

Full Length Research Paper

Adoption of chickpea varieties by smallholder farmers in southern Tigray, Northern Ethiopia

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Chickpea is one of the major pulse crops grown in southern Tigray in general and Enda-Mehoni district in particular. However, there are inadequate empirical evidences on adoption of chickpea varieties. This study aims to assess the determinants of adoption of chickpea varieties (Desi and Kabuli) by smallholder farmers. Both of the Desi and Kabuli types of chickpea were introduced by governmental and non-governmental organizations. For this study, data were collected from a total of 223 sampled households from Enda-Mehoni District. Descriptive statistics like frequency, percentage, mean and standard deviations and inferential statistics such as t-test and χ^2 -test were employed to see mean difference and association, respectively, between both adoption categories. The result of this assessment shows that from the total fifteen variables, nine of them were significant at 1, 5 and 10% probability levels between the adoption categories. Binary logit econometrics model was employed to identify the influence of hypothesized explanatory variables. The study found adoption of chickpea varieties are significantly influenced by household size, mobile phone access, residence of the household and participation of the household head in training. Hence, awareness creation through organizing trainings and strengthening the linkage between farmers-to-farmers with mobile phone owners is better if concerned governmental and non-governmental organizations considered it for further chickpea varieties adoption. In addition, it is equally important in targeting domain areas of dissemination and community based joint actions to facilitate chickpea varieties adoption in Enda-Mehoni district.

Key words: Adoption, binary logit, chickpea, Desi, determinants, Kubli

INTRODUCTION

Ethiopia is the world's 7th largest producer of chickpea, accounting for 90% of production in Sub Sahara Africa (Verkaart et al., 2016). The country is also the leading producer, consumer and exporter of chickpea in Africa

and has 4.5% share of the global chickpea market and more than 60% of Africa's global chickpea market share (ICRISAT, 2015). The diverse agro-climatic conditions in Ethiopia make it very suitable for growing chickpeas.

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Chickpea is widely grown across the highlands and semi-arid regions of Ethiopia and serves as a multi-purpose crop. The country is also considered as the secondary center of diversity for chickpea (Anbessa and Bejiga, 2002). Despite this, the predominantly produced variety which is about 95% is Desi chickpea types (Daba et al., 2005).

Chickpea is an important pulse crop next to faba bean in Ethiopia. It covers an area of 225,607.53 ha of land with estimated production of 444,145.93 tons. The productivity of the crop is about 1.97 ton/ha (CSA, 2017). Chickpea is an important source of dietary protein and minerals for many Ethiopians who could not afford animal products. It used in various forms, like green seeds, dried seeds, dehulled-splits and flour. Farmers recognize the importance of legumes in improving soil fertility and thus grow chickpea and other legumes in rotation with cereals (Dadi et al., 2005). According to CSA (2017), in Tigray region, the average productivity of the chickpea is lower than the national average which is about 1.61 ton per hectare with estimated production of 10,502.65 tons from an area of 6,524.78 ha (CSA, 2017). On the contrary, the southern zone of Tigray in general and Enda-Mehoni district in particular is a potential area for chickpea production. The average yield of chickpea in southern zone of Tigray is almost similar to the national average which is 1.86 ton per hectare (CSA, 2017). According to Southern Zone Development Corridor Office report, the total production of chickpea in Enda-Mehoni district was about 88 ton, which covers an area of 44 ha; within average productivity of 2.0 ton/ha (PC, 2016).

A study conducted in Ethiopia by Verkaart et al. (2016), shows that enhancing access to improved chickpea varieties is a promising pathway for rural development in Ethiopian chickpea growing regions. However, previous literatures indicated that the decision of farmers' adoption for a given technology is influenced by different factors across space and time including chickpea varieties. For example, Shiyani et al. (2002) reported that adoption of chickpea varieties is determined by duration of the crop maturity, farm size, farmers experience in growing chickpea varieties and village distance dummy. In Ethiopia, Dadi et al. (2005) reported that adoption of improved chickpea variety is significantly influenced by the households' access to extension, access to seed, farm size and proportion of area allocated to chickpea. In addition, Asfaw et al. (2010) also found out that adoption of chickpea varieties were determined by active family labor force, farm size and non-oxen livestock wealth, previous year knowledge about improved varieties, perception of farmers about the technology attributes and the distance dummies.

