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Determinants of smallholder farmers' participation in seed producing cooperatives in Southern Zone of Tigray, Ethiopia

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This research attempted to examine smallholder farmers' participation in seed producing cooperatives with the objectives of assessing factors affecting farmers' participation and identify the determinants of participation in seed producing cooperatives in southern zone of Tigray, Ethiopia. Both probability and non-probability sampling techniques were employed to select 192 sample households. Interview schedule with respondents and focused group discussions were employed to gather qualitative and quantitative data for the study. Descriptive statistics like frequency, percentage, mean and standard deviations and inferential statistics such as t-test and χ2-test were employed to see mean difference and association, respectively, between both participation categories. The result of the descriptive statistics shows that, from the total fourteen variables, eleven of them were significant at 1, 5 and 10% probability level between the participation categories. Binary logit model was employed to identify the determinants of participation. The result of the model shows that smallholder farmers' participation in SPCs was significantly influenced by household head's age, sex, distance to SPCs office negatively and participation in field days, participation in trainings and family labor endowment positively. Thus, enhancing the institutional support services through creating village based seed producing clusters, organizing trainings, field days and using labor saving pre-harvest and post-harvest technologies would contribute to improve smallholder farmers' participation in SPCs.

Key words: Seed, participation, seed producing cooperatives, binary logit.

INTRODUCTION

The national seed system of Ethiopia was considered as one of the key interventions in the transformation of the agricultural sector to ensure the target of doubling agricultural production by the end of 2015 (Ministry of Finance and Economic Development [MoFED], 2011). Good-quality seed is essential for any food production; it is also a technology transfer agent crucial for increasing production and productivity (Louwaars and De Boef, 2012).

Use of quality seeds in field crops alone can enhance the crop productivity by 15 to 25% (Roy, 2014). Many studies in Ethiopia indicated that increasing quality and usage of improved seed has the potential to increase Ethiopia's annual crop production (Dawit et al., 2010; McGuire and Sperling, 2011; Agricultural Transformation Agency [ATA], 2014).

In Ethiopia, the total cereal seeds requirement is estimated to be 700,000 tonnes (Thijssen et al., 2008; FAO, 2012). For instance, the total volume of improved seeds used in 2014/2015 was about 51,422.3 tonnes which is below 10% of the total volume required (Central Statistics Agency [CSA], 2015). In Tigray region, the potential seed requirement is estimated to be more than 150,000 tons, but the formal sector supply does not exceed 20,000 tonnes (Ibrahim and Fetien, 2010). This indicates that the formal seed system of the region has been less successful in supplying adapted varieties and quality seed. Yet, there remains huge gap between the demand for and supply of quality seeds in the region in general and in the study area in specific.

Promoting seed producing cooperatives is often seen as one of the institutional options to address the existing seed supply shortfall in the country. Thus, seed producing cooperatives are one of the community-based cooperatives organized by farmers at local level for seed production and distribution. Recently, seed producing cooperatives are playing a great role in an intermediary position, between formal and informal seed systems (Amsalu, 2015; Amsalu et al., 2015).

In Tigray region, though legally organized seed producing cooperatives have less than a decade history, up to December 2015, the total number of primary seed producing cooperatives has reached to 69 with a total membership size of 4009 smallholder farmers (Tigray Region Bureau of Agriculture and Rural Development Report [TBoARD], 2015). Similarly, in the study area, there were 14 seed producing cooperatives with a total membership of 1520 farmers which dominantly produced wheat, barley crops and beans in rare cases (Southern Zone Tigray Development Corridor Office Report [SZDCO], 2015). Government and non-governmental organizations gave more emphasis to seed producing cooperatives to involve in seed production and distribution of improved seeds and local adaptive seeds. Those organization support seed producing smallholder farmers in availing basic seeds and complimentary inputs, trainings and get market access.

