membership in formal groups and certification was observed. Finally, economic factors such as market prices, input costs, access to credit, and overall market conditions play a crucial role. Higher market prices for improved seeds may reduce farmers' willingness to pay, especially if their income or profit margins are constrained.

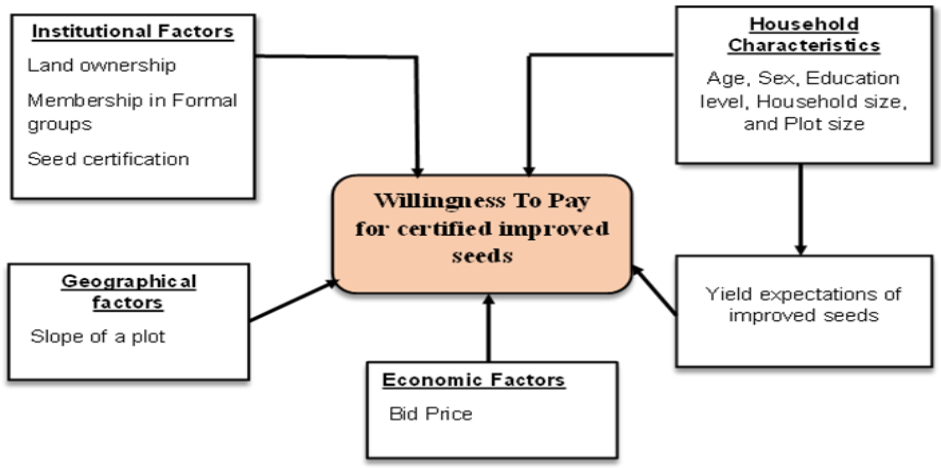

Figure 1: Conceptual Framework

Source: Researchers own work adopted from (Ngaiza, 2019)

Research Methodology

The field experiment was conducted in Kilosa and Mvomero districts with the maize producing households. The study collected primary data using questionnaire tool divided in two parts including household survey questions and the seed sales experiment. The experiment assigned an elicitation method (take it or leave it or Becker DeGroote Marschak) per household and the household head had to make a choice between a certified improved maize seed or not certified seed based on the features given by the researcher. Hence, the researcher randomly assigns the elicitation methods to households while heads of household had to make choice on type of seed.

The product was a 2kg bag of improved maize seed. The experiment used one type of improved maize seed called Tumbili SC419 where some maize seed package was intact with Tanzania Official Seed Certification Institute (TOSCI) sticker and other package was without a sticker. The information was shared with farmers. The seed has attributes including drought resistance, increasing yield with two cobs per plant and short period of maturity (75-80 days).

The farmers were educated on the importance of their participation in a study on improved seed decision making conducted by researchers from the local agricultural university. Two screening questions were asked: (i) whether a farmer was willing to participate in the study, and (ii) whether a farmer was interested in buying improved maize seeds that day. Farmers who answered 'yes' to both questions were invited to participate in the experiment; those who had no consent were not part of the experiment. The farmers were not paid to take part in the experiment. Instead, farmers were rewarded with 5000Tshs cash for their participation after the experiment. Meaning that, the money they had in the house at given point in time was used in the experiment. The experiment took 13 days, and we obtained a total of 208 participants.

The maize seeds are regarded as certified when with TOSCI sticker and not certified maize seed without TOSCI sticker.

The respondents were randomly assigned to either BDM or TIOLI elicitation method. The seed certification label was the treatment that differentiated the seed packages; however, it was a same variety of seeds. The farmer was explained about the TOSCI sticker, the aim was to assess how a farmer associates the certification sticker with the quality of maize seed and the value that they place on the certified seeds compared to other seeds. The scripts for the sales were designed to be as similar as possible across the elicitation method. Each sale began with a practice round for a token item,

in most cases a bar of soap with retail value approximately 1000, 1500, 2000, 2500, 3000, 3500 and 4000Tshs. After the practice round was complete, the respondent was given the opportunity to purchase the seeds using the same mechanism.

The experiment was conducted to each maize producing household that when one household is done then researcher moves to the next household. The willingness to pay information was obtained as follows;

TIOLI, the take-it-or-leave it treatment is a simple sales offer at a randomized price. We will randomize at three prices, 2500(2), 5000(2), and 10 000(1) TSHS. Before revealing to the respondents, it will be emphasized that the random price is picked once and there will be no bargaining. If they accept the offer price, respondents will be allowed to purchase the seeds and have until the end of the day to obtain the necessary cash. If the respondent will not accept the offered price, then will not purchase the seeds.

