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Research article

Analyzing constraints of smallholders' chickpea (*Cicer arietinum* L.) production systems in Gondar Zuria Woreda of Ethiopia using the Henry Garrett's ranking technique

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ABSTRACT

In Ethiopian, pulses are the second top most grain crops, of which chickpea takes the first place. However, chickpea production by smallholder farmers has been facing several constraints and this has not been adequately studied using the appropriate techniques. As a result, this study used Henry Garrett's ranking technique to analyze and rank constraints in the production of chickpeas. . Using the multistage sampling technique, the data were gathered from 140 randomly chosen samples. The findings indicate the smallholder chickpea producers face input, marketing, economic, institutional, and environmental constraints. As to the Henry Garrett's ranking, higher price of seed (65%), higher price of chemicals (64.3%), delays in supply of improved seed (64%), capital shortage (60.5%), shortage of improved seed (58%), and disease infestation (56.4%) are the major constraints noted in average values. It is noted that. The study concludes that ranking constraints using the Henry Garrett technique are better as compared to simple frequencies. Key prerequisites for a robust chickpea production include addressing of constraints relating to irregularity and shortage in the supply of improved chickpea seed varieties, higher cost of inputs, diseases and pests, and inability to access in-kind credit.

1. Introduction

Pulses are crucial to human well-being in the form of nutrition and food security throughout the world (Atnaf et al., 2015; Burman et al., 2010; Considine et al., 2017; Shari et al., 2018). Smallholder farmers in Ethiopia grow a variety of pulses, particularly chickpeas, haricot beans, and lentils, for both subsistence and commercial purposes (ILRI, 2013). Pulses account for approximately 13% of cultivated land and 10% of the agricultural value addition; thus, they are critical to smallholder farmers' livelihoods (IFPRI, 2010). After cereals, pulses are the second most important crop after cereals (CSA, 2015). According to the Central Statistical Agency (CSA) of Ethiopia, they account for 14.6% and 11.1% of the total grain crop area and production volume, respectively (CSA, 2016).

Chickpea (*Cicer arietinum* L.) is an important pulse crop with various benefits, including rich nutritional value, high-income generation potential, and the ability to convert atmospheric nitrogen (N) into a useable form (via N fixation) to improve soil fertility (EIAR et al., 2013). It can fix up to 140 kg N/ha from air and meets most of its nitrogen requirements for optimal growth (Eshete and Fikre, 2014). In terms of production and area coverage, it is currently grown on approximately 13.7 million hectares worldwide, with an average annual production of 12.8 million tonnes (Afzal, 2021). According to the report made by Afzal (2021) and Merga and Haji (2019) Asia, Oceania and Africa contribute 82%, 6%, and 5% of global production, respectively. Ethiopia is the sixth-largest producer of chickpeas in the world, producing over 400 thousand metric tons per year (Boere et al., 2015). Ethiopian's total area cultivated and production contributions to the African market are 43% and 63%, respectively (Ojiewo, 2016).

The chickpea sector has the potential to be a key driver of the country's agricultural development and economic growth. However, current chickpea production levels are far below the demonstrated potential (Rashid et al., 2015). Different studies have been conducted on the production constraints of chickpea. Among these, Kundu et al. (2013) presented that different biophysical and socioeconomic constraints contributed to the chickpea productivity being lower. Kundu et al. (2013) reported similar but additional points, describing biophysical constraints (insect and disease infestation, weed infestation, and damage from early

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tidal floods) and socioeconomic constraints (higher price of input cost, lack of credit, shortage of improved varieties of chickpea seed, lack of knowledge on improved varieties and damage by wild animals and theft). In addition, other researchers have identified chickpea production constraints by categorizing them as biotic constraints (insects, pests and diseases), abiotic constraints (drought, low soil fertility and heat), and institutional and policy constraints, such as the decline in investment capacity, poorly developed seed systems, volatile markets, land-related constraints, poor infrastructure, and insufficient extension service (Abate et al., 2012). Furthermore, the International Food Policy Research Institute (IFPRI, 2010) also reported that one of the constraints for chickpea production in Ethiopia is the underdevelopment of the current export market.

The abovementioned authors used qualitative methods (narration, triangulation and interpretation of the data) and simple frequency distributions to identify those constraints. However, it is difficult to prioritize the severity of constraints using such methods, hence, this study employed Henry Garrett's ranking technique, which provides the change of orders of constraints and advantages into numerical scores. Moreover, the Garrett's Ranking Technique has an advantage over frequency distributions that enable constraints to be arranged based on their severity from the respondents' point of view (Zalkuwi et al., 2015). Analyzing and identifying the severe constraints is critical for decision-makers and researchers to make informed decisions. Although the Henry Garrett's ranking technique is widely cited by researchers in India, Nigeria and others for prioritizing constraints, preferences and different attributes (Abirami et al., 2017; Kumudha and Rizwana, 2013; Oyelaran et al., 2016; Umesh and Sakamma, 2018) to the best of our knowledge, no study has been conducted in Ethiopia using Henry Garrett's ranking technique to analyze constraints. In addition to policy implications, this study will fill the literature gap to prioritize and analyze constraints in various socioeconomic aspects. Therefore, this study used the Henry Garrett's ranking technique to analyze the constraints of smallholder farmers in chickpea production system in Gondar Zuria Woreda, Northwest Ethiopia.

2. Materials and methods

2.1. Study area and sampling design

This research was carried out in Gondar Zuria Woreda, one of the potential chickpea growing areas in the Amhara region. The geographical map of the area is shown in Figure 1. According to a 2012 report by the Gondar Zuria Woreda Office of Agriculture, the Woreda has a total area of approximately 115 thousand hectares (ha). Moreover, after Teff, chickpea is the second most important crop. Based on a review of the available literature and preliminary data gathered from different key informants, we assumed that all chickpea growers face at least one constraint from the lists included in the study, regardless of the severity of the constraint. Therefore, the main intention of this study is to identify and prioritize the severe constraints that smallholder farmers face when producing chickpea crops.

To select sample households, a multistage sampling technique was used. First, Gondar Zuria Woreda was chosen specifically for its chickpea production potential. Gondar Zuria Woreda has forty rural kebeles, five of which contribute significantly to chickpea production, namely Chinchaye, Lamba, S/Sarwuha, Tach Tseda and Bahireginb. At the second stage, two potential kebeles, Chinchaye and Tach Tseda, were chosen at random from among these potential kebeles. As a result, 140 sampled respondents were chosen at random from a total of 1314 chickpea growers in both kebeles, using a simple random sampling technique. Yamane's (1967) sample size determination formula, as described in Eq. (1), was used to calculate the sample size. Finally, 53.6% ($n = 75$) from Tach Tseda kebele and 46.4% ($n = 65$) from Chinchaye kebele were selected at random using proportionate sample size to total population.