However, despite of the supports and mobilization made by the governmental and non-governmental organizations for farmers to participate in seed producing cooperatives in the area, smallholder farmers' participation in these cooperatives is still below expectation. Previous empirical studies in Ethiopian and other countries on farmers' participation in a collective action like cooperatives were reported to be influenced by different factors across space and time. For instance,

demographic and socio-economic characteristics (Dagne et al., 2015), socio-economic, demographic and location (Degnet and Mekbib, 2013), human and social capital (Woldegebrial et al., 2013; Mesay et al., 2013; Baodan et al., 2015), physical capital (Tadesse, 2013; Dagne et al., 2015) and farmers' asset endowment (Bardhan and Sharma, 2012; Gashaw et al., 2014; Dagne et al., 2015), were among the variables determining households membership/participation in collective actions. In the study area, there is inadequate availability of research specifically to explore determinants of smallholder farmers' participation in seed producing cooperatives. Therefore, this study was initiated specifically to identify determinants of smallholder farmers' participation in seed producing cooperatives in southern zone of Tigray, Ethiopia in which it can be used as spring board for further research in seed producing cooperatives.

MATERIALS AND METHODS

The study was conducted in Southern Zone of Tigray Regional State, Northern Ethiopia in 2015. Geographically, it is located between 12° 15' and 13° 41' N latitude and 38° 59'and 39° 54' E longitude and with altitudinal range of 1350 to 3925 m above sea level. It shares common border with South Eastern Tigray zone in the North, Amhara regional state from the South and West, Afar Regional state from the east. The zone is characterized by three distinct agro-ecologies, including lowlands (locally named as *Kolla*), midland (*Weinadega*) and highland (*Dega*). The zone consists of five administrative Woredas, namely Raya Alamata and Raya Azebo from lowland agro ecology and Emba Alaje, Enda Mehoni and Ofla woredas are found in the highland agro ecology of the zone (EIAR and TARI, 2011). The zone covers a total area of 4,985.72 km^2, 498,572 and 143,326 ha cultivable land. The average land holding size of households in the zone ranges from 0.25 to 1.25 ha. However, the average landholding of the selected woredas ranges from 0.25 to 0.75 ha of land per household. Southern zone has experienced two rainfall seasons; the short rainy season locally known as "*Belgi*" that occurs usually from February to April and the main rain season locally described as "*kiremti*" that comes during June to September. On average, the area receives annually about 600 mm rainfall with mean annual temperature of 25°C. Wheat, barley, faba bean, and field pea are major crops grown on the highland agro-ecology while teff, sorghum, maize and fruit crops are dominantly grown on the lowland agro-ecology of the area. Seed production is considered as an important component of crop production in the three highland woredas of the zone. Accordingly, fourteen seed SPCs have been involving seed production dominantly in wheat and sometimes in barley and faba bean crops (SZDCO, 2015).

The sample size for the study was determined according to Yamane (1967) formula to minimize availability of error and bias during sampling. The formula for sample determination at 90% confidence level is described as follows:

$$n=N/(1+N(e)2)$$

where n = 192, N = 3243, and e = 7%; n = sample drawn from the total households of the selected kebelles; N=total households estimated to involved in seed production of the selected kebelles; e=sampling error/level of precision) tolerated for the study = 7% was used.

Multi-stage sampling technique was employed to select the

Table 1. Sample households selected for the study (Office of Agriculture and Rural Development of the Selected Woredas (OoARD), 2015).

Kebelle/Primary cooperative	Participants		Non-participants		Total	
	Total	Sample	Total	Sample	Household	Sample
Ayba	266	27	432	14	698	41
Atsela	45	23	548	12	593	35
Mekan	60	17	359	8	419	25
Tahtay haya	106	21	424	10	530	31
Simret	63	13	272	7	335	20
Higubirda	140	14	213	7	353	21
Hashenge	40	13	275	6	315	19
Total	720	128	2523	64	3243	192