BDM, each participant sets a maximum price (*b*) that is willing to pay for the improved maize seed offered and the final sale price is determined randomly by drawing a paper with the price 2500 (2), 5000 (2),10 000 (1) TSHS marked on it from a bowl. If the price drawn (*p*) at random is lower or equal to the WTP (*b*) expressed, the participant must buy the seeds for the randomly determined price. Otherwise, if the price drawn (*p*) is greater than WTP *(b)* then the farmer will not purchase the seeds on that day. The condition is that paper with the random price is selected once from the bowl.

Table 1: Distribution of Elicitation Methods

	Elicitation Method	
Treatment	**BDM**	**TIOLI**
Certified	Low/High	Low/high
Not Certified	Low/High	Low/High
Total	**104**	**104**

From a random utility theory explained by McFadden (1975) it has been pointed to be a useful method to study how individuals make decision on willingness to pay for goods and services from given alternatives (Adalja et al.,2015: McFadden,1999: Ngaiza, 2019). It assumes that if faces a number of discrete choices and he is rational, then one will select an alternative that has higher utility.

The choice for specific alternative is given when;

$$\gamma_{in} > \gamma_{jn} \quad for\ i \neq j \text{ ----------} (1)$$

Where; γ_{in} utility from choice i, γ_{jn} utility from choice j, $i\ and\ j$ are alternative choices from given set (w) and n is decision maker (farmer).
Now, the probability of the farmer to choose certain alternative is given as;

$$P(i/w) = \Pr(\gamma_{in} > \gamma_{jn})\ \forall\ i \neq j \quad (2)$$

However, for the dichotomous choices it consists of two alternatives "i" and "j". With a probability that a farmer (n) will choose an alternative i(WTP=1) or j(WTP=0) given as;

$$P_n(i) = \Pr(\gamma_{in} > \gamma_{jn})\ for\ WTP = 1 \quad (3)$$

and

$$P_n(j) = 1 - P_n(i)\ for\ WTP = 0 \quad (4)$$

Each choice made by an individual farmer has an associated utility. It has been proposed by the theory that;

$$\gamma_{ij} = \beta X_{ij} + \varepsilon_{ij} \quad (5)$$

Where; γ_{ij} - Utility for the choice made by farmers, βX_{ij} – deterministic component of the utility with observable features, ε_{ij} - error term showing unobserved factors that affect utility, β – Parameters to be estimated, and X_{ij} – Observable explanatory variables.
Thus, willingness to pay (WTP) derived from a random utility model:

$$\gamma_{ij} = \alpha_i + \beta X_{ij} + \varepsilon_{ij} \quad (6)$$

Where; α_i - Price
Converting equation (6) to monetary terms/ mean willingness to pay, divide the equation by α_i to all β.

Data Analysis

Descriptive statistics such as mean and standard deviation were used to obtain the mean WTP for certified and non-certified improved maize seeds from both elicitation methods. And the characteristics of maize producing households in the study area were explained using frequencies and percentages.

For the respondents assigned with BDM (certified and non-certified), the linear regression analysis is used to obtain the relationship between willingness to pay with variables hypothesized to explain willingness to pay as follows;

$$Bid\ Price_i = \beta X_{ij} + \varepsilon_{ij} - (7)$$

Where; Bid price/ maximum WTP_i – willingness to pay, X_{ij}– Variable of interest, and ε_{ij}- error term.

The respondents assigned with TIOLI method (certified and non-certified); the probit model is used with WTP since is not observed rather a binary indicator for whether WTP is greater a certain value (random price offer). The probit model explains the yes/no decision with variables example household characteristics, institutional factors, economic and geographical factors. The model is given as;

$$WTP_i \geq P_i = \alpha_i + \beta X_{ij} + \varepsilon_i;\ for\ WTP \geq P_i\ is\ 1, otherwise\ 0 - - - - - - (8)$$

Where; WTP_i- Willingness to pay for household i, X_{ij}- vector of variables of interest, β -parameters to be estimated, and ε_{ij}- standard error term.