Hence, despite these few studies at a country level, there is an inadequate empirical studies related to chickpea in Tigray in general and in southern Tigray in particular. Therefore, this study attempted to assess factors affecting adoption of newly introduced chickpea

varieties and identify the determinant variables for its adoption, hoping that this can be used as a springboard for further studies related to chickpea in different perspectives in the study area and beyond.

RESEARCH METHODOLOGY

Area description

The study was conducted at Enda-Mehoni district Southern Zone of Tigray Regional State, Northern Ethiopia in 2016. The district is located 660 km away north of Addis Ababa and about 120 km south of Mekelle (capital city, Tigray National Regional State). Geographically, the district is located between 12.63° to 12.87° N latitude and 39.27° to 39.61° E longitude (Figure 1). Enda-Mehoni district is characterized by three distinct agro-ecologies; lowlands, midland and highland. The highland covers the largest part which accounts for about 65% of the total coverage while midland and lowland coverage is about 30 and 5%, respectively. The average landholding of the district ranges from 0.25 to 0.5 ha per household. The temporal situation of the rainfall event of the district shows bimodal event. It has light rainfall during February to April period and heavy rainfall between June and September. On average, the area receives annually about 600 mm rainfall with mean annual temperature of 25°C. Chickpea is one of the five major commodities of Enda-Mehoni district; next to wheat, barley, faba bean and field pea crops respectively (SZDCO, 2016).

Data collection and method of sampling

Multi-stage sampling technique was employed to select the sample respondents. In the first stage, Enda-Mehoni district was selected purposively based on the facts that chickpea varieties were highly promoted. In the second stage, four *kebelles* (The lowest administrative units of southern zone of Tigray, Ethiopia) namely, Embahasti, Mekan, Simret and Hizbateklehaymanot (Figure 1) were selected randomly from potential chickpea growing kebelles of Enda-Mehoni district. In the third stage, households were selected randomly based on their proportion to size from the selected four kebelles. Finally, a total of 223 respondents were randomly drawn from the lists of chickpea growers in the district.

Both primary and secondary data were used for this study. Primary data were mainly collected from sample respondents through structured questionnaire. In addition, secondary data sources from published and unpublished documents were gathered to supplement the primary data. Moreover, one day training was given for the enumerators to have common understanding of the questionnaire and ways of interviewing. Finally, the actual household survey was conducted by the trained enumerators.

Data analysis method

The collected data were analyzed using STATA software version 13. Descriptive statistical analysis was used to discuss the results of the survey using frequency, mean, standard deviation and percentages. Binary logit econometric model was employed to know the influence of hypothesized variables on decision to adopt or not adopt chickpea varieties (Table 1).

Based on the review of literatures and personal expectation of the researchers in the study area, variables like age, sex, education level, participation in off-farm activities, total annual income, total interaction made with development agents, membership in farmers' organization, mobile phone access, credit/cash received, cultivable