sample respondents. At the first stage, three Woredas (Emba Alaje, Ofla and Enda-Mehoni) was selected purposively from the five Woredas of the zone based on experience/exposure on seed producing cooperatives. At the second stage, seven kebeles (three from Enda-Mehoni and two from each Ofla and Emba Alaje woredas) was selected randomly based on their proportion to size from the 14 kebeles, which have seed producing cooperatives. At the third stage, participant (who were registered as cooperative member and involving in seed production for at least two consecutive seasons including the survey period) and non-participant (farmers who grow the same crops and have farm land adjacent to seed producing farmers, but not member of seed producer cooperatives) were identified in collaboration with office of agriculture and rural development of the respective kebeles and the seed producing cooperatives committee members of each kebelles. After having fresh list of the study population from the selected seven kebelles, samples were allocated across the seven kebelles based on probability proportional to size (PPS) sampling technique. Again to have participant and non-participant households in the strata, proceeding with probability proportional to size (PPS) sampling technique was challenging. Proceeding with probability proportional to size procedure in the participation category does not help to obtain the desired proportion of the target strata as the number of participants of SPCs would be under represented.

Sudman (1976), indicated that an adjustment in the sample size may be needed to accommodate a comparative analysis of subgroups (e.g., such as an evaluation of program participants with non-participants). Hence, the sample households for this study were selected randomly based on 2:3 ratio of participants (from the small stratum and 1:3 ratio of non-participants (from large stratum) in order to generate a statistically valid sample household number. The total sampled household selected from each sampled kebelles is presented in Table 1.

Both primary and secondary data were used for this study. Primary data were mainly collected from sample respondents, key informant interviews and focus group discussions. The primary data related to personal, socioeconomic, institutional and perceptions of farmers on the participation in seed producing cooperatives were collected through structured questionnaire. Secondary sources from published and unpublished documents and reports from relevant organizations were gathered to supplement primary data. Moreover, discussions with woreda experts of the agricultural offices, cooperatives promotion offices, input supply offices and key informants were conducted. Before collecting the data, recruitment of enumerators was done according to their experience in conducting agricultural survey and knowledge of the local language as well as culture of the community. One day training was given for

the recruited enumerators and questionnaire pre-testing was carried out. After all this, some amendment was done to the questionnaire. Finally, the actual household survey was conduct by the enumerators from November to January 2016 with a close follow up of the researcher.

The data was analyzed using STATA software version 12.1. An independent sample t-test and Chi-square test were used to see the presence of statistically significance difference and the association between those who participate and do not in terms of the hypothesized variables. Descriptive statistical analysis was used to discuss the results of the survey using frequency, mean, standard deviation and percentages. In addition, mean comparisons of independent samples and relation of sample category with variables of interest was explored. Binary logit econometric model was employed to know the influence of personal (psychological), socioeconomic, physical and institutional variables on participation decision in seed producing cooperatives.

Model specification

The dependent variable of this study is smallholder farmers' participation in SPC and it is treated as a dummy variable which takes the value of one, if the household head is participant/membership in seed producing cooperative, and zero otherwise. In this study, households who were considered as participant are those who are legally registered as members of SPCs to multiply seed based on their common interest. But, those who consider as non-participant were farmers who have adjacent land for seed production with the cooperative members but not members of the SPCs.

The logit regression model is based on the cumulative logistic distribution function as expressed by Gujarati (1995):

$$pi = \frac{1}{1 + e^{-z(i)}} \tag{1}$$

If Pi represents the probability of deciding to participate in SPC, the probability otherwise is 1- Pi:

$$pi = 1 - \frac{1}{1 + e^{z(i)}} \tag{2}$$

The ratio of Equations 1 and 2 is the odd ratio in favor of participating in seed producing cooperatives. Then, if we take the natural log of Equation 3, we have therefore where βo is the

Table 2. Definition of independent variables and expected sign for analyses (Previous Empirical Studies, 2015).

Variables name	Type of variable	Measurement	Hypothesis
Sex of household head	Dummy	1 if male, 0 otherwise	+
Age of household head	Continuous	Years	±
Education level of household head	Categorical	1 illiterate, 2 read and write, 3 grade 1-4, 4 grade 5-8, 5 grade 9-10	+
Household size	Continuous	Man equivalent units	+
Household head administration position	Dummy	1 if yes, 0 otherwise	+
Cultivable land size	Continuous	Hectare	+
Livestock size	Continuous	Total livestock in TLU	+
Distance to SPC office	Continuous	km	-
Mobile phone access	Dummy	1 if yes , 0 otherwise	+
Experience in cooperatives other than SPCs	Continuous	Years	+
Extension contact	Dummy	1 if at least once fortnightly, 0 otherwise	+
Perception on price paid for seed compare to grain of the same crop	Categorical	1 low, 2 fair , 3 attractive	+
Field days participation	Dummy	1 if yes, 0 otherwise	+
Trainings participation	Dummy	1 if yes, 0 otherwise	+