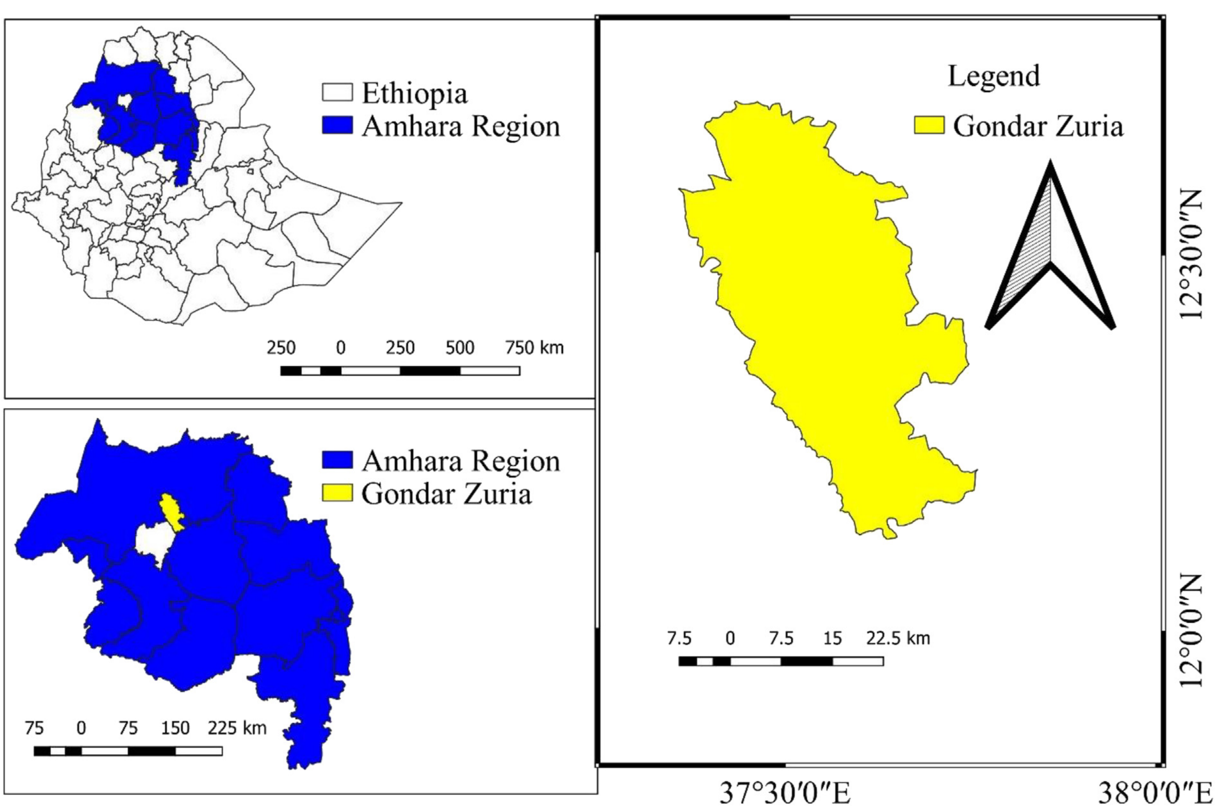

Figure 1. Map of Gondar Zuria Woreda (Source: GIS Sketch, 2018).

$$n = \frac{N}{1 + N(e)^2} \quad (1)$$

where 'N' is the total population size, 'n' is the sample size, and 'e' is the error of margin at the 95% confidence level.

2.2. Data types and collection methods

The present study used both qualitative and quantitative data collected from primary and secondary sources. Before collecting data, a kebele agricultural development agent was consulted on how to approach sample households. The kebele agricultural development agent assisted in identifying randomly selected households in convenient clustered locations for contact with interviewers. Accordingly, four clusters were established in each kebele to conduct interviews. The schedule for those clusters to collect data was then prepared, and the kebele agricultural development agent, along with local leaders, assisted in bringing selected respondents to the site. When selected respondents are unavailable on the scheduled date, the enumerators interview those households at their residence. Five enumerators were involved in data collection for this survey after receiving one day of training on the details of the interview schedule. The training is also given on how to approach farmers and ethical principles that must be followed during interviews.

Face-to-face interviews were used to collect both quantitative and qualitative data, with a semi-structured questionnaire serving as the data collection tool. The semi-structured questionnaire begins with some structured options and ends with open-ended questions that allow respondents to express their thoughts on the specific issue. Semi-structured interviews aided to gaining a deep understanding of the issue raised by allowing interviewees to add additional points not covered in the structured guidelines. Separate interview guidelines were prepared for sample respondents and key informants. The guidelines were created in such a way that they address the study's objective (identifying and prioritizing constraints of smallholder chickpea producers). The pretest was conducted on 10 randomly selected households (not included in the analysis), and the final interview guideline received some technical corrections. Following that, the primary data, which included production constraints and socioeconomic characteristics, were collected directly from sample households and key informants, while the secondary data came from a variety of secondary sources, including journal articles, annual reports, and internet sources.

2.3. Methods of data analysis

The data were analyzed using both qualitative and quantitative approaches. Qualitative data collected from sample households and key informants were triangulated with quantitative data using narration, explanations and interpretation techniques. Simple descriptive statistical tools such as percentage, mean, maximum, and minimum were used to analyze quantitative data such as household characteristics. Statistical tests (independent sample t test and chi-square) were also used to analyze the data on household characteristics, as demonstrated by Wooldridge (2000), Gujarati (2004) and Maddala (1992). Tufail et al. (2019) used descriptive and inferential statistics in their study focused on the analysis of constraints to the adoption of improved technology for Berseem Clover (Trifolium Alexandrinum) cultivation in Punjab, Pakistan.

The use of improved varieties of chickpea seed was used as a dependent variable in this study. We chose this variable because the utilization status of improved seed varieties has a greater potential to influence the production level. Evidence supports our contention that using improved varieties of chickpea seed plays a prominent role in increased production and productivity (Chichaybelu et al., 2018; Eshete and Fikre, 2014). Citrus paribus, the characteristics of quality seed can contribute up to 40% to productivity enhancement (EIAR, 2020). Therefore, the dependent variable may including using or not using improved varieties of chickpea seed. As a result, an independent sample t-test was used to compare the mean of users and nonusers of improved chickpea seeds to see if there was statistical evidence that the associated population means differ significantly. Likewise, the chi-square test was used to determine whether there was an association between categorical variables.

