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RESEARCH PAPER

Estimating the demand for certified chickpea seeds among smallholder farmers in the Eastern and South Western Shewa Zones of Oromia, Ethiopia

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Abstract

Previous studies in Ethiopia have primarily focused on the adoption of improved chickpea varieties along with complementary inputs. However, there is a significant research gap when it comes to investigating the determinants that influence the demand for certified seeds in the country. This study aims to examine these determinants and their impact on the demand for certified chickpea seeds among farmers in Ethiopia. Data were collected from 186 randomly selected sample farmers using a multistage sampling approach. A double hurdle model was used to analyze the data, considering that the decisions to participate in certified seed purchase and the quantity of seeds purchased are influenced by different factors. The results show that land size, household size, age, education level, cooperative membership, access to extension services, seed price, and distance to the cooperative office were found to significantly influence participation in seed purchase. Moreover, household size, education level, land size, livestock holding, seed price, and cooperative membership were identified as significant factors influencing the quantity of certified chickpea seeds purchased. In conclusion, by improving the skill of farmers, guaranteeing the availability of certified seeds through collaborative efforts, and implementing a program that offers subsidies on seed prices, it is possible to boost crop productivity for farmers with limited resources. The study suggests that supporting certified seed producers and implementing a seed price subsidy program could enhance crop productivity for farmers with limited resources. It also recommends policies to prioritize improving the availability and quality of certified seeds for farmers in Ethiopia.

Keywords

Certified chickpea seed, seed demand, Double hurdle model, Ethiopia

Introduction

Chickpea (*Cicer arietinum* L.) is the primary pulse crop cultivated in the central, north, and northwest highlands of Ethiopia, where Vertisols are the predominant soil type. The crop is grown in crop-livestock based farming systems by nearly 1.2 million smallholder farmers involved in its production. Chickpea production plays a vital role in the agricultural systems of the Ethiopian highlands, serving various purposes. It is commonly used as a rotational crop with cereals to improve and maintain soil fertility. Smallholder farmers choose to cultivate chickpeas after the rainy season due to their impressive ability to withstand low moisture stress, utilizing the remaining soil moisture. Furthermore, chickpeas provide an alternative source of dietary protein for individuals who cannot afford animal products. They also serve as a significant source of income for farmers through local and export markets. Lastly, the crop residue from chickpeas serves as a valuable source of

animal feed in the highland areas, where population pressure has resulted in a shortage of feed (Belete et al. 2017; Ferede et al. 2019).

The national chickpea research program has been committed to addressing various challenges in chickpea production in order to improve the productivity and production of the crop. Through collaborative efforts between national and regional research programs, a total of twenty-seven improved varieties of both Kabuli and Desi types have been successfully developed and introduced to farmers in Ethiopia. These Desi and Kabuli types have been cultivated for approximately 16 and 11 years, respectively, indicating the average age of these improved chickpea varieties (Asegie et al. 2023).

Despite the extensive efforts made, the inefficiency of the seed system in Ethiopia plays a significant role in hindering the widespread adoption of certified varieties (Ferede et al. 2019). The productivity of chickpea production still falls short of its maximum potential. The national average yield stands at a mere 1.8 tons per hectare. Furthermore, official estimates indicate that only 0.74% of the total chickpea cultivated land in Ethiopia was planted with certified seeds, a stark contrast to the 46% coverage of certified seeds for maize during the 2014/15 cropping season (Ferede et al. 2019). The coverage of certified seeds for pulses was even lower at 0.54%, compared to the 12% coverage for total cereals area. Smallholder chickpea farmers primarily rely on an informal seed system that involves seed exchange among farmers and the use of recycled seeds (CSA 2018). However, it is estimated that there is potential to cultivate chickpeas on approximately two million hectares of highly suitable land in Ethiopia, with the possibility of achieving yields of up to five tons per hectare (Dawit and Zewdie 2019).

The effectiveness of any crop improvement initiative relies on the accessibility and efficient utilization of certified and high-quality seeds. Consequently, a well-operating seed system has the potential to enhance productivity by ensuring a greater supply of certified seeds to agricultural communities. Moreover, high-quality seeds possess immense potential to enhance agricultural productivity and ensure food security (Wekundah 2012). However, the seed system of Ethiopia faces long-standing issues such as role ambiguity among different actors, a mismatch between supply and demand leading to shortages and excess inventory, delays in delivery, and quality issues due to improper production, harvesting, storage, and logistics management (Dey and Bezabih 2021).

The inefficiency of the agricultural input market in Ethiopia poses a significant challenge in achieving food security at the national level. Despite the collaborative efforts of international non-governmental organizations, public institutions, and private entities in researching and developing improved crop technologies, a considerable number of Ethiopian farmers continue to face low productivity due to their failure to use certified seeds (Dawit and Zewdie 2019). Considerable efforts have previously been dedicated to understanding the factors that affect the adoption of certified seed technology in Ethiopia. However, there has been a lack of emphasis on comprehending the factors that drive the demand for certified seeds. In order for certified seed technology to effectively contribute to reducing poverty in agricultural households in Ethiopia, researchers need to not only focus on identifying the factors that influence adoption but also on the factors that restrict seed demand at the farm level.

Despite the evident growth in the improved chickpea sector, there has been limited attention given to understanding the demand for certified chickpea. Demand analysis typically takes into account price and non-price factors, but the present research aims to concentrate solely on non-price factors in demand analysis for certified chickpea seeds in Ethiopia This is because the previous research focused on chickpea seed adoption by identifying the determinants of improved chickpea seed adoption (e.g. Verkaart et al. 2019; Ashu et al. 2023; Asegie et al. 2023). However, the aforementioned studies indicate that despite efforts made to develop improved chickpea seeds and disseminate the seeds to farmers, there was no significant increase observed in the adoption of certified chickpea seeds among Ethiopian farmers.

Smallholder farmers in the country frequently face challenges in accessing certified seeds due to the limited supply and high prices of certified seeds. The fact that only 20% of the demand for improved seeds is fulfilled in Ethiopia highlights a substantial gap in smallholder farmers' access to certified seeds (Dey and Bezabih 2021). Hence, it is crucial to comprehend the reasons why the majority of farmers in the country are not using certified chickpea seeds, despite the crop's significance in terms of food security, enhancing soil fertility, and generating foreign currency for the country.

