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The importance of chickpea, its farming system and determinant factors on technology adoption, North Shewa, Ethiopia.

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Abstract

Chickpea is one of the major pulse crops produced for home consumption and income sources. Its productivity is low due to low attention on chickpea production improvement technologies. This study examined chickpea farming system and its production status in wheat-based farming system areas. The purposes of the study were to evaluate the farming system of chickpea, to identify the determinant factors on chickpea technology adoption, and to assess the importance of chickpea in the study area. Both primary and secondary data were used for the study. The primary data were obtained from a total of 230 randomly selected rural farmers in Ensaro district. Descriptive statistics and complementary log-log methods were used to assess the farming system and the adoption status of the improved varieties. Chick pea is one of the major crops produced and farmers allocated their farm for chickpea production and grow both local and improved varieties. Neighbor farmers, the district office of agriculture and Debre Birhan agricultural research center were the main sources of improved seeds. Chickpea producers obtained more grain yield and farm benefits and better position in household income and expenditure than the non-grower farmers. Farmers who used improved chickpea varieties gained more gross margins from chickpea compared with their counterparts. Farmers near to market, better contact with extension and access to agriculture-related trainings used improved chickpea production technologies. Chickpea contributed for availability of food, income and gross field benefits improvement for the grower farmers. The improved varieties provide more grain yield than the local. Strengthen extension farmers linkage and improve market access contribute for the improvements of chickpea production and rural household income in chickpea growing areas.

Keywords: Adoption, Chickpea, C-LOG-LOG, Farming System and Gross Margin

Introduction

Legumes are the important cheap sources of protein in the diet (Hailu et al., 2014) and produced for different purposes. They contributed for soil fertility improvements and environmentally friendly crops contributed to the successive yield improvement of the consecutive cereals. It required low labor and external inputs compared to cereals (Tadesse, 2012). Grain legumes occupied 13% of cultivated land and their contribution to agricultural value addition is around 10%. The area share of chickpea was estimated to be 14% of pulses share (Joshi and Rao 2016; CSA, 2015; IFPRI, 2010). Chickpea has a share of 15% contribution in the volume of productions from the pulse crops in Ethiopia. It stands next to faba bean and haricot bean in area coverage and volume of production (CSA, 2016). It is the major legume in vertisol areas (Getachew et al., 1995) grown in Ethiopia which makes Ethiopia to stand first from Africa and seventh world chickpea producer countries (Asfaw et al., 1993).

Chickpea are two types globally, *Desi* and *Kabuli*. *Kabuli*s have larger cream-colored seed with thin seed coat and *Desi*s have smaller, reddish brown-colored seed with a thick seed coat (Joshi and Rao 2016). Amhara and Oromia regions cover more than 90% of the entire chickpea area and constitute about 92% of the total chickpea production. North Shewa, found in Amhara region, is one of the top chickpea producing zones which account for 80% of chickpea production for the country. Pulses are the third-largest export crop of Ethiopia, contributing USD 90 M to export earnings in 2007/08 (IFPRI, 2010). Pulses contributed to the economy of Ethiopia (Atnaf et al., 2015). In terms of export, Chickpea is the second next to the haricot bean. Ethiopia exported 48,739 tons of chickpea and received 22.56 M USD (FAOSTAT, 2016). Over 80% of the total chickpea production traded in the domestic market outlets (Shiferaw et al., 2005; 2007).

Despite the importance, contributions and grown by many farmers in the study area; there is no study conducted to evaluate the production system and provide solutions for the problems. The extension system gave low attention for chickpea as compared with wheat and teff. These all contributed for low production and productivity of chickpea in the study areas. Debre Birhan agricultural research center needs to introduce new chickpea production technologies. There is a need of identifying the production system, technological gaps, its importance, and existing production challenges. Research farmers' linkage intervention without identification of the farming system and the existing challenges and production gaps may take long time to bring the expected intervention outcome. Technology introduced in the two intervention kebels (small administrative unit) to assess the farmers' interest, contributions of the technologies on production and productivity improvement and farmers' income and status of food availability compared with the control sites adjacent to the interventions. So, this study was initiated to assess the farming system and to identify the existing production bottlenecks. Moreover, this study was conducted to evaluate the contributions of the technology for production and productivity improvement and to examine the farming system of chickpea for future research and development interventions. The purpose of the study focused more on a detailed understanding of the farming system of chickpea, the importance and contribution of chickpea. Therefore, the study was conducted to assess and evaluate the farming system and production status of chickpea and to identify the factors affecting chickpea technology adoption in the study area.

Methodology

Area description

Ensaro district is found in North Shewa zone of Amhara regional state, 130 km North of Addis Ababa (country capital), and 82km west of Debre Birhan town. It has a total area of 41,028.58 agricultural lands and a population of 72,011 divided into 14 (1 urban and 13 rural) administrative kebeles and characterized as a wheat-chickpea based production system with potential for teff, wheat, chickpea, faba bean, and grass pea.

Sampling procedure

The study district was selected purposively based on the potential for chickpea production and the introduction of new chickpea production technologies. Four chickpea producer kebeles were systematically selected from the district-out of 14 total kebeles. This is because of chickpea production potential and similar agroecology suitable for chickpea production. From those study areas, two kebeles were intervention and the other two control and adjacent kebeles. Finally, a total of 230 representative sample household farmers were selected using simple random sampling technique based on the probability of proportional to sampling from the selected kebeles.

Data types and collection methods

Both qualitative and quantitative data were collected through Focus Group Discussions (FGDs), key informant interview and household survey techniques. The FGDs and key informant interview were organized to collect institutional level data and general level data for characterization of the study areas. Two FGDs were organized composed of farmers with different age, sex and social status like community leaders, economy class with eight farmers per each group. The FGDs focused on the social network systems, market transaction, input-output market, climate related issues, importance of chickpea and existing challenges affecting chickpea production.

