Determinants of Farmers' Seed Replacement Rate of Chickpea (*Cicer arietinum* L.) in Central Ethiopia

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Abstract

Chickpea is a prominent pulse crop in Ethiopia, accounting for over 17% of the nation's total legume production. Farmers' seed replacement rate plays a crucial role in providing valuable insights for planning the area dedicated to quality seed production. An increase in the seed replacement rate is essential for enhancing crop productivity. This study was designed to examine determinants of farmers' seed replacement rate of chickpeas in Ethiopia. The study was conducted in six districts located within three administrative regions of Ethiopia namely, Amhara, Oromia, and Central Ethiopia. Primary data were collected from random samples of 128 farm households, and data were subject to descriptive analysis using the SPSS Software. The demographic result indicated that a majority of chickpea-producing farmers (64.8%) are in the active labor force though most of the household heads (~78%) are illiterate or only educated up to primary grades. The study indicated that the seed replacement rate for chickpea seed with the maximum five years and minimum of two years replacement interval and about 43 % of the respondents replace their seed with in three years. The findings from the cross tabulation analysis using chi square test showed a statistically significant variance between chickpea seed replacement and land holding of the household head, sex of the household and variety preferences of the household head at a significance level of (P < 0.01). The absence of reliable seed sources, seed quality and related problems, and increasing seed prices were also indicated as bottlenecks for chickpea seed replacement in the study areas. Therefore, the determinants of the seed replacement rate should be carefully observed by the responsible institutions in accessing quality chickpea seed .

Keywords: Chickpea; Replacement rate; Quality seed; Improved varieties

Introduction

Chickpea (*Cicer arietinum* L.), is recognized as a prominent legume crop in Ethiopia, accounting for over 17% of the nation's total legume production and cultivated across an area of 258,486.29 hectares, production of about 0.47 million tons and 2.16t ha^{-1} (CSA, 2022). Despite its significance as the third most cultivated food legume after common beans and faba beans in terms of both area and production, chickpea productivity in Ethiopia remains below its potential which reaches 6 t/ha (Thudi et al., 2016). This suboptimal performance can be attributed to the limited adoption of improved varieties and technologies developed by the research system, coupled with inadequate farming practices and the prevalence of biotic and abiotic stresses (Keneni *et al.,* 2016). To address these challenges and enhance chickpea productivity, it is essential to promote the adoption of improved varieties that possess resistance to pests and diseases while exhibiting high-yield potential. Additionally, fostering better farming practices, including timely planting, appropriate seed selection, and judicious use of fertilizers and water, is crucial for optimizing chickpea production (Fikre, 2014). Furthermore, mitigating the impact of biotic and abiotic stresses on chickpea cultivation is paramount. This can be achieved through the development of drought-tolerant and disease-resistant varieties, the enhancement of soil fertility through integrated nutrient management practices, and the implementation of integrated pest management strategies.

Ethiopia is recognized as a secondary center of genetic diversity for chickpeas, and its wild relative, *Cicer cuneatum*, is indigenous to the northern region of the country (Engels and Hawkes 1991; Anbessa and Bejiga, 2002; Keneni et al., 2016). Chickpea cultivation is predominantly concentrated in the central, northern, and northwest highlands of Ethiopia. The chickpea breeding and improvement program has released more than 27 varieties in the last more than 40 years from 1974 to 2019. However, about 15 varieties are under production across production areas of the country.

Elevating the productivity and production of pulse crops, particularly chickpeas, is critical for satisfying the increasing demand for food and nutrition security in Ethiopia. Studies have demonstrated that improved chickpea varieties exhibit yield advantages of up to four times higher than the local varieties traditionally cultivated by farmers (Fikre, 2016). Some of these improved varieties meet both local and export market standards due to their superior quality. In recent years, there has been an upward trend in the adoption rate of improved varieties and production technologies, leading to a positive impact on chickpea productivity and production (Fikre, 2016). This can be attributed to the heightened awareness and confidence among farmers, fostered through their active participation in selecting their preferred technologies during the early stages of variety promotion.