Results and Discussion

The data in Table 2, compares household characteristics among households that selected certified and non-certified improved maize seeds across various characteristics. Among the certified households, 74% are male-headed, slightly higher than the 71% in non-certified households. Certified households tend to have an average age of 49 years compared to non-certified with average age of 50 years and slightly larger household sizes. Certified households also have larger average plot sizes of 3.4 acres compared to 2.9 acres for the households selecting non-certified improved maize seeds. Educational attainment differs, with a higher percentage of certified households having only primary education (STD 7) at 86%, compared to 76% in non-certified households. Land ownership patterns are similar across both groups, with the majority fully owning their land, but certified households have a slightly higher incidence of renting about 12% of the households. This implies uncertainty in the quality of land that is used in planting from one season to another, since the farmer is not sure where they will get the land.

Table 2: Household characteristics in study area

Household Characteristics	**Certification**	
	Certified (%) : n=106	**Non-certified (%) : n=102**
Sex		
Male	74	71
Female	26	29
Average Age	49	50
Household Size	5	4

Plot Size	3.4	2.9
Education		
STD 7	86	76
Form 4	5	11
Form 6	0	1
Adult Education	1	0
University	0	1
Diploma	2	0
No formal Education	7	11
Formal Groups		
Yes	13	20
No	87	80
Land Ownership		
Fully owned	82	84
Partly Owned	4.	4
Rented	12	11
Long-term Lease	2	1

The variation in the selling price of the improved maize seeds in the study area is attributed by the type of seed bought, the quality of the seed and the distance covered by the farmer to obtain the seeds. The study revealed that the average selling price of improved maize seeds in the market at Kilosa and Mvomero is Tshs 13 492 and 13 521 respectively.

Table 3:Mean Market Price of Improved Maize Seed

Districts	Minimum	Maximum	Mean	Std Deviation
Kilosa	8000	18000	13492.2	2585.53
Mvomero	5000	18000	13521.3	2841.50

The high prices of improved maize seeds in the study areas as shown in Table 3 above led approximately 94% of the farmers in Kilosa and Mvomero not to buy the improved seeds. These high costs are attributed by the quality or improved features of the seeds. Also, agro-dealers have a tendency of charging high prices to compensate themselves on the costs they used to make seed available in the area.

Table 4:Barriers That cause Farmers not buy Improved Seed

Reason not to buy Improved seeds	Freq	Percentage
Too expensive	171	93.96
Don't know about them	3	1.65
They not available	4	2.2
Don't know how to grow them	4	2.2
Total	182	100

This implies that the study is relevant since it reflects the conditions that farmers face in accessing the improved agricultural inputs that leads to decrease in productivity in the country. The results on Table 5 shows that the proportion of smallholder farmers willing to pay for improved maize seeds, with comparisons across two elicitation methods including Becker DeGroote Marschak (BDM) and Take It or Leave It (TIOLI) and across two certification statuses (certified and non-certified seeds). BDM elicitation method; among the 104 farmers assessed using the BDM method, farmers that opted for certified maize seed where 53 where 60% expressed a willingness to pay (WTP) for certified seeds, while 40% were unwilling to pay. For non-certified seeds, 63% were willing to pay, and 37% were not willing to purchase certified seeds. TIOLI elicitation method; from 104 farmers that responded, TIOLI method yielded a higher WTP for certified seeds, with 77% indicating willingness to pay and 23% showing reluctance. Similarly, for non-certified seeds, 79% were willing to pay, compared to 17% who were not. The results reflect that farmers are still embracing the non-certified maize seeds in the study area. This situation is influenced by the barriers that farmers face in the market shown in Table 4 and prevalence of counterfeit or fake seeds. It is estimated that the number of fake seeds circulating in the market is about 25-50% of all commercial seeds in the market (Ronald & Mulemia, 2023).

Table 5: Willingness to Pay for Certified Improved Maize Seed

WTP	BDM Certified	BDM non certified	TIOLI certified	TIOLI non certified
Yes	32 (60%)	32 (63%)	41 (77%)	42 (79%)
No	21 (40%)	19 (37%)	12 (23%)	9 (17%)
Total	53	51	53	51

Interestingly, a slightly higher percentage of farmers are willing to pay for non-certified seeds (63%) compared to certified seeds (60%) under the BDM method. This might reflect perceptions of non-certified seeds as more cost-effective or better suited to local conditions. However, the TIOLI method consistently shows a higher willingness to pay across both certified and non-certified seeds compared to the BDM method. Specifically, 77% and 79% of farmers were willing to pay for certified and non-certified seeds, respectively. The results underscore the importance of the method used to elicit WTP, with the TIOLI approach revealing a higher propensity among farmers to invest in improved seeds. Additionally, the marginal difference in WTP between certified and non-certified seeds suggests that certification status alone may not be a decisive factor in farmers' purchasing decisions. Further research could explore the underlying reasons for these trends, including farmer perceptions and the impact of seed certification on yield and profitability.