The key informant interview was organized at district level comprising of ten group members from office of agriculture, cooperative promotion office, agro dealers and farmers representatives. This team mainly focused on input supply system, output marketing, extension-farmers linkage, the importance and focus of chickpea, and the challenges beyond the local institutes on chickpea production. The major primary data were collected using appropriate data collection instrument (questionnaires) which is mainly structured and some semi -structured. The primary data collected were pertained to the socioeconomic data including land holding, income, crop yield, livestock holding and participation in social networks, initial seed sources, extension contacts, inputs use for chickpea production, participation in extension events, and chickpea production constraints and challenges. The secondary data were collected from published and unpublished documents.

Data analysis

The data were analyzed and evaluated using different descriptive and inferential statistics. Gross margin analysis technique was employed to evaluate the field benefits of chickpea. The adoption process was also evaluated to identify the status of introduced technologies through intervention. The level of adoption and introduction of new technologies is expected to be low level and at the infant stage. The collected data indicated that the level of adoption was not symmetric in the [0, 1] interval as well. There were imbalance observations of technology adopters and non-adopters. In this situation, the complementary log-log (CLOG-LOG) model might give a solution to evaluate the level of adoption of improved chickpea technologies. Hence, instead of logit and probit models, the complementary log-log (CLOG_LOG) method was employed to evaluate and to identify factors affecting the adoption of introduced chickpea technologies. CLOG-LOG method is relevant to evaluate the level of adoption in a better efficient magnitude than logit or probit models in which the level of adoption is not symmetric in (0, 1) interval.

Model specifications

In many research activities, interest directed at the effects of the explanatory variables $X_1. . ., X_k$ and observed dependent variable Y. A commonly employed model in these settings relates the mean response E(Y) and the explanatory variables in a linear fashion:

$E(Y) = \eta = \beta_0 + \beta_1 X_1 + \cdots \beta_k X_k - -(1)$ when the dependent variate is dichotomous.

E(Y) is simply the probability of response p. The associated linear models can be generalized to:

$g\{E(Y)\} = g(p) = \beta_0 + \beta_1 X_1 + \ldots + \beta_k X_k - - - - - - - - - - - - - - - - - (2)$

Or simply g(p) = η, for some function g (‘). Since it links the random and systematic components of the linear model, g is known as the link function (Mesfin, 2017). As the commonly seen link functions in this setting are the logit, g(p)=log{p/(1-p)}, the probit, g(p)= I-1(p); and the complementary log-log, g(p)=log{-log(1-p)} (Cox, 1972). All three share the feature that they map the unit interval onto the real line. The logit link also shares theoretical connections with the natural parameter for the binomial model, 0=log {p/(1-p)} and provides a useful interpretation in certain applications as the log odds of success (CSA, 2016). Its use in logistic regression has become quite popular in recent years (Cox, 1972). The three-link functions may be inappropriate, however, for certain experimental applications. In some of these cases, a useful alternative link is the complementary.

$\log g(p) = -\log(1-p), - - - (3)$ in which it maps the unit interval into the positive real line.

Notice that the inverse function is p = 1 – exp (- η) for η> 0. For η≤ 0, one could define the inverse link as simply p = 0, so that the inverse function is continuous and non-decreasing, ∀η. Thus, the inverse link can be viewed as a form of the distribution function, corresponding to an exponential random variable with unit mean. This connection between inverse links and distribution functions is common in binary regression models (Cox, 1972): The inverse probit clearly corresponds to a standard normal distribution, while the inverse logit corresponds to a standard logistic distribution with density function $e^x / (l+ e^x)^2$ (Haile et al., 2014). The complementary log link has been applied in a wide variety of experimental settings. Under the assumption of binary response, there are two alternatives to logit models such as probit model and complementary-log-log models.

They all follow the same form $\pi(x) = \Phi(\alpha + \beta x) - - - (4)$ for a continuous cdf Φ.

Complementary log-log model says $(\log\{-\log[1-\pi(x)]\} = X_{pxn}^T \beta_{px1} - - - - (5)$

The expression on the left-hand side is called Complementary Log-Log transformation. Like the logit and the probit transformation, the complementary log-log transformation takes a response restricted to the (0, 1) interval and converts it into something in (-∞ +∞) interval. Here, the log of 1-(x)π is always a negative number. This changed to a positive number before taking the log a second time. We can also write the model down like form (1) as

$$\pi(x) = 1 - \exp\left[-\exp\left(X^T pxn X_{pxn}^T\, \beta_{px1}\right)\right] - - - - - - - - - (6)$$

Results

Demographic characteristics of the household

The family size varied in households with an average of 5.2 members. The average age of respondents was 47.6 years with a minimum of 20 and a maximum of 67 years. About 90% of the respondents were male and the balance was 10%.

Engagements in economic activities and land holding capacity of household members

Household heads and their family members participated in off-farm and on-farm business activities. Almost all (99.13%) of them participated in on-farm activities few (14.78%) of them participated in off-farm activities. The average land holding per household, per adult equivalent (AE) and per capita varied in the study areas. The control sites had lower landholding than the intervention sites both in per capita and per household heads. There is significant difference in per household land holding between them. The average per capita landholding is below half a hectare in the study area (Table 1). Farming is the main sources of household income and some farm households support the household income from off-farm activities to support and improve farmers income and expenditures. There is no significant difference among the groups in off-farm activities participations.