The widespread acceptance of improved chickpea technologies in Ethiopia has resulted in a surge in demand for seeds of improved varieties. Consequently, a substantial imbalance between demand and supply has emerged each year. Based on the current scenario, if seed demand is calculated on an area basis of 258,000 hectares, approximately 27.7 thousand tons of seeds would be required annually to cover the area. Similarly, as stated by (Tigabie et al., 2020) the annual supply of chickpea seeds is approximately 2 to 3 thousand tons, falling significantly short of the potential demand and only half of what is needed.

To address this seed deficit, it is imperative to enhance the availability and accessibility of quality chickpea seeds to farmers. This can be achieved through the production and dissemination of improved varieties of chickpea seeds, coupled with effective seed storage and distribution mechanisms. Additionally, promoting better farming practices, such as timely planting and proper seed selection, is essential for ensuring optimal seed performance and yield. By bridging the gap between demand and supply of chickpea seeds, farmers can improve their productivity, income, and livelihoods, ultimately contributing to the overall food and nutrition security of the country. While addressing the demand for high-quality seeds in the required quantity is crucial, it is not sufficient to drive production unless accompanied by a diverse range of options within the seed chain. The seed chain encompasses various stakeholders, including those from the public and private sectors, NGOs, and farmers. In the case of pulse crops, the limited availability of quality seeds has been a significant impediment to enhancing productivity (Bishaw, 2016).

The seed replacement rate plays a crucial role in assessing the adoption of certified or high-quality seeds for a specific crop, providing valuable insights for planning the area dedicated to quality seed production. Moreover, increasing the seed replacement rate is essential for enhancing crop productivity. Despite extensive research on chickpea breeding, production improvement, biotic and abiotic stress management, and post-harvest practices, the impact of prolonged use of the same seeds without replacement on yield and seed quality remains underexplored. This study aims to examine determinants of the seed replacement rate of chickpeas in central Ethiopia.

Materials and Methods

Study areas, sampling and sample size

The assessment was made in 2022 through a field survey following a multistage purposive sampling technique to identify 128 smallholder farmers from 7 districts (weredas) in three regional states (Oromiya, Amhara, and Central Ethiopia) which are the potential chickpea production zones and districts in central parts of Ethiopia. After identifying the potential regions first five zones were purposely selected including E/shoa, S/W/Shoa, N/Shoa, Oromia special zone, and Guraghe zone based on the production potential of the crop. In the second stage, from the selected zones, 7 districts were randomly selected namely Adea, Lume, Akaki, Becho, Moretina Jiru, and Abesghe districts. Thirdly, from the selected districts, 2 *kebeles* were selected each with a total of 14 kebeles randomly. Finally, 128 farm households were interviewed following random sampling techniques using a structured questionnaire to collect primary data (Table 1). By selecting these specific areas primary data related to chickpea production practices, experiences of farmers in seed replacement rate, challenges, and opportunities in chickpea production was collected.

Table 1. Location and sample sizes selected for the study of chickpeas

Region	Zone	Chickpea-producing districts	No. of selected districts	No. of selected kebeles	No. of respondents
Oromia	East Shewa	Adea, Lume	2	2	43
	Southwest Shewa	Becho	1	2	21
	Oromia special zone	Akaki	1	2	29
Amhara	North Shewa	Moretina Jiru	1	2	15
Central Ethiopia	Guraghe zone	Abashghe	1	2	21
Total			6	12	128

This questionnaire explored various aspects of chickpea production, including socio-demographic information, resource ownership, access to services, production practices, and varietal and certified seed utilization, To ensure the validity of the primary data, secondary data was also collected from experts, development agents, and model farmers. Their insights were carefully compared with the data gathered from the farmers, employing a triangulation method. This rigorous approach enabled a comprehensive assessment of the experiences and challenges faced by chickpea farmers.

Data analysis

Following the completion of data collection, the responses were coded and entered into the SPSS version 26 software program for statistical analysis. Quantitative data analysis was employed using descriptive statistics to examine the collected data. The results were organized into tables and graphs for clear presentation and interpretation. Analyisis of Variance and chi square test were also used to conduct cross tabulation and relashionship between seed replacement rate and related variables.