Table 6 presents the mean Willingness to pay (WTP) for certified improved maize seeds among smallholder farmers, segmented by seed certification status and elicitation method. Specifically, it provides the mean WTP for certified and non-certified seeds using the Becker DeGroote Marschak (BDM) and Take It or Leave It (TIOLI) methods. It was estimated that the mean WTP for certified seeds is 5377 Tanzanian Shillings (TZS) while that for non-certified seeds the mean WTP is slightly lower at 4853 TZS using the BDM method. However, the TIOLI method shows that higher percentage of farmer were willing to purchase both certified and non-certified seeds at 5000 TZS. The results imply that generally farmers in the study areas are willing and able to purchase the certified seeds at a higher price of average of 5000 TZS for a 2kg package of seeds.

Table 6: Mean Willingness to Pay for Certified Improved maize seed

	BDM certified	**BDM not certified**	**TIOLI certified**			**TIOLI not certified**		
Mean WTP	5377	4853	2500	5000	10000	2500	5000	10000
			41%	59%	0	43%	50%	7%

The lower mean WTP for non-certified seeds, especially in the BDM method, echoes findings from Gonfa (2015), who noted that certified seeds tend to be valued higher by farmers due to perceived better yield potential and reliability. However, the difference in WTP between certified and non-certified seeds in this study is less pronounced than in studies by Wossen et al. (2015), indicating that certification may

not be the sole determining factor for WTP in this context. Additionally, the distribution of WTP across price points highlights significant price sensitivity among farmers. The steep decline in willingness to pay 10 000 TZS, supports findings from Aryal et al. (2009) and Lyimo et al. (2014), which emphasize that high seed prices are a critical barrier to adoption. This is evident as a majority of farmers are only willing to pay lower amounts (2500 TZS or 5000 TZS) even for certified seeds. Furthermore, the mean WTP values in this study are lower than those reported in some other regions of Sub-Saharan Africa, where farmers have been willing to pay more for certified seeds under specific programs or subsidies (Lunduka et al., 2019). This could reflect regional differences in income levels, access to credit, or the perceived benefits of certified seeds.

Hence, the results highlight the influence of elicitation methods on farmers expressed WTP and suggest that while certification does impact WTP, it is not the dominant factor. The price sensitivity observed among farmers is consistent with broader findings in the literature, underscoring the need for pricing strategies that align with farmers' financial capacities and the perceived value of certified improved seeds. Further comparative studies could provide deeper insights into regional variations and the specific factors driving WTP in different contexts.

The linear regression model analysed data from BDM method that has a response which is continuous in nature making the dependent variable continuous. The results show that yield, plot size, education and land terrain have significant influence on willingness to pay for improved maize seed in the study area. In BDM sample, we observe WTP directly and equation (8) was estimated via linear regression, Table 7 present these results.

Table 7:Factors Influencing Farmers Willingness to Pay for Certified Improved Maize seed

Variables	**Linear Regression**			
	BDM Certified		**BDM not certified**	
	B	Sig	B	Sig
Age	8.97	0.761	0.676	0.979
Sex	2416.73	0.023**	-342.67	0.677
Household size	275.21	0.134	-306.35	0.081
Plot size	118.40	0.258	126.82	0.471
Education	-681.51	0.646	541.24	0.698
Formal group	2553.27	0.016**	-228.27	0.759
Yield	1.4441	0.036**	0.8601	0.270
Slope of land	348.75	0.671	2644.21	0.0001**