A key approach to uncovering the underlying issue behind the low participation of farmers in certified chickpea use is to explore the non-price factors that influence the demand for certified chickpea seeds. This exploration is necessary to provide policymakers with valuable insights on the most effective measures to enhance the usage of certified seeds. By gaining an understanding of the demand for certified seeds at the farm level and its determinants, investors and seed-certified production companies can accurately forecast the demand, effectively market the seeds, and distribute the desired certified chickpea seeds. This, in turn, will contribute to boosting productivity and harnessing the crop's export potential on a national scale.

The aforementioned empirical studies have brought attention to various gaps in previous research. Firstly, there is a lack of investigation into the factors that influence the demand for certified chickpea seed in Ethiopia. Secondly, the existing studies have primarily focused on the adoption of improved chickpea seeds. Therefore, it is important to note the scarcity of empirical evidence regarding the determinants of farmers' decisions to purchase certified seed and the factors that determine the quantities to be purchased among smallholder chickpea farmers in Ethiopia.

Therefore, one of the prerequisites for developing a robust seed system is a clear understanding of the factors influencing smallholder farmers' demand for certified seeds. Kaguongo et al. (2014) identified the widespread and timely availability of certified and quality seed as a key challenge in the seed system and suggest improving the seed system by providing a better atmosphere for small and medium-sized as well as large commercial seed enterprises to attract more investment and thrive. Hence, a comprehensive understanding of the elements that influence the demand for certified seeds among smallholder farmers is crucial in establishing a resilient seed system.

Objectives

The general aim of the study is to identify the factors that influence farmers' decisions to purchase certified chickpea seeds and the quantities of certified chickpeas purchased and dentify the most preferred certified chickpea seeds in rural highland areas of Ethiopia.

Specific objectives

1. To identify the certified chickpea seeds that are mostly preferred by smallholder farmers;
2. To assess the determinants of farm-level farmers' participation decisions in the purchase of certified chickpea seeds in the central highlands of Oromia, Ethiopia;
3. To examine the determinants that influence the quantity of certified chickpea seed purchased by farmers in the central highlands of Oromia, Ethiopia.

Conceptual framework

The article's conceptual framework aligns with established theories in agricultural development and market equilibrium (Ayoola 2023). The high input pay-off model assumes that farmers possess efficient resource allocation skills and respond to economic incentives, but face significant technical and economic constraints. Consequently, it proposes the need for support in the form of improved seeds, technical inputs, and fair output prices, which serve as the basis for price intervention policies. Furthermore, the market failure theory emphasizes the inadequacies of the agricultural-input market, necessitating intervention policies to address these deficiencies (Lipsey and Lancaster 1956).

The above literature indicates that the agricultural seed policy process encompasses two crucial aspects: supply and demand. On the supply side, policy authorities such as policymakers, policy service providers, policy analysts, and consultants play a vital role in shaping government actions and inactions within the seed market. On the demand side, stakeholders including farmers, seed producers, and seed marketers directly or indirectly experience the consequences of government interventions in the seed system. The interaction between these two sets of stakeholders in the agricultural seed marketplace, the outcomes of public policy interventions, are determined by the relative influence exerted by each side on industry-related issues. However, without a shared reference point for both sets of actors, a gap emerges in the policy marketplace for seeds, significantly impacting the overall performance of the seed industry. Therefore, establishing a demand-driven seed industry in Ethiopia requires an understanding of the demand level and the factors influencing the demand for agricultural seeds. This knowledge is crucial for enhancing the efficiency of the seed industry in the country as a whole and benefiting the stakeholder community.

Research methodology

Description of the study area

The study was conducted in the Eastern and Southwestern Shewa Zones of the Oromia Regional State of Ethiopia during the 2022 crop season. These study areas are among the major chickpea-producing areas in the country where certified chickpea has been practiced by farmers. The Zones represent the high potential areas based on the area of production and yield of the chickpea crop (CSA 2022). Thus, the emphasis was given to these rural highlands of Ethiopia especially the Gimbichu, Becho, Lume, and Adea districts of Oromia, Ethiopia due to their agroecological suitability for chickpea production.

Sampling procedure, sample size, and type of data

The sample size and the sample selection process should ensure the representativeness of the population. Sample size determination has a scientific approach. In this study, to determine the sample size, different factors such as research cost, time, human resources, accessibility, and availability of transport facilities were taken into consideration. The study used multi-stage procedures to collect the primary data. In the first stage, two zones were selected purposively based on the production potential of the crop. In the second stage, from the selected zones, 4 districts were randomly selected. In the third stage, 9 kebeles were randomly selected from the chosen districts. Finally, 186 farm households were interviewed using random sampling techniques. The study used primary cross-sectional farm household data. Data on farmer characteristics, chickpea farming practices, and environmental and institutional characteristics pertaining to the households were collected from the farm households. In addition to primary data, secondary data were collected from the Ministry of Agriculture, CSA, published documents, and other relevant institutions to corroborate the primary data. A structured questionnaire was designed to collect primary data, and experienced enumerators were trained to assist with the data collection process.

Data analysis methods

Following the completion of data collection, the responses were coded and entered into the SPSS version 26 software program and converted into STATA 14 software for statistical analysis. Descriptive statistical analyses such as mean, percentages, and standard deviations were used to understand farm households' demographic characteristics, resource ownership, and institutional service, production characteristics and farm input use. The determinants of farm-level participation decision and quantity of certified chickpea seeds purchase were analyzed using a double hurdle model.