Results and Discussion

Role of household age and level of education on seed replacement

The results of this study indicated that, in terms of age, a majority of the of respondents are in the middle age groups. Nearly two-thirds of participants were between 36 and 60 years old, with the largest group falling within the 46-60 age range. Younger individuals represented a smaller portion at 21.1%, and only 14.1% of respondents were above 60 years old (Table 2). This result indicated that a majority of chickpea-producing farmers are in their active labor force, with a higher proportion of older farmers compared to the younger age group. A similar study indicated by **(**Massresha *et al*., 2021**)** revealed a positive association between older age groups and the adoption of technologies like improved/certified seeds and awareness about seed replacement's impact on production.

Table 2. The age category of the respondents (N=128).

Age category	Number of respondents (n)	Percent	Std. deviation	Variance
20-35	27	21.1	0.98	0.96
36-45	35	27.3		
46-60	48	37.5		
>61	18	14.1		
Total	128	100		

The statistical analysis demonstrates a significant relationship ($X^2 = 12.6$, $P<0.05$) between seed replacement practices and the sex of the household head (Table 3). The positive correlation observed in the cross-tabulation analysis indicates that the sex of the household head is an important factor in seed replacement practices. The significant association between seed replacement decision and sex could be attributed to that 1) male and female household heads might have different levels of access to agricultural resources, extension services, and market information, influencing their ability to replace seeds; 2) gender roles and dynamics within households might affect decision-making power related to agricultural practices, including seed replacement; and 3) male household heads might have better access to support networks, such as farmer groups or cooperatives, which facilitate seed replacement.

Table 3. The relationship between seed replacement years and sex of the household.

Years of seed replacement	**Sex category**			Chi-square value	P value
	Male	Female	Total		
2 Years	3	2	5	12.6	< 0.05
3 Years	53	2	55		
4 Years	36	3	39		
>5 Years	25	4	29		
Total	117	10	128		

Table 4 depicts the level of education of the respondents. It was observed that a majority of the respondents have attended elementary education (grades 1-6). However, a considerable number of respondents can only read and write. There is some extent of illiteracy but not widespread. Highscool and higher education levels are less common. The observed educational distribution, with the majority possessing at least basic literacy, and a significant proportion of respondents having completed some formal schooling, indicates that there are chickpea producers equipped with the foundation necessary to comprehend and sustainably adopt new technologies.

Table 4. Educational level of respondents

Descriptions	Number of respondents(n)	Percent	Std. deviation	Variance
Illiterate	14	10.9		
Read and write	30	23.4	1.62	2.64
1-6 grade	43	33.6		
7-8 grade	17	13.3		
9-12 grade	14	10.9		
College and more	9	7.0		
Total	128	100		

A crosstabulation analysis between chickpea seed replacement and the level of education indicated an increase in the likelihood of chickpea seed replacement as level of education increased. However, this relationship was not statistically significant suggesting that while there might be a trend indicating that more educated household heads tend to replace seeds more frequently, this trend is not strong enough to rule out the possibility that it occurred by chance. Besides education, practical experience and other socio-economic factors may play a more significant role in influencing these agricultural decisions. Several studies support this concept, highlighting a positive correlation between education level and technology adoption (Uematsu and Mishra, 2010; Workie and Tasew, 2023**).** Possessing basic literacy and numeracy skills, as well as the critical thinking fostered by formal education, likely facilitates the assimilation of technical information and the development of necessary skills for successful technology integration. This allows individuals to make informed decisions about adopting new technologies, understand their potential benefits and challenges, and ultimately sustainably utilize them (Beshir *et al.,* 2012; Rogers, 2003; Challa and Tilahun, 2014).

Roles of land ownership status on seed replacement

Land ownership in the study area is unevenly distributed, with a majority of respondents owning less than two hectares of land (Table 5). Only a small percentage of respondents own more than six hectares of land. A significant proportion of respondents rent land to supplement their holdings. The area of land rented varies, with some respondents renting only small amounts and others renting significant amounts of farmland. A majority of respondents cultivate crops on a land size below 3.5 hectares. A smaller portion of respondents cultivate on medium-sized plots of 4-6 hectares, while only a marginal percentage have large plots exceeding 6 hectares (Table 5).