Concerning the main focus of this study, the constraints were prioritized for each respondent at the first stage using pairwise ranking methods. Following that, Henry Garrett's ranking technique was used to identify the most important constraints and analyze them. Although there is little literature on Henry Garrett's ranking technique in Ethiopia, a number of authors in other countries have used it to analyze constraints in various fields of study (Balasubramaniam et al., 2022; Eswari and Saran, 2011; Joghee and Dubey, 2018; Shanthini, 2020). Accordingly, the ranks on constraints for each respondent were converted into a score value using the procedures outlined below.

Step 1: Rank all of the variables collected from each individual respondent. The study used a pairwise ranking technique to obtain the ranks of all constraints in each category. Following that, each respondent ranked all constraints based on their severity in their opinion.

Step 2: Compute the number of respondents who respond to each rank. This shows the summary of the respondents who fall into a specific rank for each constraint. This can be calculated using Microsoft® Excel.

Step 3: Calculate the percent position by using the Henry Garrett formula presented in Eq. (2) as:

$$\textit{Percent position} = \frac{100(Rji - 0.5)}{Nj} \quad (2)$$

where Rji is the rank given for the ith variable by the jth respondent, and Nj is the number of variables ranked by the jth respondent.

Step 4: Find the equivalent value of the percent position from Garrett Table (Table 1). The estimated percent position was converted into scores using Garrett's Table (Dhanavandan, 2016). The score is then calculated

Table 1. Garrett ranking conversion Table: The conversion of orders of merits into units of amount of "scores" adopted from Dhanavandan (2016): pp.137.

Percent	Score	Percent	Score	Percent	Score	Percent	Score
0.09	99	11.03	74	52.02	49	90.83	24
0.2	98	12.04	73	54.03	48	91.67	23
0.32	97	13.11	72	56.03	47	92.45	22
0.45	96	14.25	71	58.03	46	93.19	21
0.61	95	15.44	70	59.99	45	93.86	20
0.78	94	16.69	69	61.94	44	94.49	19
0.97	93	18.01	68	63.85	43	95.08	18
1.18	92	19.39	67	65.75	42	95.62	17
1.42	91	20.93	66	67.48	41	96.11	16
1.68	90	22.32	65	69.39	40	96.57	15
1.96	89	23.88	64	71.14	39	96.99	14
2.28	88	25.48	63	72.85	38	97.37	13
2.69	87	27.15	62	74.52	37	97.72	12
3.01	86	28.86	61	76.12	36	98.04	11
3.43	85	30.61	60	77.68	35	98.32	10
3.89	84	32.42	59	79.17	34	98.58	9
4.38	83	34.25	58	80.61	33	98.82	8
4.92	82	36.15	57	81.99	32	99.03	7
5.51	81	38.06	56	83.31	31	99.22	6
6.14	80	40.01	55	84.56	30	99.39	5
6.81	79	41.97	54	85.75	29	99.55	4
7.55	78	43.97	53	86.89	28	99.68	3
8.33	77	45.97	52	87.96	27	99.8	2
9.17	76	47.98	51	88.97	26	99.91	1
10.06	75	50	50	89.94	25	100	0

by multiplying the number of respondents in that particular rank by the Garrett value.

Step 5: Calculate the total value for each constraint by summing the scores obtained in the fourth step above.

Step 6: Divide the total value by the total number of sampled households to get the averages.

Step 7: Calculate the ranks of each constraint. Ordering the average value in descending order yields the ranks of each constraint. This means that higher valued averages rank first, implying that it is the most saviour problem. Therefore, as the average value of the constraint decreases, so does the severity.

2.4. Ethics approval and consent to participate

Ethical clearance letters written with a reference number (RDAE/037/015) were collected from the Rural Development and Agricultural Extension Department, College of Agriculture and Environmental Sciences, Bahir Dar University, Ethiopia, to safeguard both the study participants and the researchers. All participants of the research, including survey households and key informants, were fully informed about the objectives of the study. They all were approached in a friendly and fraternal way. Their oral informed consent was obtained before their involvement in the study. The researchers developed confidentiality with all participants of the study through oral discussion. The questionnaire was designed to collect information that directly relates to the research objectives. As a result, the privacy of the participants was ensured, and no personal data were collected. The questionnaire was free from any degrading, discriminating, or any other unacceptable words that could offend the participants. Any phrases or paragraphs, concepts or quotations not belonging to the researchers and used in any part of the study were fully acknowledged.

3. Results

3.1. Descriptive and inferential statistics on sample household characteristics

The descriptive and inferential results of household demographic and socioeconomic characteristics are discussed in this section. The discussion is based on the households' experience in using improved chickpea varieties. According to smallholder farmers, Arerti, Shasho and Natoli are the most adaptable improved chickpea varieties in the study area. As shown in Figure 2, 55.7% of the total respondents ($n = 140$) used improved chickpea varieties during the 2016–17 production season, while the remaining 44.3% were nonusers.

Figure 3 depicts the main reasons for not using improved chickpea varieties. Smallholder farmers explained that they do not use improved varieties of chickpea seed due to a variety of constraints. The main reason given by 95.2% of smallholder farmers who did not use improved varieties ($n = 62$) was lack of improved seed. However, they didn't deny that the higher cost of improved seed was also the other reason for most (83.9%) of the respondents. Not only shortage of improved chickpea varieties, but also their absence in their immediate vicinity was described as a barrier to using improved varieties by approximately 79% of the smallholder farmers. Furthermore, delays in the supply of improved seeds, the susceptibility of improved varieties to disease and pest, and farmers' lack of awareness of the existence of improved varieties are the reasons given by about 75.8%, 66.1% and 46.8% of respondents, respectively.

One of the demographic characteristics households is age, with minimum and maximum values of 25 and 79 years old, respectively. Nonusers and users had mean ages of 47.8 and 47.2 years, respectively (Table 2). Out of the total respondents ($n = 140$), 55.7% had some level of education, with the remaining 44.3% illiterate and lacking formal education (Table 3). The grade level for educated respondents ranges from 0 to12, with a mean value of 1.7 for nonusers and 1.8 for users of improved chickpea variety (Table 2). Respondents have a minimum of one and maximum 11 family members. The average household size for users and nonusers of improved chickpea varieties is approximately 5.3 and 5.2, respectively. As shown in Table 2, age, educational level and family size are statistically insignificant, indicating that there is no significant difference in their mean value between users and nonusers of improved chickpea seed.