Empirical model specification

This section introduces the empirical model for estimating the factors that influence farm-level decisions regarding the purchase of certified chickpea seeds and the quantity of certified chickpea seeds bought in the central highlands of Ethiopia. The involvement of chickpea farmers in certified seed purchase activities is expected to be influenced by socioeconomic factors, institutional factors, as well as the demographic characteristics of the farmers. These factors were used collectively to determine whether a specific chickpea farmer finds it desirable to engage in certified seed purchase and, if so, the extent of their participation (i.e., the quantity of certified seed purchased). One of the objectives of this study is to analyze the motivating factors behind the participation of chickpea farmers in certified chickpea seed purchases. It is important to note that some chickpea farmers may choose not to participate in certified chickpea purchase activities, resulting in a portion of the dependent variable being zero. (Elhorst 1993) highlighted the difficulty in estimating models for farm household investments due to the prevalence of zero values in the dataset. The presence of only positive values in dependent variables can introduce sample selection bias, and using simple linear regression with ordinary least squares (OLS) estimation may result in biased and inconsistent estimates (Elhorst 1993; Worku and Mekonnen 2012).

Greene et al. (2008) suggested that it is necessary to use an approach that can incorporate both discrete and continuous components. To address the statistical issue associated with the dependent variable having a significant number of zero values, the conventional regression models used a binary dependent variable to assess the statistical issues related to the dependent variable. Numerous empirical researchers have examined factors influencing market participation decisions using discrete choice models: probit or logit estimators and evaluated the probability of a household's decision by assuming a logistic or normal distribution (Aman et al. 2014; Bekele and Alemu 2015). Dedah et al. (2010) pointed out that the probit/logit approaches are useful tools to provide information on how different characteristics of farmers influence the probability of investment in farm activities. However, these models fail to provide information about the level of participation in the market.

The Tobin (1958) model, also called the censored regression model can handle this estimation problem and allows for the analysis of the factors affecting the joint decision. According to this author, a censored regression model is required for a dependent variable that has a considerable number of observations with zero value. Many researchers have applied this model because it has an advantage over models such as Linear Probability Models, Logit, and Probit in that it indicates both the probability of willingness to participate in the market and the intensity of participation (Bekele and Alemu 2015; Obayelu et al. 2016). However, the Tobit model is very restrictive in its parameterization and there are limitations concerning the use of this model when the proportion of zero values for the dependent variable is significant. In the Tobit model, the censored variable (participation) and expected value conditional on the quantity of certified seed purchases are estimated by the same factors. This model considers only the dependent variable to be censored at zero and ignores the source of zero observations (Greene 2002; Newman 2004). To overcome the weakness of the Tobit model,the Heckman (2013) model was designed to deal with estimation bias associated with censoring. The author made note of the selection bias that occurs from estimation on a chosen subsample. To address the issue caused by the zero observations produced by the nonparticipation decision, he suggests using the two-stage estimating technique (sometimes referred to as the Heckit model). By performing a complete sample Probit estimation in the first stage and a corrected self-selection estimation in the second stage, the Heckit model eliminates the selection bias. The model assumes that there are different sets of independent variables at play in these two stages and that there are no zero observations in the second stage.

Cragg (1971) proposed the double hurdle model, which generalizes the Tobit model by providing a second hurdle that must be passed before observing any positive values. Both models allow the possibility of estimating the first and second-stage equations using different sets of explanatory variables. The difference is that the double-hurdle model permits potential zero values in the second stage. The first hurdle refers to the participation decision/certified seed purchase decision, and the second hurdle refers to the level of participation decision of certified seed purchased by the farm households. The second stage in the double hurdle model is open to potential zero values, and zero observations on the dependent can be either attributed to corner solution or non-participation when employing a probit estimator to stimulate the participation decision.

Additionally, the decision to engage in certified chickpea seed purchase decisions and the quantity of certified seed purchase activities can be estimated using the double Hurdle model. Therefore, a separate stochastic process can be used to model the probability of participation and the level of participation. As mentioned, the first stage of the double-hurdle model or the first hurdle in the current

analysis represents the decision by chickpea farmers whether or not to purchase certified seeds of chickpea for planting during the 2021 cropping calendar, while the second stage represents the desired quantity of certified seed purchase. In the double-hurdle model, zero observations have the potential for a positive level of certified seed purchase. Therefore, in this research, a double-hurdle model is presented as an empirical framework to examine the effects of various factors on both participation in certified chickpea seed purchase during the production season and the intensity of certified seed purchase. Following Yen and Jones (1996) the specification of the double-hurdle model can be expressed as:

Stage 1: certified seed purchase decision.

$$D_i^* = X_{1i}\beta_1 + \epsilon_i ; \epsilon_i \sim N(0,1) \quad (1)$$

$$D_i = \begin{cases} 1 & if \quad D_i^* > 0 \\ 0 & otherwise \end{cases} \quad (2)$$

Where D_i^* is a latent variable indicating whether or not the individual participates in certified seed purchase during the production season, β_1 is a vector of parameters to be estimated, X_{1i} is a vector of observed independent covariates that explain an individual's decision, D_i is a binary variable that takes the value 1 for a farm household i of certified seed purchase and 0 otherwise, and ϵ_i is an unobserved error term capturing all other factors.

Stage 2: The intensity of certified seed purchase

$$Z_i^* = X_{2i}\beta_2 + \omega_i \sim N(0,\sigma^2) \quad (3)$$

$$Z_i = \begin{cases} 1 \ if \quad D_i = 1 \quad Z_i^* > 0 \\ 0 \ if \ D_i = 0 \end{cases} \quad (4)$$

Finally, the observed quantity of certified seed purchased is determined as

$$Y_i = D_i \cdot Z_i \quad (5)$$

In this specification, a positive quantity of certified seed purchase Y_i is observed if D_i^* and $Z_i^* > 0$. This illustrates the double-hurdle element of the model. D_i^* is a latent endogenous variable representing the decision to participate in the purchase of certified chickpea by farmers i, Z_i^* is a latent variable representing the quantity purchased by farmer *i*, Y_i is the observed quantity of certified chickpea purchased by farmer *i*, X_{1i} is a set of farmers characteristics that influence the farmers' decision to participate in the certified chickpea seeds purchase decision, X_{2i} is a vector of socioeconomic and institutional characteristics of farmers that affect the quantity of certified chickpea. β_1 and β_2 are vectors of the estimable parameters. In this formulation, $(X_{1i}\,;\,X_{2i})$ may contain the same common explanatory variables, although their corresponding effects on the two hurdle equations might be quite different. ϵ_i is normalized to 1 since the outcome of the first hurdle is binary. Both error terms, ϵ_i and ω_i are assumed to be normally and independently distributed, which implies that there is no relationship between the two stages of a decision and can be written as:

$$\begin{pmatrix} \epsilon_i \\ \omega_i \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & \sigma^2 \end{pmatrix}\right] \quad (6)$$