Table 5. Land ownership status of the respondent households

Total area under cultivation in 2012/13 ha			Area owned by respondents in ha			Area rented in ha		
Area	Frequency (n)	Percent	Area	Frequency (n)	Percent	Area	Frequency (n)	Percent
0.25-2.00	47	36.7	0.25-2.00	87	68.0	0.25-2.00	52	77.60
2.10-3.50	42	32.8	2.10-3.50	24	18.8	2.10-3.50	7	10.44
3.51-4.00	18	14.1	3.51-4.00	12	9.4	3.51-4.00	1	1.49
4.10-6.00	14	10.1	4.10-6.00	3	2.3	4.10-6.00	5	7.46
>6.00	7	5.5	>6.00	2	1.6	>6.00	2	2.98
Total	128	100		128	100		67	100

An anlysis of the relationship between land ownership and seed replacement indicated a significant association the ($X^2 = 18.1$; $P < 0.05$) (Table 6). This results suggest that farmers with a larger landholdings are more likely to have the ability to access, interpret, and utilize information related to the adoption of certified seeds of improved chickpea varieties, leading to the replacement of existing ones after a thorough assessment of the benefits. As a result, it is expected that the size of land holdings will increase the probability of farmers switching from recylced chickpea seeds to new stocks. This result is in line with reports by Chandio and Yuansheng (2018) and Singh *et al.* (2018) which states that larger landholdings are associated with higher seed replacement rates, indicating that bigger farms may be prioritizing investments in improved seeds as production inputs. Another study by Workie and Tasew (2023) also revealed that experience with novel technologies, larger farm sizes, and improved access to resources facilitates technology adoption and enhances risk management capabilities.

Table 6. The relationship between seed replacement years vs landholding of household head.

Years of seed replacement	**Landholding status of sample farmers**							
	0.25 -2ha	2.1 - 3.5	3.51- 4	4.1 – 6	>6	Total	Chi square value	P value
2 Years	4	1	0	0	0	5	18.1	0.03
3 Years	36	12	7	0	0	55		
4 Years	25	10	1	2	1	39		
> 5 Years	17	5	4	1	2	29		
Total	82	28	12	3	3	128		

Land allocation for chickpea

The present study showed that 92.8% of the respondents dedicate a minimal portion of their land to cultivating chickpeas. Only 3.1% (4 respondents) allocate up to 3 hectares for this crop during the growing season (Table 7). The limited allocation of land to chickpeas production could be attributed to the landholding as 68% of respondents own less than two hectares. Besides, farmers give priority to cereals compared to chickpeas. Such variation in farmers' priority might have influenced the adoption of new chickpea technologies including the seed replacement experience of farmers. Different research findings also indicated that there is a clear relationship between farm size and the adoption of agricultural technology (Gecho and Punjabi, 2011; Solomon *et al.*, 2023; Oluwayemisi *et al.*, 2017; Abebe and Bekele, 2015; Hasen, 2015; Tura *et al.*, 2010). Households with larger farm sizes are more likely to adopt new technologies compared to those with smaller farm size.

Table 7. Land allocation for chickpeas

The area allocated in ha	Frequency (n)	Percent	Mean	Std. deviation
0.13-1.0	120	93.8	1.09	0.39
1.10-2.0	4	3.1		
2.10-3.0	4	3.1		
Total	128	100		

Chickpea varieties under production vs seed replacement years

Both Kabuli and desi chickpeas are grown in the study areas, but the Kabuli type is more prevalent. A small proportion of farmers (9.3%) produce Desi type of improved chickpea varieties in the study area. According to the survey result some improved varieties were produced in the study area out of which about 36.7%(n=46) of the respondents produced local varieties with an average yield of 12.5 qt/ha and about 29.7(n=38) of the respondents produced Arerti variety obtaining average yield of 22.75 qt/ha followed by Habru variety with 24.2% (n=31) and average yield of 19.6 qt/ha (Figure 1). About 36.7% of farm households are using the local cultivars which have low genetic potential and low yielders which could be attributed to factors associated with the use of improved seed and seed replacement rate constraints. Similar studies suggest that readily available, high-yielding crop varieties can serve as a significant catalyst for increased seed replacement rates among farmers (Joshi and Braun, 2022; Singh *et al.*, 2019).