Table 1. Off-farm and on-farm activities in days per year and land holding by kebeles days

Kebele status	Frequency	On-farm	T-test	Off-farm	T-test	SD
		Mean		Mean		
Intervention	114	95.50	1.4	4.97	-1.05	8.3
Control	116	94.89		4.96		11.42

	Land owned in a hectare			
	Per household	Per adult equivalent	Per capita	T-test
Intervention	2.29	0.53	0.475	
Control	1.785	0.455	0.395	1.99**
Average	2.04	0.492	0.43	

Source: 2016 production survey data

Major crops grown in the study area

The major five important crops produced in the area include teff, wheat, chickpea, faba bean and grass pea. All farmers did not produce all crops in the same proportion due to individual decisions: some farmers produce chickpea others produce faba bean, grass pea and so on. In the same fashion, some farmers produce wheat and majority of others produce teff. Chickpea accounted for the third major crop grown next to teff and wheat which are the primary and secondary crops respectively. From the sample respondents, 55.5% of them were chickpea producers in different land sizes (Figure 1).

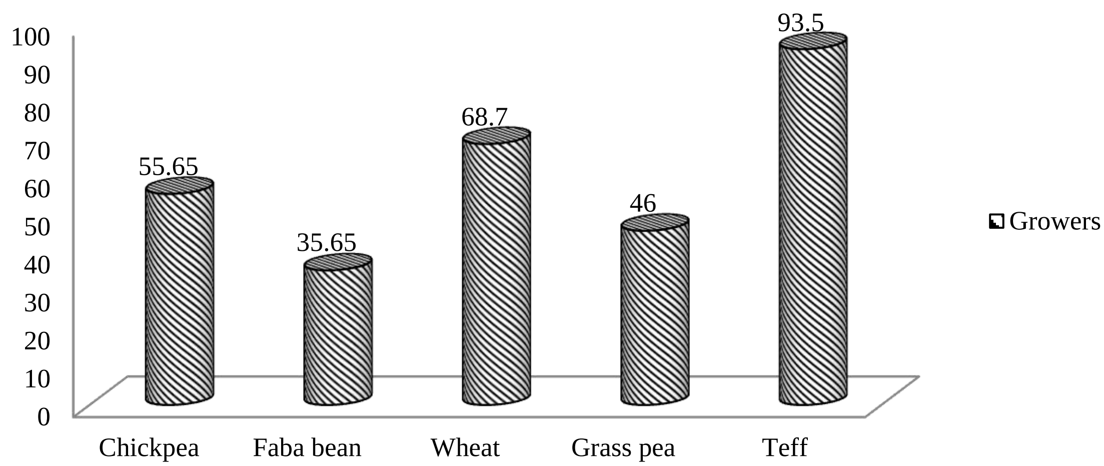

Figure 1. Major crops grown and number of producers in the area (%)

Chickpea producer farmers by kebele status

Majority of chickpea producer farmers were found in the intervention kebeles than their counter parts (Table 2). The farmers who allocated their lands with farm sizes over 0.25ha of their farmland produced significant chickpea amount of chickpea. About 44.35% the respondents were the major producers. More than half of the respondents were not such type of chickpea growers during the study period. Farmers access to information and technologies were motivated to produce crops which best suit to their interests.

Table 2. Chickpea producer farmers by kebele status

Do you produce chickpea	Kebele status					
	Intervention		Control		Total	
	Frequency	%	Frequency	%	Frequency	%
Yes	79	69.3	23	19.8	102	44.35
No	35	30.7	93	80.1	128	55.65
Total	114	100	116	100	230	100

Source: Own data manipulation

Distance from input sources and service delivery organizations

The farmers move long distances to access different agricultural related and other desired services and information from different organizations. The distance from different economic and social organizations placed relatively far to the farmers residence with an average of 80 minutes on foot walking to market located at the district town called Lemi. The input sources of improved `seed, fertilizer and agrochemicals, schools and Farmers Training Centers (FTCs) are also located far and reached after 25 minutes on foot travel to reach (Table 3). All this indicated that farmers spent more working hours to access the required inputs and information. This in turn affected the farm labour time. Farmers get most of agricultural production inputs (improved seed, fertilizer, and chemicals) from the cooperatives. Relatively, the input sources are near their residence.

Table 3. Distance of residences from different input and information sources in walking minutes

Walking distance from Institutions (Minutes)	Mean	Std. Dev.	Min	Max
Market and district town	80	45	0	180
Farmers' cooperative and FTCs	25	23	0	90
Kebele Office of Agriculture	2	0.25	0	25
Health service centre	45	35	0	180
Primary school	20	30	0	90

Source: Own survey data 2016 production season

Social capital and networking

Almost all farmers lived in the area for over twenty years and they built trusts in their locality. They experienced in the making of social gatherings and groups for collaboration and risk minimization as a group and acting on critical intervention. Most farmers participated in different socio-economic institutions voluntarily. The majority (90%) of them are members of the multipurpose cooperative. This is because multipurpose cooperative is the major sources of farm input particularly fertilizer and agro chemicals and other consumable goods. It is also available in all study areas. Other social groups like agricultural marketing cooperatives and saving and credit cooperatives are not available in some locations. Due to this, the participants are less. The social groups contributed to members through access to input-output markets, credit access and trainings for members (Table 4).

Table 4. Social group established and participation in membership

Membership in social groups	Membership			Continuation membership		
	Participation	N	%	Participation	N	%
Agricultural marketing coop	Participant	43	18.7	Yes	43	100
Women association	Participant	41	17.8	Yes	36	87.8
Saving & credit cooperatives	Participant	92	40	Yes	84	91.3
Multipurpose cooperatives	Participant	215	93.5	Yes	214	99.57

Source: Own 2016 survey data

Total livestock holdings and land allocations

The average total livestock holding of households was 3.2 in in Tropical Livestock Unit (TLU) the highest was in Diremu kebele while Salayish had the lowest number of livestock (Figure 2).