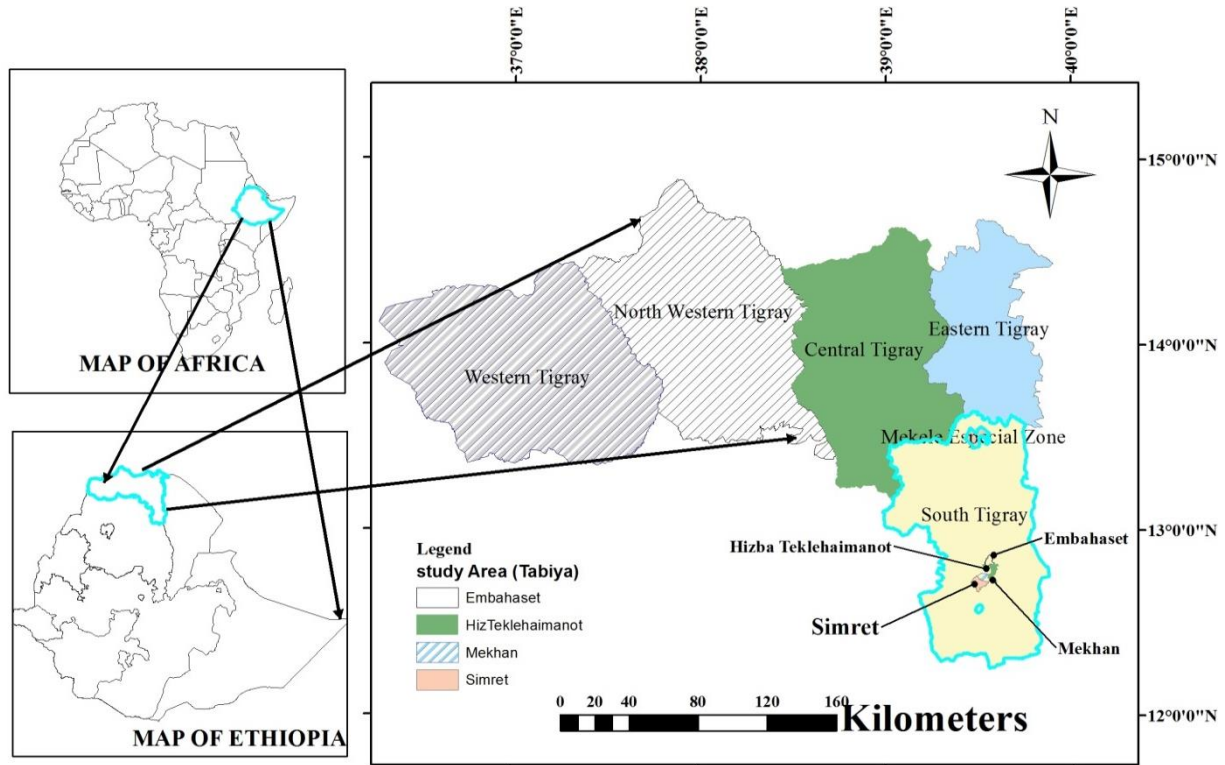


Figure 1. Map of the study area.

land size, participation in field days, residence of the household head, household size of the household head, livestock holding size and participation in trainings of household head were expectedly the most important variables that influence the adoption decision of smallholder farmers in the study area (Table 1).

RESULTS AND DISCUSSION

Descriptive analysis results of the explanatory variables

The descriptive analysis showed that, the mean age of sampled respondents was 42.3 years. There is no significant difference between adopter and non-adopter categories on age of the household head. On the other hand, the average household size in man is equivalent to 4.54. As indicated in the Table 2, the household size of the adopters was higher than the non-adopter. The inferential statistics (t-test) shows that there is significant difference between adopter and non-adopter categories at 5% significance level. Similarly, the mean cultivable land holding size of adopter and non-adopter was 0.82 and 0.64 ha, respectively whereas, the overall respondent average land holding size was 0.69 ha per household. This indicated that the cultivable land size of the respondents was smaller than national average which is 1.14 ha per household (CSA, 2015). The result of the analysis shows that the cultivable land size of the

adopters was much higher than land size of the non-adopter. The t-test analysis result shows a significant mean difference between the two categories at 1% significance level.

Following Storck et al. (1991), types and heads of livestock owned by the sample households was converted into Tropical Livestock Unit (TLU), so as to facilitate comparison among the households. The average livestock holding of the adopter and non-adopter was also 4.33 and 2.96 TLU, respectively. The t-value shows that there was significant livestock holding mean difference between respondents in both categories at less than 1% significance level. Moreover, the average annual farm income received by the respondents in the district was 9021 ETB per household per year. The income received by the adopters and non-adopter category was about 11367 and 7903 ETB respectively, per year. The annual income of adopters was much higher than the non-adopters which mean, they received about 3464 ETB more than the non-adopters. Hence, the t-test analysis result revealed that annual income has significant mean difference between both adoption categories at less than 10% significance level. The mean educational level of the sampled households was 3.40, with minimum and maximum grades of 0 and 12, respectively. On average, the samples respondents was made to interact with development agents of their respective kebelles about 24 times annually, which

Table 1. Definition of independent variables and expected sign for analyses.