Because chickpea is adaptable to black soil, the size of suitable land for chickpea determines whether improved chickpea varieties are used. The size of suitable land for chickpea in the study area ranges from 0 to 2–3 ha, with a mean of 0.7 ha for nonusers and 0.9 ha for users (Table 2). The t test revealed that the mean suitable land for nonusers was significantly lower than the mean for users ($t = -2.9$, $p = 0.004$). The frequency of contact with development agents (DA) also influences the decision to use improved chickpea seed. The finding revealed that the means of DA contact for users and nonusers were 0.7 and 2.2 (range 0–12), respectively. According to the statistical test, the mean of DA contact for nonusers is significantly lower than the mean of users ($t = -3.6$, $p = 0.001$). Another factor influencing the use of improved chickpea seed is the walking distance between the market and their home. Accordingly, the mean value of market distance for nonusers and users is 45.2 and 37.6 min (ranging from 5 to 180), respectively. This variable is also significant and has a positive sign, implying that the nonusers' mean distance is significantly greater than users' mean ($t = 2.5$, $p < 0.1$).

The chi-square test results, as shown in Table 3, confirm the existence of a significant relationship between the status of using improved chickpea seed and some of the categorical variables (access to training,

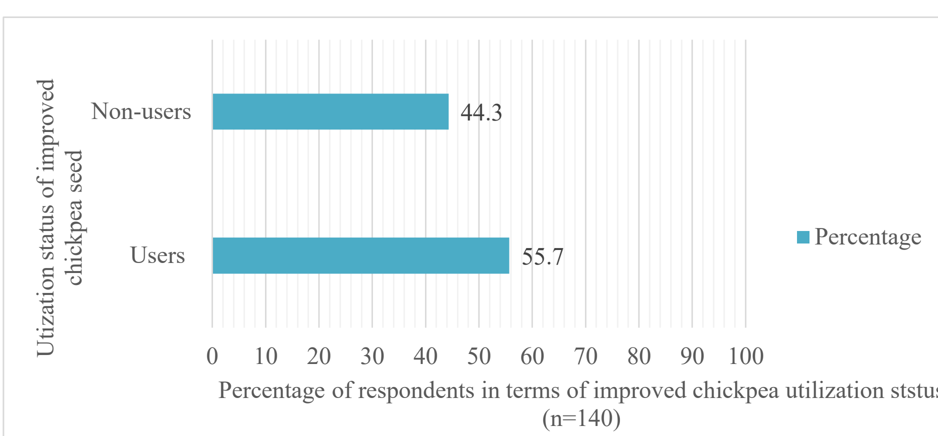

Figure 2. Composition of respondents by status of using improved chickpea seeds ($n = 140$).

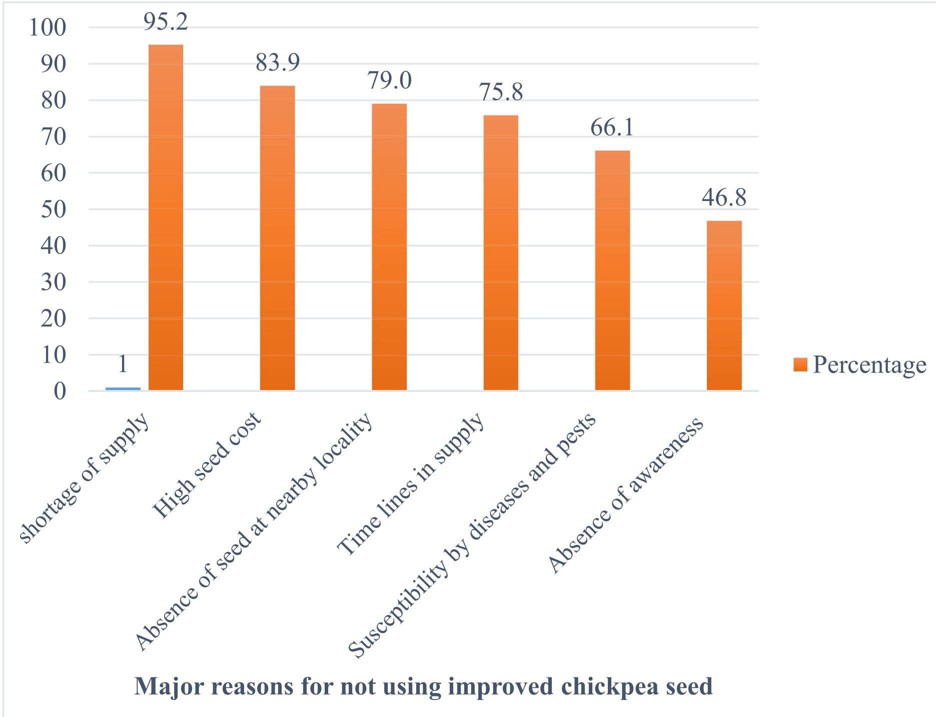

Figure 3. Major reasons of sample households (n = 62) for not using improved chickpea seeds.

access to improved seed, participation in field visits, and membership in seed multiplication cooperatives). In terms of gender, 10% (n = 14) of randomly selected respondents were female. Among 55.7% (n = 78) of improved chickpea seed users, 49.3% (n = 69) were males, and the remaining were females (Table 3). The χ^2 test result shows that there is no significant relationship between the respondents' gender and their use of improved chickpea seed.

In the study area, 34.3% of all respondents had access to improved seeds, with 33.6% using improved chickpea seed. As depicted in Table 3, the chi-square test results show a significant relationship between access to improved seeds and the use of improved chickpea seed ($\chi^2 = 52.7$, $p = 0.001$). Another factor influencing farmers' decisions to use improved chickpea seed is extension service. Short-term training, awareness creation through day-to-day contact, and field days are all forms of extension service in the study area. As presented in Table 3, 30% of respondents received training, while the remaining 70% received no training during 2016/2017 production season. Households that used improved chickpea seed without receiving any training made up 32.9% of the total respondents. The chi-square test reveals a significant relationship between the training and the use of improved chickpea seed ($\chi^2 = 10.2$, $p = 0.001$).