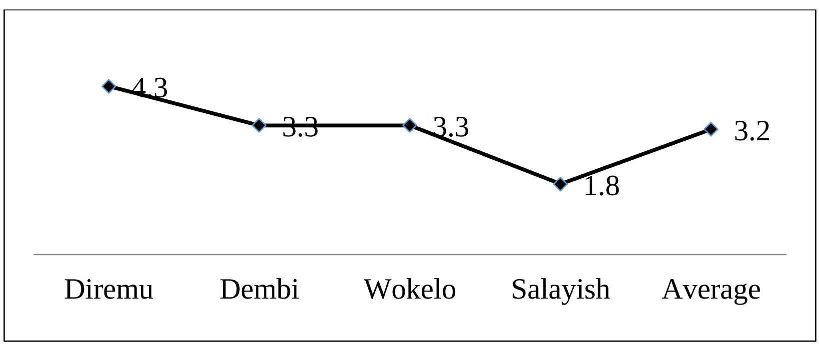

Figure 2. Average livestock holding per kebele in TLU

From the total land owned by the smallholder farmers, over 85% of the farmland was cultivated land in the study area. This made crop production to be the main economic sector in which the smallholder farmers are dependent on it. From the selected farmers during the study chickpea producer farmers who allocated their lands to produce chickpea were high in the intervention sites in which the research center had previous introduced new production technologies. The control areas had a low proportion of area allocation for chickpea production in large fields. This indicated that the research intervention played an important role to convince the farmers in allocating the most important resources to produce important crops (Figure 3).

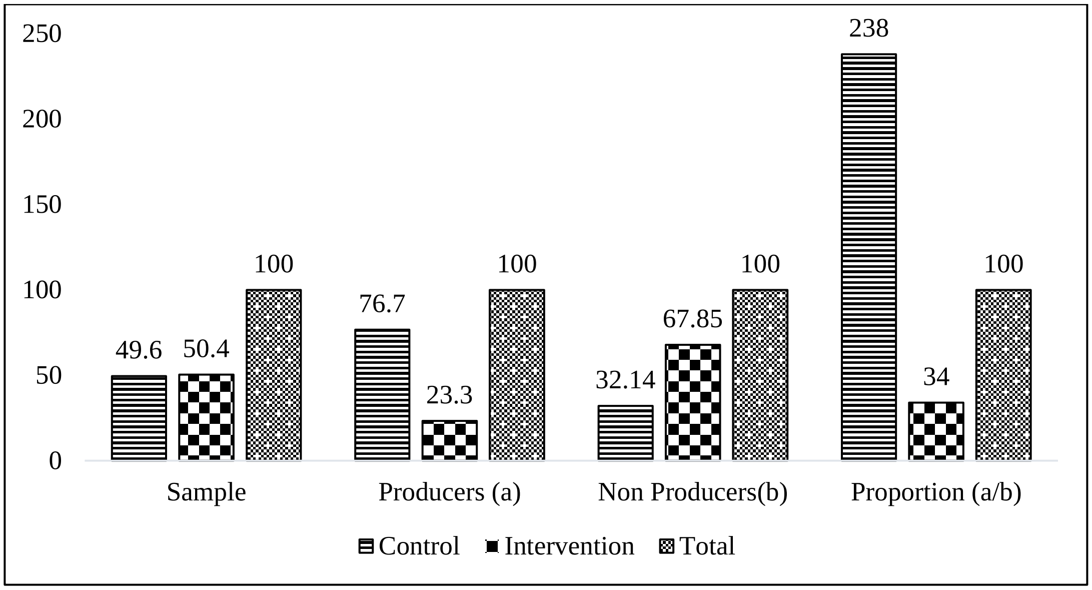

Figure 1. Comparisons of chickpea producer farmers in intervention and control areas

Human and oxen labor days required for crop production per annum

The average human labor days per person per household required for crop production was estimated below 200 persons/days per annum. Irrespective of sex differences, the highest human labor days found in the intervention kebeles and the lowest in control kebeles. Females contributed fewer labor days per annum compared to their counterparts (Figure 4). This indicated almost half of the working days per annum were lost for non-economic activities like social gatherings, political issues and other non- essential involvements.