As in the Tobit and Heck model cases, the independent double-hurdle model is estimated using maximum likelihood techniques with the log-likelihood given as follows,

$$\ln L = \sum_0 \ln\left[1 - \varphi(X_{1i}\ \beta_1)\varphi\left(\frac{X_{2i}\ \beta_2}{\sigma}\right)\right] + \sum_+ ln\left[\varphi(X_{1i}\ \beta_1)\varphi\frac{1}{\sigma}\left(\frac{Z_i - X_{2i}\ \beta_2}{\sigma}\right)\right] \quad (7)$$

The first term on the right-hand side denotes the summation over the zero observations in the sample. It indicates that zero observations are affected by both participation and level of participation decisions. The additional term in equation (7) contributes to the effect of possible zero values in the second stage decision in the double-hurdle model. The first term captures the possibility of observing zero values in the second stage decision and thus indicating the second stage is represented like a Tobit model. The second term on the right-hand side indicates summation over the positive observations; this term expresses the conditional probability distribution and density function coming from the censoring rule and observed positive values (Fabiosa 2006).

Results and discussion

Descriptive statistics results

Results show that the average ages of the respondents in Gimbichu, Becho Lume, and Adea districts are 45.3, 44, 46, and 42.7 years respectively. The overall average age across all study districts is 44.5 years, with the youngest participant being 21 years old and the oldest being 79 years old.This suggests that a significant portion of the households involved in certified chickpea seed purchase are still in their productive years, possessing extensive experience in certified chickpea procurement. These findings align with the research conducted by Tebeka et al. (2020) which indicates that the age of the household head has a notable influence on the development of knowledge and experience related to seed quality. This knowledge is crucial for farmers who are involved in seed production or rely on formal sources for purchasing seeds.

Female-headed households in rural Ethiopia face numerous challenges in agricultural production and marketing compared to their male-headed counterparts. This is due to the multiple responsibilities that female household heads have, such as collecting firewood, fetching water, childbearing, and managing household tasks. Additionally, they also have to manage farm-related responsibilities, which further adds to their burden. These multiple tasks, combined with limited access to resources and land ownership, as well as economic and social shocks like poverty and food insecurity, contribute to the difficulties faced by female-headed households in the country (NPC 2018).

Similarly, the current research findings reveal that the majority of farm household heads (94.6%) are male, with only a small percentage being female. Additionally, it is evident that male farm household heads dominate the purchase of certified chickpea seeds. Therefore, it is crucial to make efforts to ensure that improved inputs, especially certified chickpea seeds, are accessible to both female and male-headed farm households. This will help to secure the seed supply for farming households in the study areas.

Experience shows that a knowledgeable farmer has the ability to use advanced agricultural technologies such as improved seeds and fertilizers. They are also capable of engaging in certified seed farming activities according to the cropping calendar and effectively managing available resources. The research findings reveal that approximately 61.9% of the household heads have completed elementary school and possess basic literacy skills. On the other hand, 23.8% of the surveyed farmers are illiterate, while 14.3% have completed high school in the Gimbichu district. Moreover, in the Becho district, 23.4% are illiterate, 2.1% can read and write, 40.5% have completed elementary school, and 34% have completed junior and high school. Similarly, in the Lume district, 30.2% are illiterate, 24.5% can read and write, and 34% have completed elementary school. In the Adea district, 25%,11.3%, 36.4%, and 27.3% of the sampled farmers are illiterate, can read and write, have completed elementary school, and have completed junior and high school, respectively. The results indicate that the education level of the household head has a significant influence on certified chickpea seed purchases, with a statistical significance of less than ($P < 0.01$). Moreover, it positively influences the decision-making process regarding the purchase and quantity of certified chickpea seeds. Therefore, the higher the education level of the household head, the more likely the farmer is to make informed decisions regarding certified chickpea seed purchases. This finding is consistent with (Teressa 2019).

The study findings indicate that the mean number of household size per household varied across different districts. Specifically, in Gimbichu, Becho, Lume, and Adea districts, the average household sizes were 5.9, 7, 6.4, and 5.4 persons respectively. Moreover, the average household size for certified chickpea seed purchasers was approximately 6.5 individuals, whereas for non-certified chickpea purchasers, it was 5.5 persons. Presumably, households with larger sizes are more inclined to engage in purchasing certified seeds in order to achieve higher productivity and meet the family's food consumption and selling needs. Moreover, the presence of a larger household enables the execution of various farming operations that are necessary when utilizing certified seeds. According to the t-test, there is a significant ($p < 0.05$) disparity in household size between individuals who purchase certified chickpea seeds and those who do not. Consequently, the likelihood of a farmer participating in certified seed purchase is influenced by the size of their household.

The land is the primary factor of production. In Gimbichu, Becho, Lume, and Adea districts, the average landholding of the sampled farmers was approximately 1.3, 1.6, 1.6, and 1.06 hectares respectively, with a minimum size of zero and a maximum size of 4.8 hectares. Farmers who purchase certified chickpea seeds hold an average of 1.5 hectares of farmland, while those who purchase non-certified chickpea seeds hold an average of 0.65 hectares. The t-test analysis reveals a significant difference in landholding between certified and non-certified chickpea seed purchasers at a significance level of ($P < 0.05$). This indicates that the size of the landholding plays a crucial role in determining the demand for certified chickpea seeds. To address the challenge of land scarcity, young farmers often share land with their parents and relatives after marriage or gain access to farmland through sharecropping and renting. During the cropping season, the study districts recorded rented-in and rented-out land areas of 1.2 hectares and 0.03 hectares respectively.