Household participation in field days is also low, accounting for only 20% of total respondents (Table 3). However, the chi-square test is still significant, implying that the decision to use improved chickpea seeds significantly related to field day participation ($\chi^2 = 9.9$, $p = 0.002$). According to the findings, only 17.9% of respondents are members of seed multiplication cooperative. The chi-square statistic indicates that household use of improved chickpea seed is significantly related to membership in seed multiplication cooperatives ($\chi^2 = 24.2$, $p = 0.001$).

3.2. Constraints of smallholder farmers in chickpea production and distribution system

Several constraints face smallholder chickpea producers in the study area. Based on reviews of the literature and preliminary survey tests, 27 constraints were identified for this study. The constraints were divided into five categories to make the analysis more simple and understandable: input, marketing, economical, natural and environmental, and institution-related constraints. Following is a discussion of constraints in each category.

3.2.1. Input-related constraints

Input-related constraints are one of the constraint categories identified in this study. This category includes the absence as well as shortage of improved chickpea varieties, both poor quality and delay in supply of improved chickpea seeds, shortage of chemicals and poor supply of fertilizers.

Table 2. Descriptive and inferential results of continuous variables on demographic and socioeconomic characteristics of households (n = 140) surveyed in Gondar Zuria Woreda during the 2016-17 growing season.

Variables	Minimum	Maximum	Mean values		T- tests	
			Mean of user	Mean of nonusers	t value	Sig. value
Age	25	79	47.2	47.8	0.3	0.791
Education	0	12	1.8	1.7	-0.1	0.976
Family size	1	11	5.3	5.2	0.1	0.938
Suitable land (hectare)	0	2.3	0.9	0.7	-2.9	0.004***
Frequency of DA contact/year	0	12	2.2	0.7	-3.6	0.001***
Market distance (Minutes)	1	180	37.6	45.2	2.5	0.013**

Note: ***, **significant at the 1% and 5% levels of significance, respectively.

Table 3. Descriptive and inferential results for categorical variables on demographic and socioeconomic characteristics of households (n = 140) surveyed in Gondar Zuria Woreda during the 2016-17 growing season.

Variables	Responses	Status of using improved chickpea seed		χ^2-value	Sig.
		Nonuser	User		
Sex	Female	5 (3.6)	9 (6.4)	0.5	0.496
	Male	57 (40.7)	69 (49.3)		
Educational status	Illiterate	42 (30)	20 (14.3)	0.4	.595
	Literate	49 (35)	29 (20.7)		
Access to improved seed	No	61 (43.6)	31 (22.1)	52.7	0.001***
	Yes	1 (0.7)	47 (33.6)		
Training on improved seeds	No	52 (37.1)	46 (32.9)	10.2	0.001***
	Yes	10 (7.1)	32 (22.9)		
Participation in field visit	No	57 (40.7)	55 (39.3)	9.9	0.002***
	Yes	5 (3.6)	23 (16.4)		
Access to market information	No	20 (14.3)	22 (15.7)	0.3	0.603
	Yes	42 (30)	56 (40)		
Membership to seed multiplication cooperative	No	62 (44.3)	53 (37.9)	24.2	0.001***
	Yes	0 (0)	25 (17.8)		

Note: ***: significant at the 1% level of significance.
The numbers in parentheses indicate the percentage value from the total respondents.

As shown in Table 4, the farmers' major input constraint was a delay in the supply of improved chickpea varieties. The first constraint had an average score of 64. This constraint exists because suppliers do not provide improved variety seeds on time, particularly during sowing when demand is high. The results show that the shortage of improved chickpea seeds ranked second among input constraints, with an average score of 58 (Table 4).

Another significant constraint is the shortage of chemicals, which received an average score of 57. Endosulfan (35%) is used by farmers in the study area to control chickpea disease, such as ascochyta blight and fusarium wilt. Poor fertilizer supply, absence of improved chickpea varieties, and poor quality of improved seeds are ranked fourth, fifth and sixth, respectively (Table 4).

3.2.2. Marketing-related constraints

Marketing-related constraints identified include higher price for improved chickpea seed, transportation shortage, absence of demand for improved chickpea seed, lower prices for chickpea, lower production capacity of chickpea seed producers, higher prices for chemicals, and lack of timely market information.

The higher cost of improved chickpea seeds is ranked first by sample households, with a mean value of 65.3 (Table 5). Respondents in the study area reported that the price of seed at the time of sowing is rising, despite a capital shortage during that season. Aside from the cost of improved seeds, the higher cost of chemicals is ranks second, with an average value of 64.3 (Table 5). Chemical scarcity, as described in Table 4, could contribute to the cost increase.

Access to timely and reliable information on the market price of chickpea seed and products is expected to be a crucial factor in farmers gaining a competitive advantage. Farmers in the study area face difficulties accessing reliable market information. Even if they obtain information from their neighbors, they must contend with market price fluctuations that occur overnight. Such circumstances compelled farmers to distrust market buyers. Chickpea production capacity and lower price are ranked fourth and fifth, respectively. The production capacity in this study refers to the volume of chickpea product harvested by the smallholders. Respondents stated that they produce and supply a moderate quantity of chickpea products for the local market or cooperatives. According to the explanation of respondents during the interview, the market price of chickpea is attractive, although we incur higher input costs. The absence of demand for improved seed, access to transportation and market distance are ranked sixth, seventh and eighth among marketing constraints.

3.2.3. Economic constraints

Economic constraints, such as a shortages of suitable land, labor, draft power, and capital, are the third category of constraints discussed. Table 6 shows that the shortage of financial capital is ranks first among the economic constraints. When households lack capital, they may be unable to purchase necessary agricultural inputs, particularly fertilizers and improved seed varieties. In addition, a shortage of suitable land for growing chickpea is ranked second among economic constraints. Moreover, shortages of draft power and labor are ranked third and fourth in this constraint category.

3.2.4. Environmental and natural constraints

Table 7 shows that chickpea diseases rank first in the category of natural and environmental constraints. Chickpea is frequently infested

Table 4. Calculated Garrett values for input-related constraints among sample households (n = 140) surveyed in Gondar Zuria Woreda during the 2016-17 growing season.