Variables name	Type of variable	Measurement	Hypothesis
Sex of household head	Dummy	1 if male, 0 otherwise	+
Age of household head	Continuous	Years	±
Household size of the household	Continuous	Man equivalent	+
Livestock holding size of the household	Continuous	TLU (Tropical Livestock Units)	+
Education level of household head	Continuous	Years	+
Cultivable land size	Continuous	Hectare	+
Mobile phone access	Dummy	1 if yes, 0 otherwise	+
Membership in any organizations	Dummy	1 if yes, 0 otherwise	+
Field days participation	Dummy	1 if yes, 0 otherwise	+
Trainings participation	Dummy	1 if yes, 0 otherwise	+
Access to credit/cash	Dummy	1 if yes, 0 otherwise	+
Engagement in off-farm activities	Dummy	1 if yes, 0 otherwise	+
Total annual income	Continuous	Ethiopian Birr	+
Interaction made with DAs	Continuous	Number of interaction	+
Residence of the household head Kebelle1 (Embahasti base)	Dummies	1 if Embahasti, 0 otherwise, 1 if H/teklehaymanot, 0 otherwise 1 if Mekan, 0 otherwise and 1 if the Simret, 0 otherwise	±

DAs: Development Agents live at kebele level.

Source: Summarized depending on previous empirical studies.

implies at least 2 times per month. The analysis results of the educational background and interaction made with development agents of the respondents does not show significant mean difference between adopter and non-adopter (Table 2).

The majority (71.25%) of respondents were male headed, whereas the remaining were female headed households. The percentage of male headed household in the adopter category was higher than in the non-adopter category whereas, the percentage of female headed households in the adopter category was smaller than in the non-adopter category. The result from chi-square ($\chi^2=5.45$) shows significant association between sex

of household head and chick pea varieties adoption at less than 5% level of significance. In recent years, owning personal mobile phone can have important effect on receiving up-to-date information on day to day activity of the household from others with minimum cost. Majority (57.40%) of the respondents owned mobile, 69.44% were adopters and 51.66% were non-adopters household heads. The chi-square result ($\chi^2=6.31$) indicated that there was significant association between owning mobile phone and adoption categories at 5% significance level. Farmers in their residence are involved in different social, economic and cultural organizations. The analysis result shows that majority (59.64%) were member

of farmers' organization, while the remaining 40.36% had no involvement in farmers' organization. The result of the chi-square analysis ($\chi^2=0.095$) shows that there was no significant association between farmers organization and adoption. Similarly, Table 3 reveals that the majority (77.58%) of the respondents have no access to credit in cash and or in kind. The percentage of households who have access to credit/cash is the same among the adopters and non-adopters. There is no significant association between adoption and access to credit/cash at $\chi^2=0.087$. The majority (64.57%) of the respondents, with 65.28% and 64.24% of them adopter and non-adopter respectively, did not

Table 2. Descriptive and inferential analysis results of continuous explanatory variables.

Variable	Adopter		Non adopter		Total		t value
	Mean	SD	Mean	SD	Mean	SD	
Age of household head (years)	42.68	11.06	42.13	12.78	42.30	12.23	-0.312
Household size (count in man equivalent)	5.00	2.01	4.33	1.77	4.54	1.87	-2.52**
Cultivable land size (hectare)	0.82	0.48	0.64	0.44	0.694	0.46	-2.75***
Livestock holding size (TLU)	4.33	3.02	2.96	2.36	3.40	2.66	-3.66***
Education level (years)	3.58	3.51	3.38	3.63	3.44	3.59	-0.39
Interaction made with DAs	25.06	29.55	23.91	30.24	24.28	29.96	-0.27
Annual farm income (Birr)	11367.33	16032.54	7903.51	12552.20	9021.88	13831.12	1.76*

*, ** and *** represents significance at 10, 5 and 1% significance level, respectively. SD: Standard Deviation.

participate in off/non-farm income activities; whereas, about 35.43% of the respondents (34.72% of adopters and 35.76% of non-adopters) participated in off/non-farm income activities. The chi-square result ($\chi^2=0.023$) showed that there was no significant association between participation in off/non-farm activities and adoption.