Information source and certified chickpea seeds purchase

Based on the research results, it has come to light that 77% of farmers engage in growing different improved seeds acquired from a range of sources including model farmers, farmers cooperatives,the local market, and private seed producers. Nevertheless, it is important to highlight that a mere 38.7% of the farmers surveyed choose certified chickpea seeds with a well-established provenance. Chickpea farmers opt to replace their seeds with new ones due to the superior yield advantage and disease resistance offered by the various chickpea varieties. The study findings indicate that the majority of chickpea grower farmers (70%) acquired information regarding certified chickpea seeds from seed producer cooperatives. On the other hand, the remaining farmers obtained this information from farmers cooperatives, neighboring farmers, development agents, and research centers .

The findings reveal that farmers producing certified chickpea in Gimbichu, Becho, Lume, and Adea districts had an average farm experience of 11.4, 9.4, 9.8, and 9.6 years respectively. Around 39.3% of the farmers sourced the certified seeds from seed cooperatives, and approximately 17.2% of the chickpea farmers engaged in cluster farming to produce the seeds. The farmers expressed that they obtained their certified chickpea seeds from these sources due to their consistent availability, superior quality, and limited availability from other sources. Hence, it is imperative for the government and practitioners to enhance the capabilities of seed producer cooperatives, enabling them to produce high-quality chickpea seeds and expand their involvement in the market. Moreover, 39.3% of the farmers surveyed opted for certified chickpea seed purchase, while the remaining percentage did not engage in such purchases. The certified chickpea seed grown includes Arerti, Ejire, and Habru chickpea varieties. The results indicate that 99% of chickpea farmers who participated in the study purchased supplementary inputs

like Karate, Roundup, and Gallant chemicals for effective management of insect pests and weeds in chickpea production. These insecticides and herbicides have proven to be highly efficient in controlling biting, chewing, and sucking insect pests, as well as managing weed growth in the chickpea farmland.

The farm households purchased an average of 20 kg of certified chickpea seed per household. In Gimbichu Becho, Lume, and Adea districts, the quantities of certified chickpea seed purchased were approximately 17.3 kg, 11 kg, 51.8 kg, and 13.8 kg, respectively. According to the one-way ANOVA test, there is a significant difference in the quantity of certified chickpea seed purchased per household among the study districts at a significance level of ($P < 0.001$). This difference may be attributed to the agroecological variations between the districts. Overall, the results indicate that there are significant socioeconomic differences between certified chickpea seed purchasers and non-certified chickpea seed purchasers, as shown in Table 1.

Table 1. Descriptive statistics of continuous variables included in the double hurdle model.

Variables	Unit	Certified chickpea seed purchasers (71)	Noncertified chickpea purchasers (115)	t-stat
Dependent Variable				
Certified chickpea seed purchase participation decision	Yes = 1 No = 0	1(25%)	0 (75%)	
Mean certified chickpea seed purchased	Kg	20	0	
Independent Variables				
Age	Years	46.2	40.7	3.10****
household size	AE	6.45	5.52	2.8***
Land size (ha)	Ha	1.65	0.83	5.32***
Experience in certified chickpea growing	Year	9.7	4.5	2.57***
Certified chickpea seed /qt	Qt	5,865	3572	2.52***
Livestock owned	TLU	9.4	6.2	1.9**
Distance to nearest all weather road	minutes	18.82	19.14	0.179
Distance to cooperative offices	minutes	28.3	25.2	1.08
Distance to the extension office	minutes	74.5	84.9	1.17

Source: Own survey result, 2022.

According to the survey findings, it was found that 69.6% of the farm households included in the sample opted to buy certified chickpea seeds for the 2021/2022 cropping season. Additionally, the survey revealed that a significant majority of respondents (75%) sold their chickpea harvest to traders during the peak harvesting season in January, primarily to meet their household expenses. These results highlight the dual significance of chickpea production, as it not only contributes to food security but also serves as a valuable cash crop in the study districts.

Farmers' access to certified chickpea seeds

The study findings indicate that a significant proportion of the participants (75%) expressed worries regarding the limited accessibility of certified chickpea seeds. Moreover, an even greater majority of farmers (85.9%) voiced their dissatisfaction with the exorbitant prices of these seeds. The farmers who were surveyed also highlighted that agricultural extension agents primarily prioritized assisting model farmers, thereby neglecting the requirements of farmers with limited resources. Moreover, the findings indicate that the availability of certified chickpea seeds is extremely limited, and unfortunately, the quality of the seeds supplied to farmers was subpar. These seeds exhibited low adaptability,were susceptible to diseases, and were occasionally delivered late. As a result, it is of utmost importance to strengthen the capabilities of seed suppliers in addressing quality concerns related to certified seeds through continuous monitoring and evaluation.

Additionally, the supply of certified seeds should be determined based on environmental suitability and consultation with farmers, taking into consideration disease-resistant varieties. The research findings also revealed that a significant percentage of respondents (66.4%) did not receive any extension services or advice regarding the significance of purchasing certified chickpea seeds. This indicates that more than half of the chickpea producers lacked proper guidance on acquiring certified seeds. This underscores the necessity for the government and development practitioners to tackle the scarcity of certified chickpea seeds by offering support to certified chickpea seed producers and granting subsidies to certified chickpea seed suppliers. Such assistance would enable farmers with limited resources to afford and acquire these seeds and it is vital to prioritize inclusive certified seed extension services in order to enhance chickpea production and productivity.

Access to training and sources of certified chickpea seeds

The majority of smallholder farmers who purchase certified chickpea seeds (75.2%) are members of farmers' cooperatives/unions. However, a significant portion of these farmers (65.3%) have not received formal training on chickpea production. This highlights the oversight of agricultural cooperatives in recognizing the importance of training for improving farmers' knowledge and skills in certified chickpea production. Such training is crucial for enhancing the overall production and productivity of this crop. The study also reveals that 60.4% of the sampled farmers obtained certified seed from the office of agriculture, while 19.3% purchased from seed producer cooperatives. Additionally, 17.7% of farmers exchanged seeds with their neighboring farmer. In addition, nearly all farmers (99.5%) purchase supplementary inputs such as pesticides and herbicides in conjunction with certified chickpea seeds. Nevertheless, chickpea remains classified

as a subsistence crop, and most farmers cultivate it without the use of fertilizers. This could be attributed to the historical generalization and assumption that the crop can meet all its nutritional needs through natural nitrogen fixation. The research findings are consistent with a previous study conducted by (Dawit and Zewdie 2019).