Factors	Score of Ranks						Total Value	Average	Rank
	1	2	3	4	5	6			
Delay in supply	4312	2583	1350	552	148	46	8991	64	1
Shortage of improved chickpea seed	2618	2142	1782	1058	444	92	8136	58	2
Shortage of chemicals	2695	1953	1404	782	629	322	7785	57	3
Poor supply of fertilizers	1925	1323	864	1150	666	805	6733	48	4
Absence of improved chickpea varieties	1309	1134	1674	690	1295	552	6654	47.5	5
Poor quality of improved seed	693	693	1134	1610	1073	805	6008	43	6

Table 5. Calculated Garrett values for marketing-related constraints among sample households (n = 140) surveyed in Gondar Zuria Woreda during the 2016–17 growing season.

sMarketing constraints	Scores of Ranks								Total Value	Average	Rank
	1	2	3	4	5	6	7	8			
Higher cost of seed	4320	1809	1140	1007	517	200	128	20	9141	65.3	1
High cost of chemicals	2880	2881	1920	636	282	360	0	40	8999	64.3	2
Timeliness for market information	3280	1005	1320	742	1363	240	352	40	8342	59.6	3
Production capacity	1360	2144	1500	1272	564	480	384	120	7824	55.9	4
Low price of chickpea	1600	1876	900	1325	752	520	576	100	7649	54.6	5
Absence of seed demand	560	536	1020	1060	1034	960	288	660	6118	43.7	6
Shortage of transportation	320	402	840	689	611	1400	1184	360	5806	41.5	7
Market distance	0	268	480	477	329	1280	1056	940	4830	34.5	8

Table 6. Calculated Garrett values for economic-related constraints among sample households (n = 140) surveyed in Gondar Zuria Woreda during the 2016-17 growing season.

Economic Constraints	Scores of the Ranks				Total value	Average	Rank
	1	2	3	4			
Shortage of capital	4380	2632	1012	440	8464	60.5	1
Shortage of suitable land	3285	1512	1672	1320	7789	55.6	2
Shortage of draft power	2628	2184	1540	1320	7672	54.8	3
Shortage of labor	1022	1232	1716	2860	6830	48.8	4

with diseases such as Ascochyta blight, Fusarium wilt and Dry root rot. The disease ascochyta blight, also known locally called 'ADRKIT/MICH,' is the most serious chickpea pod-bearing disease. In addition, insect pests are the second environmental and natural constraint in the study area. Cutworms are the most common pests affecting chickpea production for most farmers in the study area.

Table 7 also reveals that unseasonal rain ranks third in this category. According to the discussion of key informants, unseasonal rain is the cause of diseases such as Fusarium wilt. However, respondents reported that this is not a common occurrence that hinders chickpea production in their area. Moreover, respondents ranked drought and low productivity of land as the fourth and fifth constraints, respectively.

3.2.5. Institutional constraints

Table 8 shows that the inability to supply improved chickpea varieties ranks first among institutional constrain, with an average score of 59.6. According to the Henry Garrett Ranking, as shown in Table 8, inaccessibility to in-kind credit is also ranked second.

In line with this, only 98 farmers in the study area received chickpea seed as an in-kind form of credit during 2016/2017 production season. This particular study included 25 of these households. The third and fourth institutional constraints are lack of technical training and awareness on improved chickpea varieties.

4. Discussion

4.1. Discussion of descriptive and inferential statistical results

This discussion is based on the results shown in Figures 2 and 3 and Tables 2 and 3. According to the findings of this study, 44.3% of respondents do not use improved varieties of chickpea seed (Figure 2). Sampled respondents were mentioned different reasons why they didn't use improved varieties (Figure 3). Almost all respondents (95.2%) justified that shortage of improved varieties of chickpea seed as a reason not to use. In the study area, improved varieties of chickpea seed are not supplied as the amount required by smallholder farmers. As explained by the key informants and sample households, the improved varieties available in the study area are distributed in the form of demonstrations by research centers. In addition, small-scale farmer-based contractual seed multiplication with Tsehay multipurpose farmers' cooperative union is another source of improved chickpea seed in the study area.

In addition to short supply, higher seed cost and absence of improved varieties near their locality are other challenges of using improved varieties, as described by 83.9% and 79% of respondents, respectively. Smallholder farmers incur higher seed costs to purchase at the market as

Table 8. Calculated Garrett values for institutional constraints among sample households (n = 140) surveyed in Gondar Zuria Woreda during the 2016-17 growing season.

Institutional Constraints	Scores of the Rank				Total	Average	Rank
	1	2	3	4			
Shortage of supplying improved chickpea variety	4964	2128	880	378	8350	59.6	1
Inaccessibility to credit	3942	1848	1452	540	7782	55.6	2
Inaccessibility to technical training	2336	1848	2024	783	6991	49.9	3
Awareness on improved chickpea varieties	1314	1288	1848	1539	5989	42.8	4

Table 7. Calculated Garrett values for environmental and natural constraints among sample households (n = 140) surveyed in Gondar Zuria Woreda during the 2016–17 growing season.

Environmental and natural Constraints	Scores of the Rank					Total	Average	Rank
	1	2	3	4	5			
Diseases	3525	1380	1650	960	375	7890	56.4	1
Insect pests	2775	2580	1300	1000	225	7880	56.3	2
Unseasonal rain	3150	2280	1200	760	425	7815	55.8	3
Drought	2325	1260	1150	1520	675	6930	49.5	4
Lower productivity of land	1425	1680	900	920	1300	6225	44.5	5

there is no access to get improved varieties of chickpea through the formal seed system. According to the expression of respondents during the interview, some farmers who obtained improved varieties from research centers for demonstration purpose and farmer-based seed multiplication. Those farmers sell their products, which is improved varieties, in expensive price in the market. It means the smallholder farmers will be forced to pay higher costs to purchase those varieties from farmers at the local market. In case if what they want is not available at their local market, they will be forced again to go far away to look for it. Most farmers buy improved varieties of chickpea from West Belesa Woreda, which is adjacent to the study area and approximately 70 km away from Gondar Zuria woreda. Based on their views and perception, varieties that are unique to their local landraces are considered to have improved and better quality regardless of the stage of seed classes. The respondents also witnessed that those improved varieties purchased at the market were found to be more productive and better priced compared to local landraces. Studies suggested that ensuring adequate availability of quality seed to farmers at the local level and at affordable prices can improve the adoption rate of improved varieties (Gaur et al., 2010). The results of this study confirmed is the existence of a significant relationship between access to seed and the use of improved chickpea seed varieties (Table 3). The utilization of high-quality varieties that are adapted to different agro-ecological zones is crucially important to increase yield as well as to improve the quality of grain available to the market (Bhatia and Raghavan, 2016).