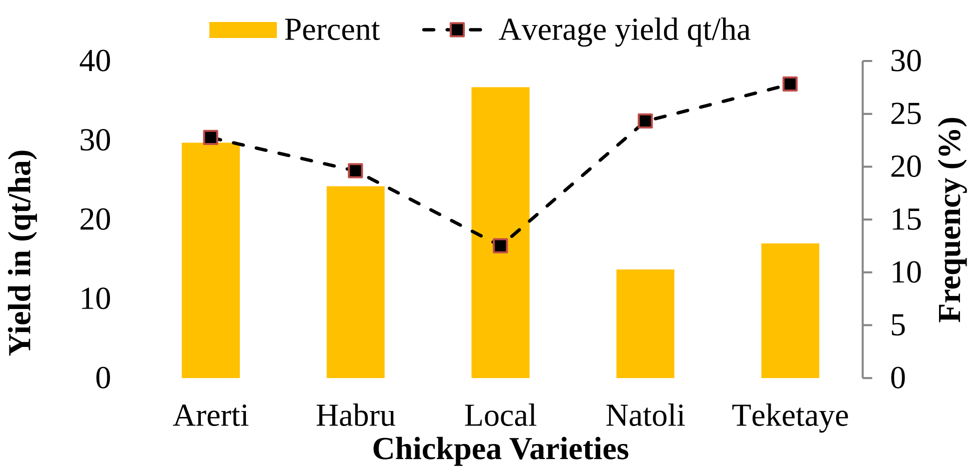

Figure 1. Chickpea varieties under production and average yield

Table 8 shows the relationship between chickpea varieties and seed replacement years in the study areas. The results indicated that out of the 128 farmers who were sampled, only 5 farmers replaced their chickpea seed every two years. Additionally, 55 farmers, accounting for 42% of the sampled farmers, replaced their chickpea seeds at an intervals of every three years. Furthermore, 39 farmers, constituting 30.5% of the farmers, replaced their chickpea seed every 4 years, while 29 farmers, representing 22.7% of the farmers, replaced their chickpea seed at intervals exceeding 5 years. In addition, out of the 93 farmers surveyed in Oromia, only 1 farmer opted to replace their chickpea seed every 2 years. On the other hand, 41 farmers replaced their chickpea seeds every 3 years, while 28 farmers replaced their seeds at 4-year intervals. Interestingly, 22 farmers replaced at intervals exceeding 5 years. Based on this result, it can be inferred that a majority of farmers in the study areas replace chickpea seeds at intervals of 3 years (Table 8). The observed inconsistency in seed replacement practices amongst farmers could be attributed to limited access to quality seed, as well as the absence of reliable seed sources and economic consideration to buy seed every year.

The study revealed a strong and statistically significant positive association ($X^2 = 38.4$; $P < 0.01$) between chickpea seed replacement and the variety preferences of the household head. The analysis showed that as the household head's preference for different varieties of chickpea seeds increases, there is a corresponding increase in the rate of seed replacement. This means that households where the head has a strong preference for diverse or improved varieties of chickpea are more likely to engage in the practice of replacing their seeds regularly (Table 8).

Table 8. The relationship between chickpea varieties and the seed replacement years

Years of seed replacement	**Farmers' preferred varieties in the study area**							**Chi sqare value**	**P-value**
	Local	Arerti	Habru	Natoli	Shasho	Teketay	Total		
2 Years	2	1	0	0	0	2	5	38.4	0.003
3 Years	20	14	14	5	0	2	55		
4 Years	16	11	7	4	1	0	39		
>5 Years	19	7	2	0	0	1	29		
Total	57	33	23	9	1	5	128		

Constraints of seed replacement

The study showed that there are various concerns around seed replacement and the adoption of new chickpea varieties. It was observed that 50% (n=64) of the respondents lacked reliable sources for obtaining certified seeds. Additionally, 22.7% (n=29) reported experiencing a shortage of high-quality seeds, while 15.6% (n=20) highlighted rising seed prices as significant barriers to seed replacement (Figure 2).