About 59% of respondents attended trainings, 70.83 and 53.64% were adopters and non-adopters, respectively. The percentage of household who did not participate in trainings was higher in non-adopter category than adopter. The result of the chi-square analysis ($\chi^2=5.96$) shows that there was significant association between trainings participation and adoption at 5% significance level. In addition, about 37.67% respondents participated in field days, whereas about 48.61 and 32.45% of the respondents were adopter and non-adopter respectively. The percentage of households that participated in field days is higher in the adoption category whereas that of households who did not participate in field days are much higher in the non-adopter category than in adopter. The result of the chi-square analysis ($\chi^2=5.42$) shows that there was significant association between field days participation and

adoption at 5% significance level (Table 3).

Determinants of chickpea varieties adoption

The model result in Table 4 indicated that household decision to adopt improved chickpea varieties was significantly influenced by household residence, household size, mobile phone access and training participation of the head of the household. All the four significant variables positively influenced chickpea varieties adoption (Table 4).

Residence of the household head lived

The probability of adopting improved chickpea varieties was significantly and positively affected by residence of the household lived at 1% significance level. The result of the model indicated that the probability of adopting improved chickpea varieties were increased by 43.7% in Simret, 41.6% in H/teklehaymanot and 45.7% in Mekan kebelles, respectively, as compared to the base kebele (Embahasti). The probable reason

for this evidence of adopting improved chickpea varieties variation from kebele to kebelles could be due to difference in soil types, rainfall pattern and elevation. Recent study in the district, pointed out that households in the base kebele have higher probability of adopting improved faba beans varieties, which need longer time for maturing than the other kebelles (Hagos and Girma, 2018). Hence, this is proof that the Embahasti kebele have good alternative potential for other commodity adoption than chickpea. This result is consistent with previous findings on India reported by Shiyani et al. (2002), that adoption of improved chickpea varieties is significantly different from district to district. Similarly a study by Zenaye (2016) from Ethiopia showed that district dummies of household head significantly affected food legume adoption.

Household size of household head

The result is consistent with prior expectation; and availability of more household size was positively influencing farmers' adoption decision of chickpea at less than 10% level of significance. The result

Table 3. Descriptive and inferential analysis results of dummy explanatory variables.

Variable	Description	Adopter		Non adopter		Total		χ^2
		N	%	N	%	N	%	
Kebele of the household head	Embahasti	10	13.89	59	39.07	69	30.94	16.70**
	Mekan	27	37.50	31	20.53	58	26.01	
	Simret	18	25	36	23.84	54	24.22	
	H/teklehaymanot	17	23.61	25	16.56	42	18.83	
Sex of household head	Male	59	81.94	101	66.89	160	71.75	5.45**
	Female	13	18.06	50	33.11	63	28.25	
Access to mobile phone	Yes	50	69.44	78	51.66	128	57.40	6.31**
	No	22	30.56	73	48.34	95	42.60	
Membership in any farmers organization	Yes	44	61.11	89	58.94	133	59.64	0.095
	No	28	38.89	62	41.06	90	40.36	
Access to credit/cash	Yes	17	23.61	33	21.85	50	22.42	0.087
	No	55	76.39	118	78.15	173	77.58	
Engagement in non/off farm activities	Yes	25	34.72	54	35.76	79	35.43	0.023
	No	47	65.28	97	64.24	144	64.57	
Training participation	Yes	51	70.83	81	53.64	132	59.19	5.96**
	No	21	29.17	70	46.36	91	40.81	
Field day participation	Yes	35	48.61	49	32.45	84	37.67	5.42**
	No	37	51.39	102	67.55	139	62.33	

* and **represents significance at 5 and 10% significance level, respectively.
Source: Survey Result (2016).

of the model indicates that as household size in worker unit of the household increased by one unit, the probability of adoption of improved chickpea varieties increased by 3.6%. Consequently, this may be due to the fact that, the availability of family labor increases the capability of the household to allocate his/her farm land for chickpea varieties that needs additional labor to keep them from human theft ensuring its consumption at green pod stage of the crop. A similar result was reported by Asfaw et al. (2010) in Ethiopia. However, Musimu (2018) reported that the probability of adopting common beans varieties decreased with increasing household size. This finding has been justified by the household with a large household size using its income for household consumption expenditure rather than investing in new technology.