Land ownership	-640.76	0.569	1184.50	0.155
Distance	198.18	0.438	-271.99	0.321
Cons	461.26		3385.86	
N	53		51	
R^2	0.4021		0.4951	
		Probit Regression		
	TIOLI certified		**TIOLI not certified**	
	B	Sig	B	Sig
Age	0.1962	0.558	0.0647	0.083*****
Sex	0.6157	0.348	-0.3445	0.688
Household size	0.1957	0.407	-0.2540	0.426
Plot size	0.0819	0.657	0.0689	0.747
Education	1.9347	0.010******	4.8390	0.245
Formal groups	-1.7110	0.068	1.1610	0.324
Yield	1.4901	0.145	1.7527	0.254
Slope of land	-2.5033	0.050******	0.8354	0.393
Land ownership	0.0745	0.939	0.1059	0.826
Distance	0.5203	0.044******	0.7192	0.291
Price	-0.00065	0.024******	-0.00056	0.021******
N	53		51	
LR	-13.4705		-10.5665	

****** p < .01, ** p < .05, * p < 0 .1***

The analysis presents two sets of regression models (linear regression and probit regression) applied to data on the willingness to pay for certified and non-certified improved maize seeds using the Becker-DeGroot-Marschak (BDM) and Take-It-or-Leave-It (TIOLI) methods. The results are discussed as follows;

Sex: the coefficient for sex is 2416.725 with a significance level of P= 0.023, indicating that male respondents are significantly more likely to pay a higher price for certified seeds compared to female respondents. While for non-Certified Seeds the coefficient is negative (-342.672) and not statistically significant (p = 0.677), suggesting no significant difference in willingness to pay between male and female respondents for non-certified seeds. This finding aligns with research indicating that male farmers often have better access to resources, including financial capital, which may influence their willingness to pay for improved inputs (Almansa et al., 2012; Apurba et al., 2020; Belay, 2018).

Formal group membership; membership in formal groups positively affects the willingness to pay for certified seeds, with a significant coefficient of 2553.27 (p = 0.016). While for non-certified seeds the effect is negative (-228.2715) and not significant (P= 0.759), indicating that group membership does not significantly influence the willingness to pay for non-certified seeds. This suggests that social networks or group memberships enhance access to information and resources, encouraging investment in certified seeds, corroborating findings by Bandiera and Rasul (2006).

Yield; the yield variable is significant (p = 0.036) with a positive coefficient of 1.4441, indicating that higher expected yields are associated with a higher willingness to pay for certified seeds. It implies that the more yield that a farmer gets from the certified improved maize seeds it increases his ability to pay for seeds in the next season. While for non-certified seeds the yield coefficient is positive (0.8601) but not significant (p = 0.270), suggesting that yield expectations do not significantly influence the willingness to pay for non-certified seeds. This is consistent with literature suggesting that farmers' willingness to invest in improved inputs correlates with their expectations of enhanced productivity (Munthali, 2013).

Slope of Land: the coefficient is 2644.21 with a highly significant p-value (0.0001), indicating that farmers with sloped lands are more willing to pay for non-certified seeds. While for certified maize seed the variable is positive but not significant (P=0.671). This might be because non-certified seeds are perceived as less risky or better suited to the challenging conditions of sloped lands, a finding that contrasts with the general preference for certified seeds in flatter areas where productivity is usually higher. The farmers are not familiar with the performance of the certified improved maize seed hence they tend to be hesitant and hold to what they know.

Education; has a significant positive coefficient of 1.9347 (p = 0.010), suggesting that more educated farmers are more likely to pay for certified seeds. This implies that educated farmers have high willingness to pay for certified maize seeds compared to those with no formal education. This could reflect their ability to assess the cost-benefit of such seeds. These results are consistent with those obtained by Danso-Abbeam et. al. (2014), and Okoffo et. al. (2016) that found that education level has significant influence on willingness to insure cocoa farms in Ghana. Slope of Land: the slope of land is significant (p = 0.050) with a positive coefficient (-2.5033), indicating that farmers with sloped lands are less likely to pay for certified seeds than those with flat lands. This is interesting when compared to the linear regression results, where slope significance was observed for non-certified seeds. It suggests

varying risk perceptions between certified and non-certified seed choices depending on land topography.

Age; It is statistically significant at 1% with P=0.083 and positively influences farmer's willingness to pay for non-certified maize seed. This implies that when the age of maize farmer increases by one year then the likelihood to pay for the non-certified maize seed increases by 6.5%. Implying that older farmers have less ability to pay for the certified maize seeds since most of them are dependent on farming as source of income, poor health and having more dependants (grandchildren). The results conform with the prior expectations and the findings by Aidoo et. al. (2014) which stated older farmers are less likely to pay and insure their farms.