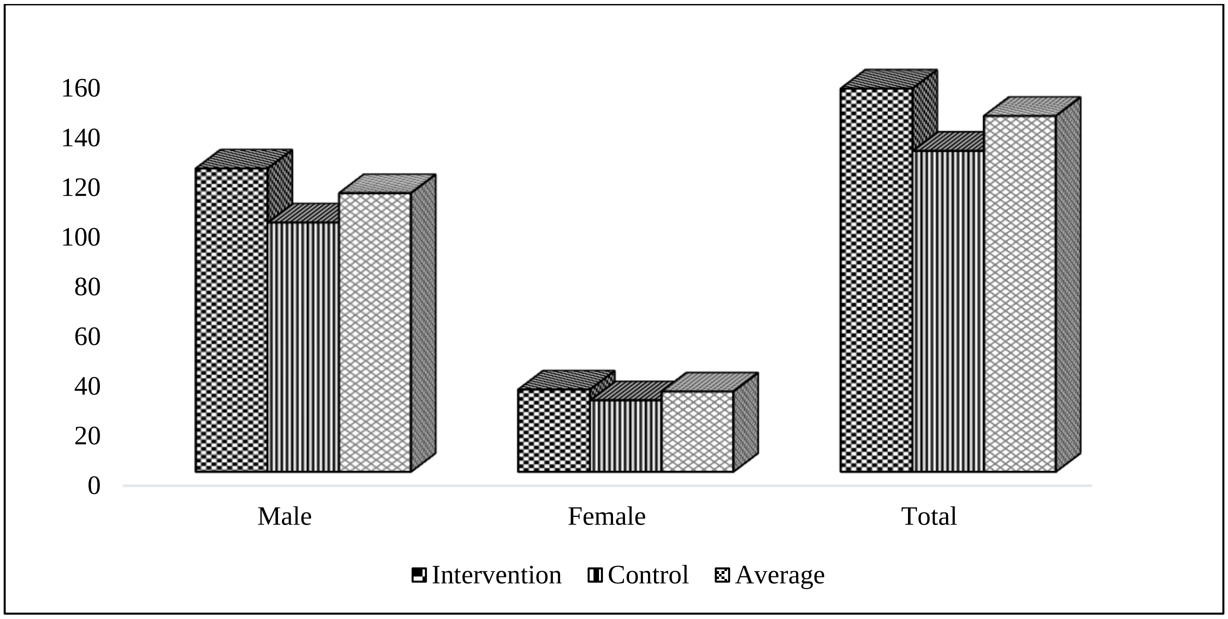

Figure 4. Crop labor days required for cop production per annum per kebele

The average oxen days required for plowing and threshing for crop production activities were estimated below 30 days per annum. More oxen days found in the intervention kebele than others. This also depended on the size of farmlands owned by rural households (Table 5).

Table 5**.** Average oxen days required for crop production by kebele status

Kebele status	Mean	Std. Dev.	Min	Max
Intervention	29.87	14.72	6	78
Control	22.77	13.78	3	105
Average	26.24	14.65	3	105

Source: Own data manipulation

Adopters of improved chickpea varieties among the growers and sources of initial seeds

From the total respondents 39% of them were chickpea growers from those total chickpea producers 60% of them growing improved varieties of chickpea during the study period. Only 44% of the farmers continuously produced the improved varieties of chickpea for more than one production seasons. Chickpea grower farmers initially adopted *Kabuli* chickpea than *Desi,* but continuous adoptions declined in *Kabul*i than *Desi* type of chickpea (Table 6). The reason for this decline of continuous adoption was good local market demand for *Desi* types of chickpea compared to *Kabuli*. This is because the *Desi* types are similar in color and tests with the local varieties.

Table 6. Adopters of improved varieties of chickpea from the chickpea producer farmers

Chickpea types	Response	Initial Adopters		Continuous adoption		Pearson's χ^2
		Adopters	Non-adopters	Adopters	Non-adopters	
Kabuli	N	34	56	10	24	60.26***
	%	38	62	29.4	70.6	
Desi	N	20	70	14	6	2.45
	%	22.2	77.8	70	30	

Source: Own 2016 survey data

The main sources of improved seed for *kabuli* chickpea were the offices of agriculture and neighbor farmers through extension linkages with the seed enterprises and producer farmers based on seed marketing and exchanges. The main initial sources of seed for *Desi* chickpea type were research center through demonstration and pre-scaling up interventions (Figure 5).