Source: Summarized depending on previous empirical studies.

intercept and β_i is the slopes parameter in the intercept model. The slopes tell us the log-odds in favour of deciding to participate in seed producing cooperatives changes by a unit. The stimulus index Z_i refers to as the logs of the odds ratio in favour of deciding to participate. The odds to be defined as the ratio of the probability that a farmer participate P_i to the probability he will not $(1- P_i)$.

$$\left(\frac{pi}{1-pi}\right) = \frac{1+e^{Z(i)}}{1+e^{-Z(i)}} = e^{Zi} \tag{3}$$

Therefore,

$$\left(\frac{pi}{1-pi}\right) = \frac{1+e^{Z(i)}}{1+e^{-Z(i)}} = e^{Zi} \tag{4}$$

$$\frac{pi}{1-pi} = \frac{1+e^{Z(i)}}{1+e^{-Z(i)}} = e^{Bo} + \sum_{i=1}^{M} BiYi \tag{5}$$

Taking the natural logarithms of the odds ratio of Equation 5 will result in what is called the logit model as indicted.

$$Li = Ln \left(\frac{pi}{1-pi}\right) = lm\left[e^{Bo} + \sum_{i=1}^{M} BiXi\right] = Zi \tag{6}$$

where Li = the log odds which is also called the logit. If the disturbance term u_i is taken in to account, the logit model becomes:

$$Zi = Bo + \sum_{i=1}^{M} Bixi + \varepsilon i \tag{7}$$

Therefore, the econometric model was used in this study to identify determinant variables that influence households' participation in seed producing cooperatives. For the purpose of this study, definition of fourteen explanatory variables and their expected sign was hypothesized in Table 2.

RESULTS AND DISCUSSION

Descriptive and inferential analysis results of the study

The descriptive analysis showed that, the mean age of sampled respondents was 41.58 years. This implies that the mean age of the respondents was at productive age. The average household size in man equivalent was 3.98 and 3.52 for participant and non-participant categories, respectively. The mean cultivable land holding size of the total respondents was 0.869 hectare per household. This shows the land size was smaller than national average which is 1.14 hectare per household (CSA, 2015). The livestock holding in Tropical Livestock Unit (TLU) varied from 0 to 14.76 TLU whereas the average livestock holding was 5.06.

The mean distance from the cooperative office to respondents' residence was 2.69 km whereas the mean walking distance for participant and non-participant respondents was 2.31 and 3.46 km, respectively. According to the t-test analysis result there was statistically significant mean difference between the participation category in all the continuous variables at 1, 5 and 10% significance level (Table 3).

The majority (75%) of respondents were male headed

Table 3. Descriptive and inferential analysis results of continuous explanatory variables (Own Survey, 2016).

Explanatory variables	Participants		Non-participants		Total		t-value
	Mean	SD	Mean	SD	Mean	SD	
Age of household (years)	40.78	8.52	43.23	11.40	41.58	9.621	-1.685*
Family size (count in man equivalent)	4.740	1.48	4.185	1.068	3.828	1.184	2.666***
Cultivable land size (hectare)	0.919	0.400	0.767	0.2313	0.869	0.359	2.815***
Livestock size (TLU)	5.367	3.138	4.455	2.4661	5.064	2.956	2.032**
Distance to SPCs office (km)	2.311	2.340	3.464	2.674	2.696	2.509	-2.436**

Sources: Computed from own survey, 2016. *, ** and *** represents significance at 10, 5 and 1% probability level respectively. SD: Standard deviation.

whereas remaining were female headed households. As far as education level is concerned, majority (35.9%) of the respondents was illiterate followed by (23.4%) under the category of grade 1 to 4. Of the total respondents, 63% had involved in local administration position, while 37% had no any local administration position. Majority (66%) of respondents had experience in cooperatives other than the seed producing cooperatives like multipurpose, saving and credit and livestock and livestock products cooperatives, whereas the remaining about one third (34%) of the respondents have no any experience in cooperatives other than SPCs. Majority (70.8%) of the respondents owned mobile. About 55.7% of respondents were made at least one contact fortnightly with development agents while the remaining 44.3% of the respondents was not made contact fortnightly.