The inability to access improved varieties on time is a constraint for 75.8% of respondents. As farmers respond, the agricultural cooperative does not supply nor is it available at the market during the sowing season. As a result, farmers are handicapped by the shortage of seeds at the critical time of sowing. The findings revealed that the susceptibility of improved chickpea varieties to diseases and pests is also a limiting factor in the use of improved chickpea seed varieties. According to key informants, the Arerti variety is particularly susceptible to Ascochyta blight and cutworm, which makes farmers hesitant to use it. Another reason for not using improved varieties, as shown in Figure 3, is a lack of awareness of their existence. Consistent with this finding, Asfaw et al. (2011) reported that knowledge of existing varieties influenced the adoption of improved varieties.

The results of this study show that the utilization status of improved chickpea seed is statistically related to suitable land holding size, frequency of DA contact, market distance, training on improved seeds, participation in field days, and membership in seed producer cooperatives. The availability of sufficient and suitable land is expected to encourage farmers to use improved seed. The results of this study confirmed that as the size of the suitable land for chickpea production increases, so does the likelihood of using improved seed. Agricultural extension activities such as frequency of DA contact, participation in field days and training on improved varieties are important parameters that influence the decision of farmers to use improved seed. The finding of Anyango (2016) supports the results of the present study that training before farming significantly influenced the farmer's decision to use improved chickpea seeds. The study conducted in Kenya by Anyango (2016) revealed that the use of improved chickpea varieties could be increased by increasing field days. Membership in seed multiplication cooperatives is thought to provide access to improved seed varieties. As presented in Table 3, there is a significant association between membership in seed producer cooperatives and the use of improved seed. The Tana seed multiplication farmers' cooperative is the only seed multiplication cooperative in the study area. Private and public seed sectors have limited roles in multiplying the seeds of chickpea (Gaur et al., 2010; Shiyani et al., 2002). The limited role of the private and public sectors hampered smallholder farmers' access to seed.

4.2. Constraints of smallholder farmers in chickpea production and distribution system

Smallholder farmers in Gondar Zuria Woreda faced various constraints. Input, economic, marketing, environmental and institutional constraints study identified and prioritized in this study. The leading input-related constraint, as shown in Table 4, is a delay in the supply of improved chickpea seed. In the study area, there is no formal chickpea seed delivery system. Instead, improved chickpea seed varieties are distributed by the Tsehay Union and Gondar Agricultural Research Center (GARC) through farmer-based seed production. Findings reveal that farmers' seed producer associations cover the lion's share of the seed supply and became an innovative approach that enhanced the chickpea seed system (Chichaybelu et al., 2018). The evidence shows that the seed producer cooperatives and local seed businesses have mechanisms to ensure the quality parameter of seeds through the seed quality control committee (EIAR, 2020). The committee ensures standard isolation distance, clusters the land, roughens off-types in a timely manner, and overall field management and postharvest handling as per recommended procedures.

Most of the time, those working to deliver improved seeds inform farmers after they have decided to sow local varieties of chickpea or other commodities. One of the sample households responded that "I was planning to sow improved varieties of chickpea by taking from cooperatives. However, they told me that the seed had run out after providing for a few farmers. After that, I was forced to purchase local variety at the market. Unfortunately, the seed I sowed was destroyed due to quality issues.".

Other farmers also claim that "due to late decision, I sowed local variety of chickpea that matured lately and reduced productivity due to lack of moisture." Scientific evidence shows that chickpea is sensitive to high as well as low temperatures at the reproductive stage (Gaur et al., 2010). Both extremes of temperature led to flower drop and reduced pod set. These scenarios occurred due to imperfections in the seed supply system. Studies revealed that imperfections in local seed markets and lack of availability of improved varieties in the desired quality and time are the key constraints in accessing and utilizing improved seeds of chickpea (Asfaw et al., 2011a). Similar results were also reported by Rao et al. (2013), who found that the lack of timely delivery of improved chickpea seeds together with other constraints significantly affects smallholder farmers in utilizing improved chickpea varieties.

The shortage of improved chickpea seed was ranked second among input-related constraints, with an average score of 58 (Table 4). Smallholder farmers in the study area explained that they were unable to improve the quality of the declared varieties of chickpea seed. According to the findings of this study, the majority of respondents (95.2%) did not use improved seeds due to a lack of supply (Figure 3). In the study area, there was also a significant association between seed access and the use of improved seed. Different authors, including (Eshete et al., 2013; Fikre et al., 2020), argued that limited access to improved varieties determines the adoption rate, which in turn affects the crop yield. When farmers lack access to improved varieties via formal seed systems, they opt to buy at the local market. Particularly, they have been using Kabuli-type Arerti variety of chickpea as improved when they got it from the market. Because of its higher productivity and market demand, this variety is preferred over other available varieties in the study area. A study on yield gaps, adoption and seed commercial behavior: implications for the chickpea seed system in Ethiopia by Alemu and Bishaw (2019) showed that 22% of smallholders used purchased chickpea seed. Likewise, Rao et al. (2013) reported that approximately 48.9% of sampled households used the purchased kabuli-type chickpea, mostly sold in the market. The purchased seed can be either certified seed of improved varieties or noncertified seed of landraces or improved varieties. Chickpea, particularly kabuli-type varieties, has high market value (Fikre et al., 2020). Moreover, the study conducted on cost of production and profit measures for chickpea in India by Sengar et al. (2018) indicated that the prices have increased considerably and the consumer is hard hit to buy his pulse requirements. This suggests that when varieties are preferred at the market, the tendency of farmers to use these varieties would increase.

The other input-related constraint is a shortage of chemicals, which is ranks third with an average score of 57 (Table 4). According to key informant responses, the Tsehay Union is the only chemical supplier for farmers in the study area. The Tsehay Union also brings this chemical from the Adami Tulu Chemical Factory. According to the report of the Tsehay Union, this factory is the only supplier of chemicals and cannot supply the quantity demanded. Moreover, smallholder farmers also faced a shortage of fertilizers, which is ranked fourth, with an average score of 48, as presented in Table 4. In some cases, with relation to fertilizer supply, farmers face a shortage of urea during the sowing season of chickpea. Such issues happen due to patterns of distribution. Hence, chickpea is sown after Teff, maize, and other major crops; mostly the fertilizer was distributed at the sowing time of Teff and maize, leaving little for chickpea crop. Evidence from a study conducted in Sub-Saharan Africa (SSA) tapping into the economic potential of chickpea by (Fikre et al., 2020) confirmed that poor access to inputs is one of the socio-economic factors in chickpea production and distribution systems.