Farmers preferred chickpea varieties

Farmers had reported that the chickpea varieties that were highly preferred a year prior to the survey period were Arerti, Ejire, and Habru. This preference could be attributed to market demand, availability of improved seeds, and the productivity of these varieties. Approximately 14% of the sampled farmers cultivated the certified Arerti chickpea seed variety, while around 7% grew the Ejire variety and 4% grew the Habru variety. The remaining farmers cultivated local cultivars. The results of the one-way ANOVA test indicated a significant difference in variety preference among the study districts at a level of ($P < 0.001$). This difference in preference could be attributed to variations in weather and soil conditions across the districts. Consequently, it is crucial to target specific areas for the expansion of new chickpea varieties.

During the survey period, it was observed that the average productivity of Arerti, Ejire, and Habru chickpea varieties on farmers' farmland was around 23.2, 20.8, and 21.6 quintals per hectare, respectively. These findings show that the production of local chickpea varieties by the majority of farmers in Ethiopia leads to a lower crop productivity compared to its potential yield. The estimated crop yield at the research station is 2.5–3.0 t/ha. Previous findings show that the current average farm yield of chickpea in Ethiopia stands at approximately 55% of the crop's yield potential. This indicates that there is still significant room for farmers to enhance their yield by adopting certified chickpea seeds and accompanying agricultural practices. Table 2 provides a visual representation of the preferred chickpea varieties as indicated by farmers.

Table 2. Chickpea varieties among smallholder farmers.

Chickpea variety	Frequency	Percent
Arerti	24	14
Ejire	12	7
Habru	7	4
Non-users of certified seed	143	75
Total	186	100

Source: Own survey result, 2022.

Trends of chickpea seed demand

The study's findings reveal that farmers choose to purchase certified chickpea seeds for various reasons. Approximately 22%, 36%, and 25% of the surveyed farmers consistently opted for certified seeds consistently over the past three years. This suggests a growing trend in the demand for certified chickpea seeds starting from 2020. However, there was a subsequent decrease in their procurement of certified chickpea seed between 2021 and 2022. The process of replacing chickpea seeds is a lengthy one, taking up to 8 years, mainly because there are only a few superior varieties available compared to the ones currently being used. This choice is driven by the desire to increase yield, meet market demands, and ensure resistance against pests. However, a considerable number of farmers show limited interest in periodically replacing chickpea seeds owing to the exorbitant price of certified chickpea seeds. To gain insights into the trends of certified chickpea seed purchases for seed replacement, Table 3 provides a visual representation of the data over the past three years.

Table 3. Trends of certified chickpea demand over the last three years.

Seed type	2019/20		2020/2021		2021/2022	
	Frequency	%	Freq	%	Freq	%
Arerti	14	8.1	21.2	10.3	24	14
Ejire	5	2.7	8	4.2	12	7
Habru	3	2.1	7	4.7	7	4
Non-users of certified seed	164	87.1	150	80.8	143	75
	186	100	186	100	186	100

Source: Own survey result, 2022.

Econometrics results

Determinants and intensity of certified chickpea seed demand

This section focuses on the factors that determine the purchasing decision and quantity of certified chickpea seeds purchased among smallholder farmers in the study districts. To achieve this objective, the double hurdle two-step approach was employed. This approach assumes that the two error terms from the two hurdles are normally distributed and independent. It means that the decision to purchase certified chickpea seeds and the quantity of purchase were treated separately for the sample chickpea farmers. The results of the model indicated that the error terms of the two equations were not correlated. This implies that the decision to purchase certified chickpea seeds and the quantity purchased are independent choices made by farming households. This insight can help in designing policy interventions more effectively by identifying the specific factors that influence each decision and tailoring strategies accordingly. Furthermore, it reveals the accuracy of the estimation in the model by allowing for separate analysis of each equation. In essence, understanding the absence of correlation between error terms provides valuable insights into the factors that influence farming households' decisions and quantities purchased, leading to more targeted interventions and a better understanding of agricultural practices. Table 4 presents the econometric model results for the participation decision and quantity of purchase of certified chickpea seeds.

Table 4. Cragg's double hurdle model estimates for certified chickpea seed purchase decision and quantity of purchase.

Variable	First hurdle (participation decision in chickpea purchase Decision)			Second hurdle (quantity of certified chickpea seed purchased)		
	Coef.	Z-stat	Marginal Effect	Coef.	Z-stat	Marginal Effect
Household size	0.32***	4.2	0. 066	0.198***	2.64	0. 025
Education	1.56***	3.55	0.293	0.70***	11.5	0. 11
Age of household head	0.031**	2.14	0.0064	-0.44	0.58	-0.147
Sex of household head	4.3	4.8	0.35	0.40	0.72	0.0 67
Chickpea farmland size in hectare	0.91***	5.92	0.019	4.3***	5.5	1.92
Size of livestock (TLU)	0.64	0.72	0.12	0 .64***	7.2	0.012
Training on certified chickpea seed	0.004	0.01	0.009	22.65	0.88	6.76
Access to extension advise on certified chickpea use	0.35***	8.30	0.0763	3.76	1.43	2.55
Distance to extension office	-0.004*	-1.72	-0.008	1.8	1.31	0.049
Distance to all weather road	-3.66	0.02	-0.566	0.00	-1.08	-0.003
Distance to coop office	-4.52	0.4	-0.5832	-0.53	1.61	-0.02
Member to farmer cooperatives	0. 87***	9.3	0. 15	0.81***	2.67	0.046
Purchase price certified chickpea seed	-0. 04***	-5.99	-0. 008	-0.23**	-2.28	-2.92
Constant	-2.16***	-1.83		2.67***	2.34	
Sigma	42.04			23.84		

Asterisks indicate levels of significance: *** = 0.01, ** = 0.05 and * = 0.10.