The study shows that 72.7% of participants and 60.9% of the non-participants were found participated in field days. However, the percentage of respondents participated in field days was higher in the participant category than non-participant. About 65.6% of respondents attended trainings (87.9% participant and 25% non-participant). About two-third (67.7) of the respondents have perceived that the price paid to seed compared to grain is attractive, while the remaining 22.9% and 9.9% of the respondents perceived that the price paid is fair and low, respectively. The percentage of respondents who perceived that the price is fair in the non-participant category is two times higher than in participant category and lower by about 24% than participant on the percentage response of the price is attractive. The chi-square result shows significant association between the variables sex, experience in cooperatives, perception on price paid to seed, frequency of extension contact, participation in field days and participation in trainings and participation in seed producing cooperatives among the participant and non-participant category at less than 1, 5 and 10% significance level.

However, educational level, administration position and mobile phone access variables do not show significance association between participant categories on participation in SPCs in the study area (Table 4).

Determinants of household participation in seed producing cooperatives

The overall performance of the model goodness-of-fit ($\chi 2=133$; P=0.99) was non-significance. According to Hosmer and Lemshow (1989), statistics, the non-significance chi-square indicated that the logistic regression model prediction of household participation in seed producing cooperatives does not significantly differ from actual observed. The *pseudo R squared* value was 0.47, indicating that the independent variables explain 47% of the farmer's choice to participate or not. Thus, the model was found fit for this study. The results of the logit regression model estimate indicate that out of the 14 explanatory variables included, six variables were found to have significant influence on the probability of being a participant in seed producing cooperatives in southern zone of Tigray. The variables considered significant to determine the participation of smallholder farmers in SPCs were: sex of household head, age of household, family size, distance to seed producing cooperative office, participation in field days, and participation in trainings (Table 5). Consequently, the significant explanatory variables, which have effects on participation of farmers in seed producing cooperatives in the study are discussed.

Sex of household head

The result of the study is not consistent with the prior expectation (Table 2); it negatively influenced farmers' participation in SPC at less than 1% probability level. All other thing kept constant, the odds ratio in favor of participation in SPC decreases by a factor of 0.09, as the sex of household head changes from female to a male headed household. This implies that female headed household has a higher probability of participate in SPCs than that of male headed household. Therefore, the possible reasons for the negative relationship might be; first, female have probably low negotiating power than male, and then they might expect that organizing in cooperatives will be the best option to sell their produce

Table 4. Descriptive and inferential analysis results of dummy and categorical variables (Own Survey, 2016).

Variables	Description	Participants		Non-participant		Total		χ2
		N	%	N	%	N	%	
Sex of household	Male	91	71.1	53	82.8	144	75	
	Female	37	28.9	11	17.2	48	25	
	Total	128	100	64	100	192	100	3.125*
Education level	Illiterate	43	33.6	26	40.6	69	35.9	
	Read and write	11	8.6	6	9.6	17	8.9	
	Grade 1-4	33	25.8	12	18.8	45	23.4	
	Grade 5-8	23	18	15	23.4	38	19.8	
	Grade 9-10	18	14.1	5	7.8	23	12	
	Total	128	100	64	100	192	100	3.55[NS]
Administration position	Yes	85	66.4	36	56.2	121	63	
	No	43	33.6	28	43.8	71	37	
	Total	128	100	64	100	192	100	1.88[NS]
Mobile phone access	Yes	95	74.2	41	64.1	136	70.8	
	No	33	25.8	23	35.9	56	29.2	
	Total	128	100	64	100	192	100	2.13[NS]
Experience in cooperatives	Yes	93	72.7	37	57.8	130	67.7	
	No	35	27.3	27	42.2	62	32.3	
	Total	128	100	64	100	192	100	4.300**
Frequency of extension at least one times fortnightly	Yes	79	61.7	28	43.8	107	55.7	
	No	49	38.3	36	56.2	85	44.3	
	Total	128	100	64	100	192	100	5.584**
Field day participation	Yes	93	72.7	25	60.9	118	61.5	
	No	35	27.3	39	39.1	74	38.5	
	Total	128	100	64	100	192	100	20.32***
Training participation	Yes	110	87.9	16	25	126	65.6	
	No	18	14.1	48	75	66	34.4	
	Total	128	100	64	100	192	100	70.24***
Perception on price paid to seed compare to grain of the same crop	Attractive	97	75.8	33	51.6	130	67.7	
	Fair	22	17.2	22	34.4	44	22.9	
	Low	9	7	9	14.1	18	9.4	
	Total	128	100	64	100	192	100	11.44***