Distance to Market: the variable is significant (p = 0.044) with a positive coefficient (0.5203), indicating that farmers located further from markets are more likely to pay for certified seeds by 52% other factors remaining constant. This finding might be related to the difficulty in accessing seeds, where the quality and reliability of certified seeds become more valued as distance increases. This finding is inconsistent with that by (Yaregal & Benyam, 2022) that assessed willingness to pay for improved teff seed that distance was not significant.

Price: for both certified and non-certified seeds price coefficient is negative and significant for both certified (p = 0.024) and non-certified seeds (p = 0.021). This implies that increase in price by 1000Tshs reduces the likehood of the farmer to be WTP by 0.065% and 0.056% respectively when other factors remain constant. This result is consistent with the law of demand, as the price of seeds increases, the probability of a farmer's willingness to pay decreases. The similarity of results across seed types indicates that price is a crucial factor influencing the willingness to pay regardless of certification.

In summary, certified seeds are perceived as higher quality, possibly leading to a higher WTP influenced by factors like yield expectations, slope of land, distance, price, sex of household head and formal group involvement. While for non-certified seeds may be seen as less reliable, making factors like education, age and price sensitivity more important. And BDM method captures individual valuations based on potential gains (yield), which is why factors like yield and formal group membership are significant. While TIOLI captures a more binary decision (take or leave), leading to the significance of structural factors (like land slope) and human capital (education) in decision-making. Hence, the differences in WTP across methods and seed types highlight the varied factors influencing farmers' decisions, depending on the context and perceived benefits of the seed types.

Conclusion and Policy Recommendations

Importantly, the research underscores farmers WTP for these superior seeds. This emerging demand presents an invaluable opportunity for farmers to embrace innovative and improved agricultural inputs and farming practices that enhance productivity and food security in the region. The investigation has brought to light that the average market prices of a 2kg package of improved maize seed is Tshs 13 492 and 13 521 in Kilosa and Mvomero respectively. With these prices, farmers have been lamenting that they are high for them to afford buying the improved maize seed each season. This leads to the unsustainability of using the improved seeds in the study area. The farmers have a mean WTP Tshs 5000 for 2kg package of certified improved maize seeds. This indicates that maize producing households in the study area possess the financial capacity and motivation to invest in and utilize certified improved maize seeds at this price point. However, there are farmers that are holding the non-certified maize seeds as we can see that 49% of them chose it and are ready to pay at less or equal price compared to that of the certified maize seeds.

Additionally, the research identifies several influential factors affecting farmer's WTP for maize seeds, including yield, education level of the household head, formal groups, age, sex, price and slope of land. However, factors that influence WTP for certified maize seeds includes sex, formal group, yield, distance to market and price. This signifies that maize farmers are more inclined to invest in certified improved maize seeds when there are established formal groups/cooperatives such as AMCOS, expectation of increasing yield, and reasonable prices charged for these improved seeds. Efforts need to be done to ensure ease availability of certified improved maize seeds and pricing strategies should be reasonable to allow farmers to purchase quality seeds.

Recognizing the profound importance of maize as a staple food consumed by the majority of Tanzanians. It is imperative that the Government, through the Ministry of Food and Agriculture, takes deliberate steps to provide subsidies to seed companies engaged in the production of certified improved maize seeds. Such subsidies can be directed toward reducing the costs associated with breeding, registration and certification of these seeds. By facilitating cost reductions to seed companies it will encourage lowering of maize seed prices for agro-dealers who, in turn, sell to farmers. In the same line the government can opt to provide a subsidy to farmers amounting to Tshs 8100-8500 to bridge the price gap between their WTP and market prices. Moreover, initiatives should be done to educate farmers on the benefits of having formal groups or cooperatives in their respective areas. Most of the wards did not have formal groups that represent maize farmers. In Ulaya village at Kilosa there were having Community Based Organization (CBO) that had few members that

operate it and gain several benefits in agriculture and other activities. Hence, there is a need to encourage the formation and support of formal farmer groups and cooperatives, as they positively influence the adoption of certified seeds. Cooperative members can collectively purchase seeds at reduced prices, benefit from shared resources, and facilitate knowledge exchange. These groups can play a pivotal role in enhancing access to improved agricultural inputs and improving overall farming practices. Hence, this dual approach seeks to empower farmers to increase productivity sustainably.

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