Determinants and quantity of certified chickpea seed purchase

The study's results indicate that the size of a household in adult equivalent has an influence on the likelihood of participating in the purchase of certified chickpea seeds, leading to higher productivity. In rural areas, larger households contribute labour to the farm, suggesting that farmers with bigger households are more likely to provide the necessary labour for cultivating improved varieties. The size of the economically active labour force within a household significantly influences the decision to purchase certified chickpea seeds. The coefficient for the overall model is statistically significant at a 1% probability level. The marginal effect of 0.066 suggests that if the size of a household increases by one individual, the probability of participating in the purchase of certified chickpea seeds would increase by 0.066. This could be attributed to the fact that larger households require higher productivity to meet household consumption needs and generate income for various expenses. Furthermore, in the seed demand model, household size influenced the quantity of certified seed purchased, with statistical significance at a level of less than ($P < 0.001$). This finding aligns with the research conducted by Ayana et al. (2014) on improved chickpea and groundnut varieties in Ethiopia. Similarly, Conteh et al. (2015) indicated that farming in rural areas heavily relies on family labour, and larger households provide the necessary labour for timely farm operations, thereby enhancing productivity. This implies that bigger households are better able to utilize new agricultural technologies.

The level of education attained by the head of the household has a significant influence on the purchase decision of certified chickpea seed and the quantity of certified chickpea seed purchased at a statistical significance level of 1%. This implies that higher levels of education are associated with improved access to information and greater knowledge about certified chickpeas. As a result, farmers with more education are more likely to use certified chickpea seed to increase the productivity of the crop, thereby uplifting their livelihood. The marginal effect indicates that for each additional year of education completed by the household head, the likelihood of purchasing certified chickpeas increases. This suggests that farmers with a formal education actively participate in the production of certified seeds. The research findings are consistent with a previous study conducted by (Kifle et al. 2022).

The age of the household head had a significant positive influence on the likelihood of participating in the purchase of certified chickpea seeds. This finding suggests that older farm households, who have accumulated more resources, are more likely to purchase certified chickpea seeds compared to their younger counterparts. The model estimation indicates that for every one-unit increase in the age of household heads, there was a 0.64% increase in the decision to purchase certified chickpea seeds. It was anticipated that as the age of the household head increased, their level of experience would also increase. Consequently, farmers with more experience would use their knowledge and ideas effectively to purchase certified chickpea seeds for the enhancement of certified chickpea seed production, thereby boosting the income of chickpea farmers. These findings align with the research conducted by (Dey and Bezabih 2021).

Land is a limiting factor in the production process. The findings of the study suggest that the total land holdings of the sampled farm households had a positive and statistically significant effect on the farmers' decision to participate in purchasing certified chickpea seeds and the quantity of their purchases, with a 1 percent probability level. The marginal effect indicates that if the cultivated land increases by 1 hectare, the probability of farmers participating in the purchase of certified chickpea seed by the sample farm household would increase by 0.019, and the quantity of certified chickpea seed purchased would increase by 1.92 kg as the size of the farm household increases by 1 hectare. This result aligns with the research conducted by Ayana et al. (2014) in Ethiopia. Therefore, households with larger land holdings tend to allocate more land for certified chickpea cultivation.

The study's findings reveal that, as anticipated, livestock holdings had a significant and positive effect on the quantity of certified chickpea seed purchase at a 1% significance level. According to the marginal effect observed in the results, for every one livestock increase in tropical unit, the amount of certified seed purchase is expected to rise by 0.64 kg, assuming all other factors remain constant. These findings align with the research conducted by (Zewde 2019). The study findings indicate that the proximity to the agricultural extension office had a negative and statistically significant effect on farm households' decision to purchase certified chickpea seeds.The marginal effect of the overall participation equation reveals that a decrease of 1 kilometer in the distance to the agricultural extension office would result in a 0.008 increase in the probability of deciding to purchase certified chickpea seeds. This implies that farmers who are closer to the agricultural extension office are more likely to buy certified chickpea seeds. Consequently, having access to agricultural extension services allows farmers to benefit from expert advice and knowledge regarding the certified seeds, which were released and verified by the research center. These findings align with the research conducted by (Ferede et al. 2019).

The study findings indicate that access to extension services had a positive and significant effect on the likelihood of purchasing certified chickpea seeds. It was observed that access to extension services significantly influenced the decision to participate in purchasing certified chickpea seeds by farm households, thereby enhancing chickpea productivity at a significant level of 1%. This suggests that farmers who received extension services were likely to increase their purchase of certified seeds by approximately 0.0763 compared to those who did not receive such services. This highlights the role of access to extension services in improving technical knowledge and providing information on best practices. This indicates that extension contact plays a role in influencing farmers' decision to purchase certified chickpea seeds, especially as the frequency of contact with farmers increases. In particular, farmers who actively sought extension advice on improved chickpea technologies were more likely to participate in purchasing certified chickpea seeds. These findings are consistent with the research conducted by Asegie et al. (2023), which highlighted the importance of agricultural extension services in assisting farmers through training provision on seed selection, planting techniques, crop management practices, new technology promotion, and partnership development to enhance extension policies and practices, with the ultimate goal of boosting agricultural productivity and sustainability. Thus, it can be inferred that extension services play a crucial role in influencing farmers' decisions when it comes to buying certified seeds and the quantity they purchase. This is achieved through the provision of valuable information, conducting training sessions, setting up demonstration plots, showing market opportunities, and sharing peer endorsements.