The survey result indicated that the absence of reliable seed sources, seed quality-related problems and increasing seed prices were crucial gaps for chickpea seed replacement in the study areas. This has to get attention from responsible public and private institutions in accessing quality chickpea seeds from a reliable source at a reasonable price. Collaborative efforts of responsible stakeholders are also required to raise awareness among farm households regarding available improved chickpea technologies, and reliable seed sources that supply their specific demands. These stakeholders can empower farm households to make informed decisions about seed replacement, ultimately contributing to enhanced chickpea production and improved livelihoods. Our results are consistent with the findings of Singh and Singh (2016), Bhandari et al. (2021), and Kakoty and Barman (2015), who all identified similar factors contributing to low seed replacement rates for pulses and cereal crops.

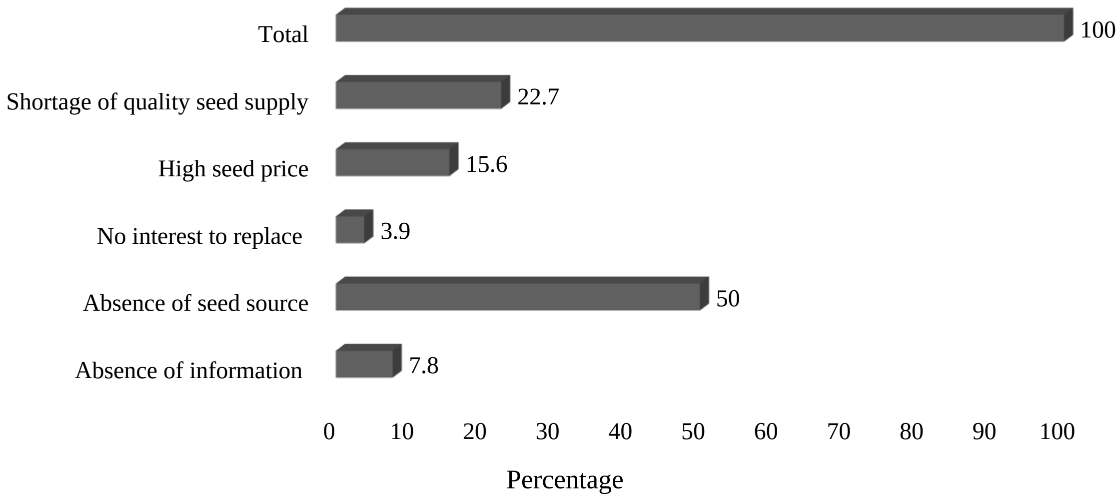

Figure 2. Farmer's response and constraints of seed replacement

Conclusion and Recommendations

Farmers in the active labor force are more reliable in technology adoption and utilization of existing technologies like improved/certified seeds. As indicated from the result, there is positive correlation between chickpea seed replacement and the variety preferences of the household head as the household head's preference for different varieties of chickpea seeds increases, there is a corresponding increase in the rate of seed replacement. The findings also suggest that farmers with larger landholdings are more likely to have the ability to access, interpret, and utilize information related to the adoption of certified seeds of improved chickpea varieties, leading to the replacement of existing ones. As a result, it is expected that the size of land holdings will increase the probability of farmers switching from old chickpea seeds to new ones. The study results additionally highlight that the absence of reliable seed sources, seed quality-related problems, and increasing seed prices were crucial gaps for chickpea seed replacement in the study areas. This has to get attention from responsible public and private institutions in accessing quality chickpea seeds from reliable sources at reasonable prices. By addressing these key challenges and implementing targeted interventions, the study area can improve their chickpea productivity by adopting new technologies like the use of certified seed, replacing their old chickpea seed with new ones, and increasing income for farmers, leading to a more resilient and sustainable agricultural system. The following recommedations can be drawn from the present study:

- For sustainable supply of improved chickpe seed establishing partnerships between public institutions, private seed companies, and local farmers is crucial.
- Leverage extension services is important to strengthen agricultural extension services to provide ongoing support and guidance to farmers on seed selection, proper demanding and technology adoption.
- Facilitate access to informationn to develop and disseminate information tailored to the needs of farmers with varying landholdings to help them make informed decisions about seed replacement.

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