*, ** and ***Represents significance at 10, 5 and 1% probability level respectively. NS: Non significant.

and benefit from market and they may show higher tendency to participate. Obed (2013) reported that females are more likely joining to community saving and investment grouping program, which implying female may desire to join grouping as a buffer mechanism. Secondly, in the study area, non-governmental organizations made a deliberate effort to encourage female-headed households to join SPCs than male headed households. This finding is similar with the findings of Nwaobiala (2014) in Nigeria, Obed (2013) in Malawi and Dagne et al. (2015) in Ethiopia who reported that, female headed households are more likely to participate in community based program and membership in cooperative than male headed, respectively.

Table 5. Econometric results on determinants of participation in seed producing cooperative in southern zone of Tigray (Econometric Model Result, 2016).

No.	Variable	Coefficient	S.E	|Z|	Sig	Odds ratio
1	Sex of household	-2.407	0.718	3.35	0.001***	0.090
2	Age of household	-0.068	0.028	2.42	0.016**	0.933
3	Education level	0.206	0.210	0.98	0.329	1.228
4	Family size	0.841	0.265	3.17	0.002***	2.319
5	Local administration position	0.124	0.489	0.25	0.799	1.132
6	Livestock size	-0.041	0.104	0.39	0.695	0.959
7	Cultivable land size	1.535	0.961	1.60	0.110	4.641
8	Years of experience in cooperatives	-0.534	0.518	1.03	0.302	0.585
9	Distance to SPCs office	-0.247	0.104	2.37	0.018**	0.781
10	Mobile phone access	-0.347	0.567	0.61	0.541	0.707
11	Frequency of extension contact	0.769	0.510	1.51	0.132	2.169
12	Field day participation	0.868	0.504	1.72	0.085*	2.383
13	Perception on price paid to seed	0.628	0.385	1.63	0.103	1.874
14	Training participation	3.330	0.579	5.75	0.000***	27.949
15	Constant	-2.344	1.682	1.41	0.160	0.0940

Hosmer and Lemeshow goodness of fit test ($\chi 2$ = 133; P=0.994)		
Observation		192
Pseudo R^2		0.47
-2log likelihood		64.00
Correctively predicted percentage		77.57

Source: Own Survey, 2016. *, ** and *** represents significance at 10, 5 and 1% probability level respectively.

Age of household head

The result of the study shows that age of household head had negative influence on farmers' participation in SPCs at less than 5% probability level. The result of logit model shows that, as the age of the household head increases by one year, the logs of odds ratio in favor of households' participation in seed producing cooperatives decreases by 0.93. This implies that the older age farmers are reluctant to accept new ways of doing activities like seed production organized in cooperatives. This study is comparable with the study conducted by Greenwell (2010) who reported that age of household head had negative relationship with decision to join national smallholder farmers' association in Malawi. In addition, studies conducted in Ethiopia by Amare (2014), on participation of women farmers' in seed producing and marketing cooperatives/local seed business, Getachew and Girmay (2012), participation of the household head in seed production and marketing and Woldegebrial et al. (2013), on probability of households to join cooperative membership was shown to negatively influenced between participation/membership and age. The authors conclude that young heads of households are more likely to acquire new knowledge and learn new techniques than the orders.