To capitalize on the advantages of Garrett's ranking technique over frequency, we compared the score values for a shortage of improved chickpea seed (2618) and a shortage of chemicals (2695) (Table 4). If only first scores are considered, the second constraint would be a shortage of chemicals. However, the results are reversed when each constraint is ranked and averages are computed. This simple illustration shows the advantage of Garrett's ranking technique over frequency. The results of this study are in agreement with the findings of Zalkuwi et al. (2015), who argued the advantage of Garrett's ranking technique over frequency.

This study identified higher input costs, such as seed and fertilizers, and the dominant constraints in chickpea production and distribution systems (Table 5). Various authors reported that the higher price of improved technologies is the major constraint for adoption and came up with similar findings in this study (Mitschke, 2015; Peer et al., 2014). In addition, Asfaw et al. (2011) reported that market imperfection in local seeds is a major constraint for the adoption of improved bean seeds. In the case of chemicals, respondents explained that they are forced to buy them from private traders with a two-to threefold higher prices that co-operatives due to short supply by cooperatives.

The major economic constraints are reported in this study. Accordingly, smallholder farmers severely faced severe capital and suitable land shortages for chickpea production. Earlier findings by different authors are in agreement with the results of this study, which reported a lack of resources to carry out the necessary activities associated with the utilization of improved technologies (Silva and Broekel, 2017). The access and availability of resources determine rural households' decision to utilize improved agricultural technologies. Regarding suitable land holdings, chickpea requires fertile soil with a good drainage system. The researchers suggested that chickpeas grow on heavy black or red soils and require a soil pH of 6.0–7.0 (Eshete and Fikre, 2014). As a result, the shortage and size of land allocated have been found to be major constraints for the adoption of improved and new agricultural technologies (Kasshun, 2014; Tura et al., 2010).

Chickpea is prone to damage by many diseases and insect pests (Eshete and Fikre, 2014). The results of this study show that diseases and pests are the main environmental related constraints (Table 7). Chickpea is affected by diseases such as Fusarium wilts (*Fusarium oxysporum* f. sp. *ciceri*), Dry root rot (*Rhizoctonia bataticola*), and Ascochyta blight (*Ascochyta rabiei*), as well as pests pod borer (*Helicoverpa armigera*) and cut worm (*Agrotis segetum*) (Eshete and Fikre, 2014; Fikre et al., 2020; Gaur et al., 2010). Consistently, other authors reported that chickpea production is constrained by diseases such as ascochyta blight, fusarium wilt, and dry root rot (Keneni et al., 2016; Ojiewo, 2016). According to the discussion with respondents during the interview, they controlled these diseases and pests using chemicals and weeding the field properly. However, the increased cost of chemicals due to a lack of supply made it difficult for them to control chickpea diseases and pests if manifested in their fields. They explain that if the symptom of disease (drying of chickpea sparsely) is observed, they are obliged to buy chemicals at any cost from traders. In the case of improved chickpea seed, responsible regulatory bodies are going to check that any class of seeds must be 100% free from Acochyta infection (ES, 2016). In Ethiopia, at the federal level, the responsibility related to seed regulatory or quality assurance systems is given to Plant Variety Release, Protection, and Seed Quality Control Directorate under the Ministry of Agriculture (EIAR, 2020).

Unseasonal rainfall is another environmental-related constraint in the study area. Key informants and respondents described that unseasonal rainfall patterns rarely occur in the area and slightly affect chickpea productivity. Unseasonal rainfall patterns mostly contribute to pests and diseases, which impedes farmers from utilizing improved seeds (Mitschke, 2015). Similarly, a lack of a persistent rainfall pattern is reported as one of the constraints for the adoption of new eco-farm technologies (Kasshun, 2014). Chickpea is a cool season legume crop mostly grown on residual soil moisture. High temperature and terminal drought are common in different regions of chickpea production with varying intensities and frequencies (Devasirvatham and Tan, 2018). Our finding depicted that a shortage of supplying improved chickpea seed is the leading constraint among institutional categories (Table 8). In the study area, there is no formal seed system to supply quality-declared improved varieties of chickpea based on the demand of the farming community. As explained by key informants, the only suppliers of improved varieties are Gondar Agricultural Research Center (GARC) and Tsehay multipurpose farmers' cooperative Union. These organizations only supply a small amount of seed to selected farmers either in the form of demonstrations or seed multiplication contractually with smallholder farmers. The evidence confirmed that limited availability of seed is the major cause of low chickpea productivity (Atnaf et al., 2015).

In the study area, both cash and in-kind credit are provided to smallholder farmers. In the case of cash credit, most farmers have access to it. However, due to a shortage of improved chickpea seed varieties, in-kind credit is limited to small groups of farmers who grow chickpea on a selected cluster of land. Inaccessibility of technical training and awareness of improved chickpea varieties are the other constraints identified by this study. There is a positive perceived impact of most advice on both crop yields and income (Hamilton and Hudson, 2017). One of the major causes of low crop yields is the limited awareness of seeds of new crop varieties (Eshete et al., 2013). Fikre et al. (2020) argue that awareness creation to increase demand for improved production technologies and linking farmers with the right market through extension services and policy support would enhance adoption, thereby having a positive economic impact.

5. Conclusion and policy implications

The study prioritized smallholders' chickpea production constraints into various categories based on their severity in the study area using Garratt's ranking technique and found it to be an important method of ranking compared when to simple frequency distributions. Accordingly, the most significant constraints affecting smallholder farmers' chickpea production are timelines in the supply of improved chickpea seed, short supply and higher cost of inputs, shortage of productive resources, diseases and insect pests, and inaccessibility to in-kind credit. Therefore, the researchers recommend that the Ministry of Agriculture and the Ethiopian Institute of Agricultural Research work jointly to multiply the required amount of seeds at the most crucial time. In addition, necessary inputs such as improved chickpea seeds and chemicals should be delivered at reasonable cost through farmer cooperatives. The farmers' cooperatives are available and accessible to all farmers due to the existing structure. If these inputs are delivered like fertilizer, the sever constraint of inputs would be reduced.

6. Limitations of the study

This study is conducted mainly to identify the constraints that smallholder chickpea producers have been facing. To do this, the authors perceived that a total of 27 constraints were grouped into five subcategories. As the number of constraints increases, households become confused to prioritize one from another. This is why such classifications are required to prioritize the identified constraints. Based on this, the constraints were prioritized and ranked from each category. However, the current study does not prioritize the constraints against the total perceived constraints at a time. Future research should focus on identifying and prioritizing constraints at least by taking saviour constraints from each of the current subcategories.

Declarations

Author contribution statement

Asrat Mulat Asegie: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Almaz Giziew, Dereje Ayalew: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

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