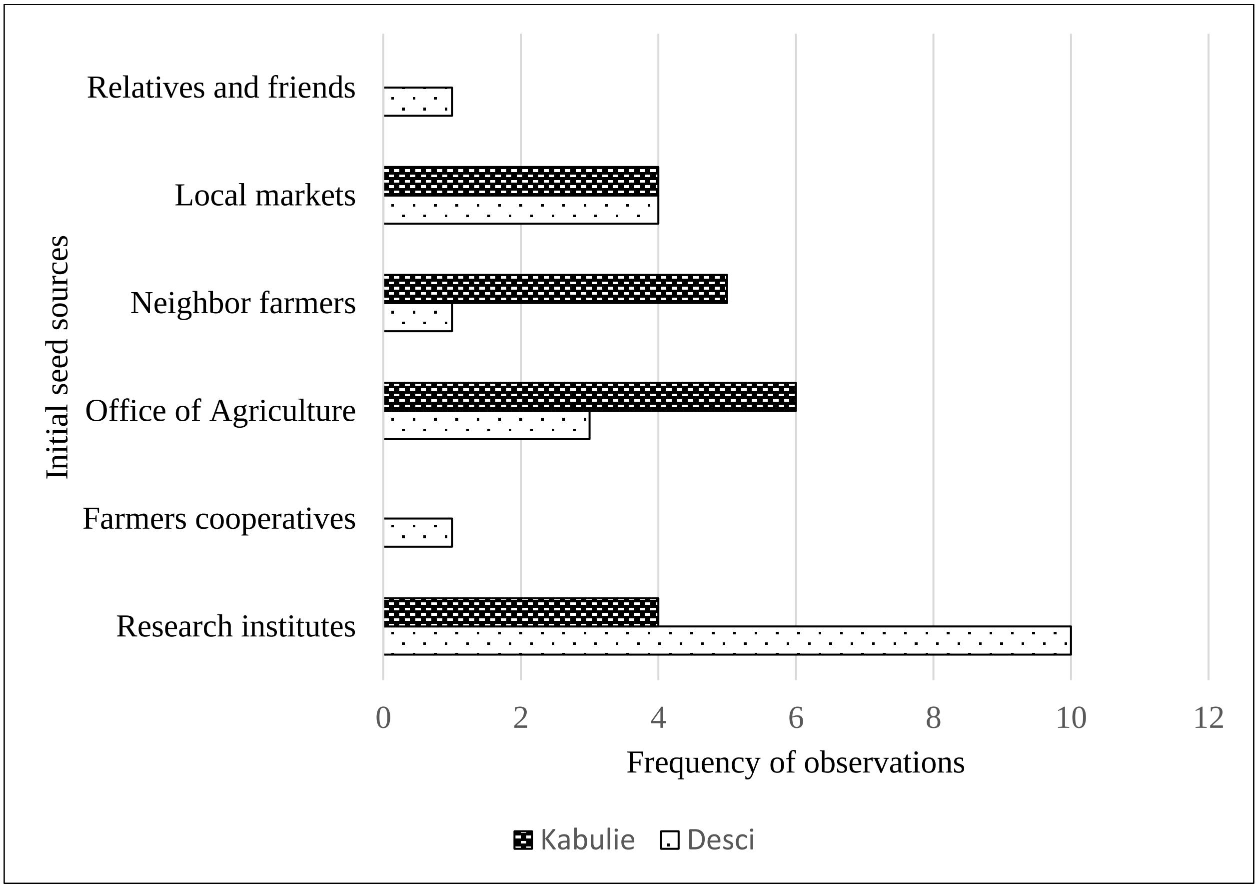

Figure 5. Graphs of improved seed sources of *Desi* and *Kabuli* chickpea varieties

Production and productivity of chickpea produced in the study area by kebele in Kg/ha

Majority of the farmers growing local varieties and obtained low yield compared to the improved varieties. The productivity of chickpea was more for the improved varieties compared with the locals (Table 7). This is because of better management and high yield capacity of the improved chickpea varieties. The improved varieties introduced in the areas provided to the farmers based on research recommendations and management practices.

Table 7. Average production, area allocation and productivity of chickpea by varieties

Chickpea types	N	Average area and production of chickpea		Productivity kg/ha
		Area in ha	Production in kg	
Kabuli	10	0.231	279	1207.79
Desi	14	0.343	465.5	1357.14
Local	78	0.348	363.54	1044.655

Source: Own data manipulation

Chickpea varieties under production in the study area

During the time of the study, the average productivity of chickpea estimated 1100 kilograms per hectare. Productivities were higher in intervention kebeles and lower in control kebeles. Poor management of vertisol, late planting of chickpea, disease and insect pest infestation, and access to seeds of improved varieties contributed to low productivity of chickpea (Figure 6).

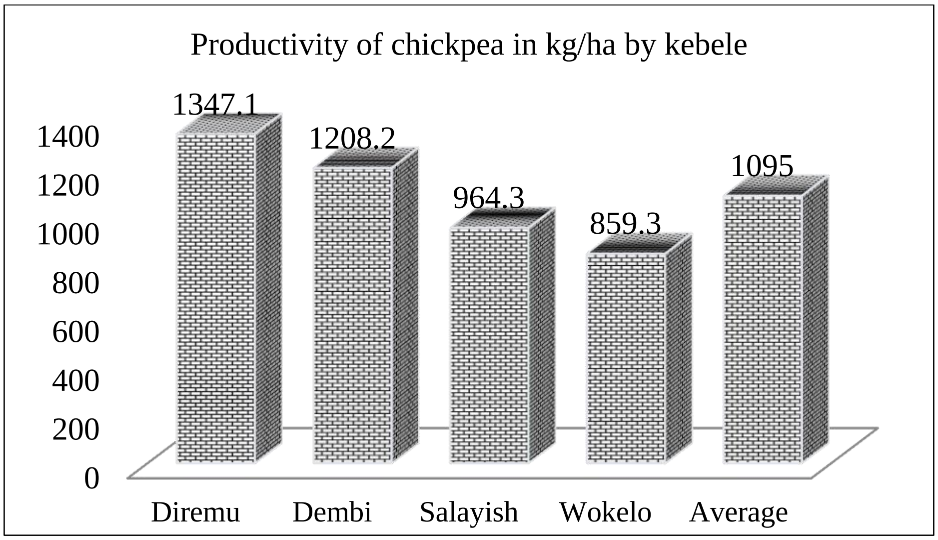

Figure 6. Productivity of chickpea in Kg per hectare

Contributions of chickpea to the household economy

Contribution for food availability and cause of food shortage

Some of the households faced food shortages over a period of 12 months during the study time. The household members faced on food shortage were less on high chickpea producer sites compared to the less producer sites. The food shortage problem was higher in control kebeles compared to the intervention kebeles (Figure 7a). This indicated that given other conditions were similar chickpea production contributed to food availability to the households. Poor harvest trends and land shortage of households contributed to critical food shortage happened. Wastage of crop production resulted from different crop damages like animals, over dried, untimely rainfall, and field pests. Limited access for land faced for limited production of the required amount and type of grain for food self-sufficiency (Figure 7b). This was because of the low level of production coverage and productivity of chickpea in the control sites.

Journal of Science and Inclusive Development Vol. 2, No. 1, DOI: 10.20372/jsid/2020-16