Access to mobile phone

Access to mobile phone is an important tool for a farmer to obtain a variety of information and experiences from various sources. The result of this study shows that ownership of mobile phone is significant and positively influenced adoption of chickpea varieties at $p < 5\%$. This

can help farmers get up-to-date information and be aware of the new innovations from different sources. Farmers get information related to the improved agricultural production practices, market information and experiences from different stakeholders as well as mobile phone used to call the extension experts when they want his service. As the logit model result indicated, farmers that had access to mobile phone had higher probability to adopt the chickpea varieties than the farmers who do not have mobile phone. This shows that ownership of mobile phone increase the likelihood to adopt chickpea varieties by 14.9% as compared to those who do not have mobile phone. This is consistent with the finding of Letaa et al. (2015) who reported that passion over modern information communication devices such as mobile phone significantly affected adoption of improved common bean varieties.

Participation in training

As the binary logit model indicates, the likelihood of adoption of improved chickpea varieties was significantly and positively affected by household's attendance of training session ($p < 5\%$). Farmers' participation in training

Table 4. Binary logit analysis results for adoption chickpea varieties in Enda-Mehoni district.

Variable	Coefficient	Std. Err	Marginal effect	Z
Total annual income Kebelle 1 (Embahasti)	9.24	0.000	1.830	0.73
Kebelle 2	1.937	0.115	0.437	3.80***
Kebelle 3	1.877	0.111	0.416	3.73***
Kebelle 4	2.083	0.099	0.457	4.57***
interaction made with extension agents	0.001	0.001	0.000	0.26
Land size	0.184	0.085	0.036	0.43
Total livestock of the households	0.074	0.016	0.014	0.91
Household size of the households	0.184	0.019	0.036	1.86*
Age of the households	-0.004	0.003	0.0001	0.31
Off farm activity participation	0.219	0.078	0.044	0.56
Education level of the households	-0.079	0.010	0.016	1.49
Cash/ input received	0.267	0.089	0.054	0.61
Membership in any organization	-0.116	0.073	0.023	0.32
Mobile phone access	0.776	0.072	0.149	2.06**
Gender of the household	-0.587	0.089	0.116	1.30
Training participation	0.759	0.800	0.145	1.81*
Field days participation	0.527	0.083	0.107	1.29
Cons	-3.620	1.356	-	2.67***
Observation	-	223	-	-
LR chi ² (17)	-	51.92	-	-
Prob> chi ²	-	0.000	-	-
Log likelihood	-	-114.31	-	-
Pseudo R ²	-	0.20	-	-
Predicted probability	-	0.27	-	-

*, ** and *** represents significantly varied at 10, 5 and 1% probability level, respectively.

Source: Survey Result (2016).

has a higher probability of adopting improved chickpea varieties than those who did not attend. The model indicated that adoption of chickpea varieties increases by 14.5% as compared to those who did not attend training. This implies that farmers that have the chance to participate in training can fill their gap of practical application (like time of planting, importance of improved varieties, weeding, harvesting, application of chemicals), and marketing that are provided to farmers by development agents and concerned governmental or non-governmental bodies related to improved technologies at farmers training centers. This finding is comparable with finding of Dadi et al. (2005), Mulugeta (2011) and Masresha et al. (2017) in Ethiopia. The authors concluded that training has a positive significant influence on adoption of haricot beans. This is due to the fact that farmers with better training status could have better information and confidence and hence, are likely to adopt haricot bean varieties.

CONCLUSION AND RECOMMENDATION

The study examined the factors influencing adoption of

improved chickpea varieties and revealed that household's residence, household size, participation in training and mobile phone access of household heads were responsible for increasing the probability of adopting chickpea varieties. Adoption decision was found to be a combination of economic, physical and institutional variables of the farmers. Hence, understanding of the significant factors that lead farmers to adopt improved chickpea varieties is imperative in policy design and implementation for further adoption of improved technology in the district. In addition, we recommend that concerned governmental and non-governmental organizations should consider providing appropriate training, targeting domains of chickpea producing areas and integrating new Information Communication Technology (ICT) like mobile phone for farmers in their locality to have access to up-to-date information on agricultural technologies in order to promote the adoption of improved chickpea varieties in the district and beyond.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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