The study's findings indicate that the purchase price of certified chickpea seed had a negative and significant effect on farmers' decisions regarding the probability and quantity of purchasing certified chickpea seed at the 1% and 5% significant levels respectively. The study shows that a higher price of certified chickpea seed makes it less likely for farmers to afford purchasing it. Additionally, the findings demonstrate that for every one Birr increase in the price of certified chickpea seed, the probability of a chickpea farmer purchasing it decreases by 0. 008. Similarly, the quantity of certified chickpea seed purchased decreases by 2.92 kg with every one Birr increase in the price of chickpea seed. This finding implies that in the study areas, there is a limited availability of certified chickpea seeds. Despite the high demand for these seeds, farmers may be compelled to purchase a small quantity of certified seed for sowing or even refrain from buying them altogether due to their expensive cost. Consequently, they tend to switch to using local landraces. In such situations, only farmers who have financial resources can afford to buy the certified chickpea seeds. To address this issue, it is necessary to support farmers by providing them with credit access or subsidizing the certified chickpea seed production through the reinforcement of local chickpea seed producer cooperatives. The findings of this research contradict the findings of Zewde (2019) which demonstrated a positive correlation between the cost of chickpea seeds and the utilization of improved chickpea seeds. The conflicting findings of these studies can be attributed to the unique circumstances surrounding each investigation. The study conducted by Zewde (2019) primarily aimed to comprehend the supply chain and market dynamics of Green Pod Chickpea marketing. They employed a multiple linear regression model to identify the main factors influencing the volume of Green Pod Chickpea Marketing. Conversely, the current study focuses on the factors that influence the purchase of certified seeds and the quantity of certified chickpea seeds purchased by farming households, employing a double hurdle model. It is evident from these studies that the contextual and methodological disparities between them can result in contradictory findings concerning the costs of chickpea seeds and their purchase.

Moreover, the findings indicate that being a part of farmers cooperatives had a positive and statistically significant effect on both the likelihood of engaging in certified chickpea seed purchase and the quantity of certified chickpea seeds purchased, with a significance probability level of 1%. The marginal effect suggests that for every one unit increase in the membership status of farming households in agricultural cooperatives, there is a 0.15 increase in the decision to participate in chickpea purchase and a 0.046 kg increase in the quantity of chickpea seed purchased. This implies that as the membership status in farmers cooperatives increases from zero to one, the decision to participate increases by 0.15 and the quantity of certified chickpea seed increases by 0.046 kg for farmers who are members of farmers cooperatives. This suggests that cooperatives are expected to possess a larger capital base and encompass a larger number of individuals, making them similar to sizable organizations in comparison to smaller farmer groups. They actively organize diverse programs at the district or even regional level to enhance the knowledge of farmers. By becoming members of cooperatives, farmers expedite the efficient distribution of essential agricultural information, thereby influencing their decision to engage

in certified seed procurement.The above findings demonstrate that membership in farmers cooperatives positively influences the likelihood of purchasing certified chickpea seeds and the quantity bought by providing access to high-quality seeds at competitive prices. Cooperatives ensure seed quality and authenticity, encouraging purchases and securing bulk discounts through collective bargaining. Technical assistance and training improve members' skills in using certified seeds effectively, leading to higher yields. Cooperatives also offer access to markets for produce, valuable information on price trends, and foster a sense of community and peer influence. Various cooperative activities and resources, such as seed farm monitoring, demonstration plots, training programs, and agronomic advice, significantly influence farmers' decision-making processes and empower them to make informed choices when selecting seeds for their crops. Consequently, this leads to an increase in the quantity of certified seed purchases, ultimately resulting in higher productivity for their farming endeavors and a subsequent boost in income for farming households.

Conclusions and recommendations

In conclusion, the research highlights the limited use of certified chickpea seeds among farmers due to factors such as limited accessibility, high prices, and limited attention by agricultural extension agents. It can be inferred from this information that there is a necessity to enhance the capabilities of local seed producer cooperatives and certify them in the production of high-quality seeds. This action will ensure the timely accessibility of certified seeds to farmers, providing them with access to a wide variety of quality seeds that are tailored to their specific growing conditions. Moreover, it calls for the involvement of relevant organizations to assist farmers in affording the high cost of certified seeds and promoting their use. This could potentially include providing subsidies for certified seeds as well as agricultural machinery for seed winnowing. Additionally, the findings suggest that in order to guarantee that farmers receive timely and pertinent information and support, it is crucial for agricultural extension service providers to give priority to seed production. The study also underscores the need for improved monitoring of seed suppliers and the high demand for certified seeds despite the cost barrier for some farmers. From the study, it can be observed that both the size of a household and the level of education of the household head have a significant effect on the likelihood of purchasing certified chickpea seeds and the quantity of seeds purchased. It can be inferred from the findings that empowering farmers groups through training and technical support in areas such as seed production, quality management, seed certification requirements, seed preservation, and seed multiplication will enable them to grow their own certified seeds. As a result, their dependence on external seed suppliers will decrease, and they will have better access to high-quality seeds. Larger household sizes are more likely to participate in the purchase and cultivation of certified seeds due to the need for higher productivity.The findings also show that the age of the household head, size of land holdings, and livestock holdings all have a significant effect on the likelihood and quantity of purchasing certified chickpea seeds. Furthermore, being close to agricultural extension offices raises the chances of buying these seeds, underscoring the significance of professional guidance and expertise in improving chickpea yield and boosting income for farmers. Furthermore, being close to agricultural extension offices increases the chances of purchasing these seeds, emphasizing the importance of professional guidance and expertise in enhancing chickpea yield and increasing profits for farmers. Finally, the study highlights the positive influence of farmers' cooperatives on the probability of buying certified chickpea seeds, resulting in higher productivity. However, the expensive cost of certified seeds has a negative influence on farmers' choices, highlighting the necessity for farmer support. The aforementioned findings and conclusions lead to the following recommendations:

In order to address the challenge posed by high prices of certified chickpea seeds, the government and development partners should implement subsidies to make chickpea seeds more affordable for farmers, thereby incentivizing them to adopt certified seeds that can result in a better harvest.

The government should establish a seed policy that will enhance the accessibility of certified seeds, as well as improve the distribution network for farmers. One way to accomplish this is by strengthening seed producer cooperatives and private seed producing companies.

Researchers and extension personnel should organize training sessions for farmers to enlighten them on the advantages of using certified chickpea seeds and the proper techniques for handling them.

The findings suggest that seed companies should focus on supplying certified chickpea seeds to farmers in closer proximity, as distance affects seed demand and utilization.

Statement of conflicts of interest

There is no conflict-of-interest present. We would like to verify that there are no known conflicts of interest linked to this publication, and there has been no substantial financial backing for this project that could have impacted its results.

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