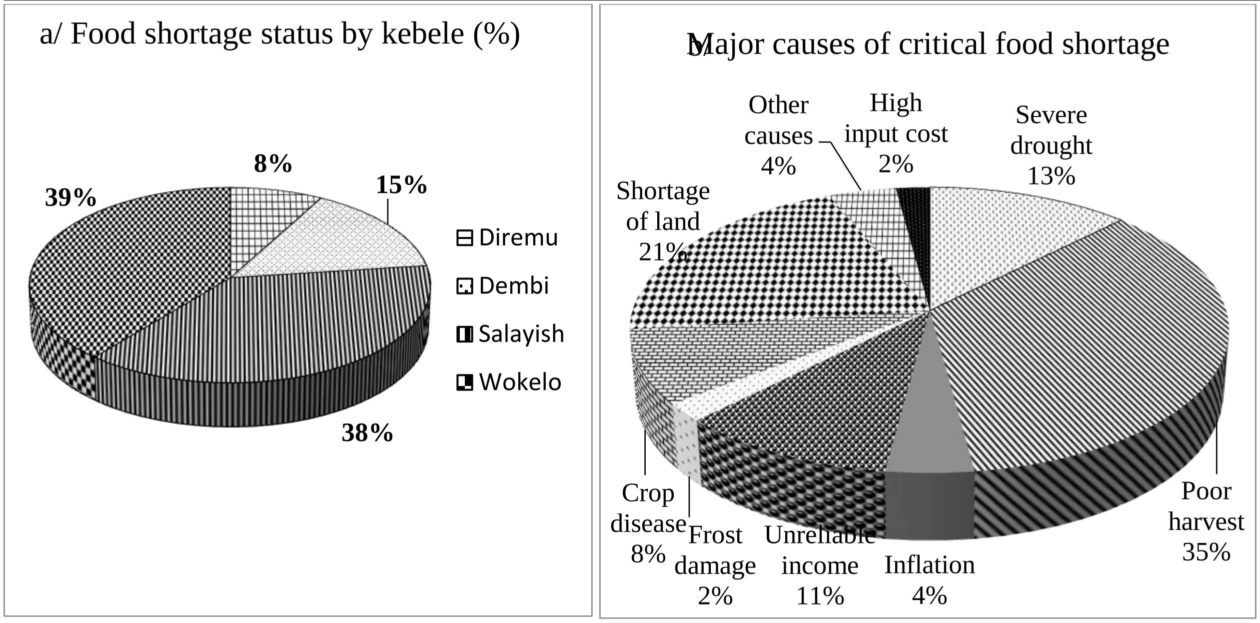

Figure 7. a/ Food shortage statuses by kebeles b/ causes of food shortage in the study area

Source own data manipulations

Contributions for gross margins, better income, and expenditure

The intervention areas (kebeles) generated more gross margins than the control areas. This outcome was resulted from high productivity of chickpea due introduction improved production practices and high yielder varieties in the intervention areas compared to the control areas. Intervention kebeles generated a higher amount of cash income per hectare of farmland in chickpea production compared to the counter parts. Household average monthly income and expenditure in Birr per kebele indicated high monthly income obtained in intervention kebeles without affecting the expenditures. This resulted from high gross margins generated from chickpea production. The intervention sites had net annual income compared to the controls (Figure 8)

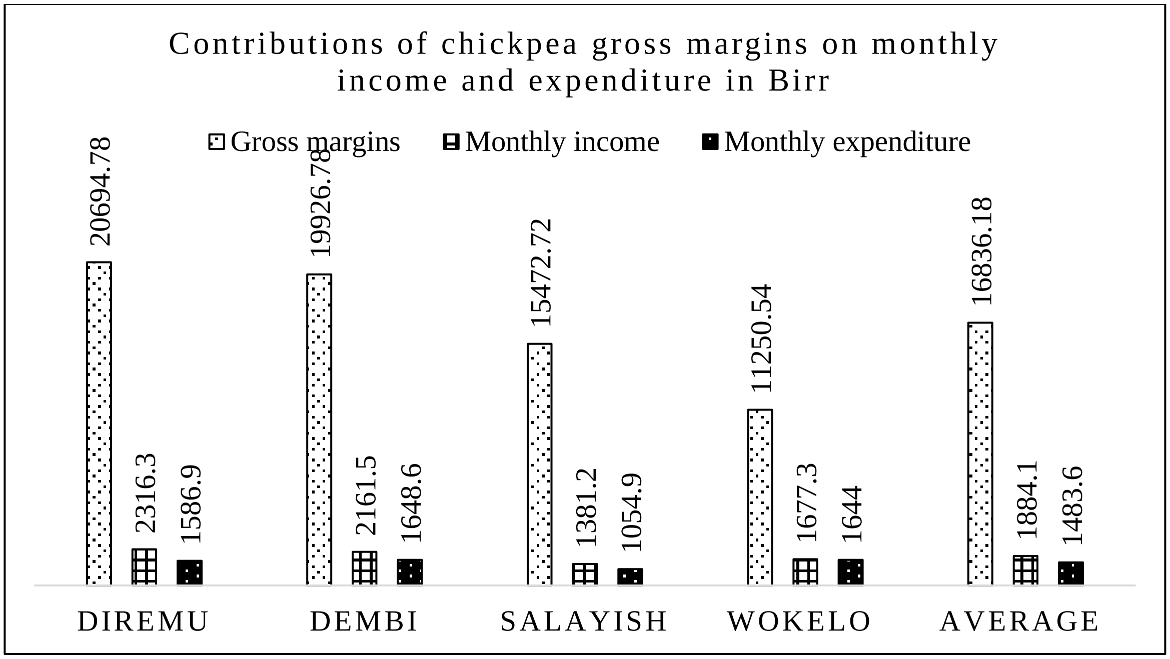

Figure 8. Gross margins of chickpea and monthly income and expenditure by kebele status in birr

Majority of the producers produced chickpea on at least 0.25 hac of land. The remaining produced it in small farm size. Different improved varieties of chickpea were produced in the study area. Few of them adopted by the producers were *Arerti* (*Kabuli* type produced by 12 farmers) and both *Mastewal* (produced by10 farmers) and *Natoli* (2 farmers produced) were *Desi* types. Relatively, Arerti and Mastewal varieties were known and adopted by more producers. Majority of the farmers' grown local varieties compared to the improved chickpea varieties.