Family size of household head

The result is consistent with prior expectation; availability of more household size was positively influencing farmers' participation in SPC at less than 1% level of significance. The result of the model indicates that keeping all other factors constant, participation in SPC increased by a factor of 2.32, as household size in worker unit of the household increased by one. Consequently, this may be due to the fact that, the availability of family labor increases the capability of the household to fulfill demand of the cooperative seed multiplication standards and can manage the seed production activities properly. Seed multiplication needs more labor in planting rows, frequent weeding, logging out and threshing of the produced seed separately than the common crop/grain production activities. Hence, the farmers who have more family labor may not need to request additional labor for seed production purpose. The finding of this study confirms the findings of Amare (2014) from Ethiopia, who found that family size had positive and significant influence to household participation in women farmers' participation in seed producing and marketing cooperatives. Similarly, Karli et al. (2006) from Turkey also reported that households with higher family size had higher probability to enter agricultural cooperatives.

Distance to seed producing cooperatives office

Similar to the prior expectation, distance to office of the SPCs negatively affects farmers' participation in SPC at less than 5% probability level. The result of logit model shows that, as the distance from SPC office to the household heads residence increases by 1 km, the logs of odds ratio in favor of household participation in SPC decrease by 0.78. This is due to the fact that, participation in cooperatives may need up-to-dated information on the day to day activities of the cooperatives and operations. Therefore, the nearby farmers have better chance of getting reliable information related to seed production from the cooperative member than farmers far away. The finding of this study is similar with finding of Obed (2013) and Muthyalu (2013). For instance Muthyalu (2013) reported that distance to multi-purpose cooperatives have negative influence on farmers' input and output marketing in Tigray.

Participation in field days

As expected, participation in field days was positively related to farmers' participation in SPCs at less than 10% significance level. The result of the odds ratio shows that, if the household participated in field days, the odds ratio in favor of household participation in SPC will increase by 2.38. This implies that household who participated in field days enables to understand the importance of seed practically through observation of farmers' field in the areas of seed production and seed producing cooperatives. This study is comparable with studies of Mesay et al. (2013) in Amhara region conducted on participation in local seed multiplication and Woldegebrial et al. (2013) in Tigray region conducted on cooperative membership.

Participation in trainings

Different trainings were provided related to seed production and seed producing cooperatives in the study area. As expected, participation in training was positively related to farmers' participation in seed producing cooperative at less than 1% level of significance. The result of the odds ratio shows that, if the household participated in training, the logs of odds ratio in favor of household participation in SPC will increase by 27.95. Therefore, logit result shows that, farmers who participate in trainings will be more probable to participate in seed producing cooperatives than not participated in training. This indicated that, participation in training is imperative to convince farmers and to provide knowledge and skill on the practical experience of seed production in cooperatives. The finding of this research is similar with findings of Tadelle (2011), Woldegebrial et al. (2013), Mesay et al. (2013) and Baodan et al. (2015).

CONCLUSION AND RECOMMENDATIONS

Cooperative based seed production is among the development efforts undertaken by the government of Ethiopia to ensure seed security of the rural farmers at local level. The study found that smallholder farmers' participation in seed producing cooperatives is affected by different personal, socio-economic and institutional factors. Accordingly, female headed households, relatively younger farmers, farmers who have participated in field days, trainings, relatively have larger productive household size and farmers who are living nearby to cooperative office have better tendency to participate in SPCs. Therefore, in future priority interventions on smallholder farmers' participation in SPCs in southern zone of Tigray should be better if policy makers, concerned governmental organizations and NGOs place more emphases on:

(1) Encouraging aged household heads and male headed households to join seed producing cooperatives
(2) Strengthening the capacity of smallholder farmers on seed production and SPCs by arranging adequate trainings and field days visits.
(3) Promoting labor saving technologies like row planter, harvester, thrasher and cleaner machines should take into consideration by research centers and stakeholders to increase labor availability of households in the peak seasons so as to increase household participation in seed producing cooperatives, and
(4) Village based clusters of seed production should be promoted by concerned governmental and NGOs to encourage distant farmers to participate in seed producing cooperatives and to produce seed in quality and quantity at grass root level.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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