Factors affecting chickpea technology adoptions

This adoption study was focused on continuous adoption, not on initial adopters. This was because farmer may try and teste the technologies and will continue when it suits his/her interests otherwise, he/she might stop to continue. The major socio-economic and institutional factors affected the allocation of land resources for chickpea production and investments in agriculture to purchase farm inputs. This influenced the production of chickpea and the adoption of improved chickpea varieties and other production packages of drainage, planting time, seed rate and bio fertilizer in the study area at various levels of significances. The determinant factors affected the continuous adoption of chickpea technologies in the study areas are market distances, extension contact and training access (Table 8).

Table 1. Factors affecting continuous adoption of improved chickpea technologies.

Variables	Coefficient	t	P>|t|
Age	-0.04	-0.2	0.84
Sex	-0.32	-0.34	0.70
Family size	0.1	0.80	0.43
Adult literacy ratio	0.01	1.24	0.22
Main market distance	-1.50***	-3.26	0.001
Distance from agricultural office	3.53	0.62	0.532
Distance from seed source	-0.32	-0.38	0.707
Frequency of extension contacts	0.03***	2.35	0.019
Training access	0.32***	2.57	0.010
Field day participation	-0.13*	-1.89	0.058
Constant	-2.46*	-1.83	0.067

Source: Own 2016 survey data

Discussion

The largest proportion (>85%) of cultivated land owned by the farmers mostly allocated for crop production purposes and crop farming is the main sources of food and income for the family. The area has a potential for chickpea production and suitable for improved varieties introduced to the areas. Chickpea is one of the major crops grown in the area next to teff and wheat. The overall chickpea production contributed for the betterment of producer farmers in food availability, farm income, household expenditure and productivity compared with the counter parts. Producer farmers generated more gross-margin and field benefits from chickpea compared to non-grower farmers and placed long time food availability.

New technologies contributed to the improvement of chickpea productivity resulted in 1.3 to 1.9 tons/ha with similar area coverage. Ethiopia has the highest yield gain of chickpea from10 producing countries in the world (Foyer et al., 2016). The share of volume in the African changed from 46% to 63% between (1996-2006 to 2009-2013) production seasons. Similarly, there was a relative change in area coverage and production of chickpea from 1995 to 2008 production seasons (Mesfin, 2017). Due to limited access to improved seed, majority of them are grown in local chickpea varieties.

Based on land availability and participation in off-farm activities, the total labor employed for crop production per annum varied across the study areas. Many actors involved in seed dissemination and technology transfer of improved varieties. The intervention kebeles improved their social capital and production skills through linkage with research institutes and have access to improved seed. As farmers who had adopted improved technology could enhance their annual income due to high gross farm income resulted from productivity of improved chickpea varieties compared to the non-adopters (Tegegne, 2017). Desi chickpeas provided high productivity than Kabuli and local varieties adopted by the farmers. This adoption is compelled by the local market and home consumption habits. There is high chickpea production and technology adoption in the intervention sites. This is because of the high productivity of improved chickpea varieties as a result of research intervention. Adopters of chickpea producer farmers interested in continuously adapting to *Desi* type of chickpea because of its adaptability, disease resistant and local market demand. As chickpea is becomes an important crop grown by farmers in the study area for cash income and home consumption (Shita et al., 2018).

Newly introduced chickpea varieties contributed to the improvement of farmers' income. Niebuhr farmers, research organization and offices of agriculture facilitated and fastened the technology transfer process as the primary sources of improved varieties and related production improvement technologies (Tadesse, 2012). Farmers grown the improved chickpea technologies have higher gross income than non-growers contributed to income improvement for the rural households. The main institutional factors are market distance, extension contacts, and low access to training as influenced chickpea production improvement (Verkaart et al., 2019; Joshi and Rao, 2016). Information access through extension contact positively affected the adoption of improved chickpea technologies (Asfaw et al., 2010; Postelnicu et al., 1989). Like farmer living closer to market and those who had closer contact with the extension system are more likely to adopt new technology and use it more (Getachew et al., 1995). Market distance affected the adoption of chickpea technologies negatively and significantly, similar with several extensions contacts and access to training affected the continuous adoption of improved chickpea technologies positively and significantly (Worku, 2019).

Conclusions

This study gave emphasis for the importance of chickpea in the study area. Chickpea contributed for the household economy in terms of food availability, gross margins and income and expenditures. Chickpea producer farmers placed in a better condition on food availability, gross margins and household income and expenditure. Improved seed sources contributed for informal and formal seed dissemination. Neighbor farmers, research centers, and offices of agriculture were the main sources of improved varieties of chickpea introduced in the area. New technologies contributed for the betterment of the farmers. The intervention areas earned higher gross field benefit and productivity from chickpea than the controls. Many of the farmers who adopt new technologies were convinced to continue the production of improved chickpea varieties, particularly for desi chickpea types. Market distance, access to different training, and frequency of extension contact influenced the adoption of improved chickpea production technologies. Market distance influenced by farmers' residence affected the rate of adoption of chickpea negatively and significantly whereas frequent extension contacts and access to training affected positively and significantly for the allocation of farmland to the production of chickpea.

Facilitating farmer-to- farmer seed exchange rate will improve the production and productivity of chickpea. Strengthen extension farmers' linkage and access to training for the rural households will help to improve the awareness of farmers for the adoption of improved agricultural technologies. Provision of extension advice for chickpea grower farmers and aware the farmers about chickpea production improvement technologies and market potentials will increase the number of producer farmers and enhance the production and productivity of chickpea in similar areas through the adoption of chickpea technologies. The aggregation of agricultural produce through organizing the farmers helps them to improve the market participation of chickpea producer farmers and contributes for improving the adoption rate of chickpea. This will improve further the status of household income for chickpea producer farmers. The provision of new technologies through the existing farmers' institutions and extension system will fasten the adoption rate of similar technologies.

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