Impact of Participation in Vegetables' Contract Farming on Household's Income in the Central Rift Valley of Ethiopia

Gemechu Mulatu[*], Jema Haji, Belaineh Legesse, Mengistu Ketema

School of Agricultural Economics, Haramaya University, Dire Dawa, Ethiopia
*Corresponding author: geme.chu@yahoo.com

Abstract This study analyzed the impact of vegetables' contract farming on the household's income using data collected from 423 smallholder vegetable farmers from four districts of the East Shewa zone, central rift valley of Ethiopia. The study combines both quantitative and qualitative data obtained from desk review, an in-depth household interview, and focus group discussions. The propensity score-matching technique was employed for data analysis due to lack of baseline data and non-randomness of participation in contract farming. First, a probit regression model was used to estimate the propensity for matching participants and non-participants. Then, their incomes were compared. Results show that contract farming has a significant positive effect on the incomes of participating households. Given the vegetable production opportunities available in the study area, it is important to address the challenges of vegetable producers to benefit from contract farming and increase their incomes.

Keywords: *vegetables' contract farming, propensity score matching, central rift valley, Ethiopia*

1. Introduction

Contract farming has existed for a long time for vegetables [7]. It can be either oral or written agreement between growers and buyers or processors. However, it has been a controversial subject in the discussion on rural development. Empirical studies in developing countries provide a varied analysis about participation and income effect of contract farming. Warning and Key [30], Miyata *et al.* [18], Zeller and Saigenji [31], Jony [12], Bellemare [6], Wainaina *et al.* [28], Velde and Martens [27] found that participation in contract farming improves household income. Other studies, however, found that CF lowers the incomes of smallholder farmers [17]. Due to the high transaction costs associated with contracting with small-scale farmers, large firms usually exclude poorer smallholder farmers from contracts [26]. However, Warning and Key [30], in Senegal, Miyata *et al.* [18] and Wang *et al.* [29], in China, found no evidence of exclusion of smallholders from participation.

The theoretical underpinning of contract farming is often explained using the lens of New Institutional Economics (NIE), from the perspective of Transaction Cost Theory (TCT). The agro-food sector can be tied together through several ways ranging from the sale of goods via arm's length transaction agreements to the consolidation of two or more stages under a common management of a single firm. Every type of relationship between these vertical stages is called vertical coordination

[20]. One particular mechanism of vertical coordination in Agri-food value chains is CF. Contract farming is considered as the minimization of transaction cost arrangement to organize the production and sales process between farmers and their customers. NIE assumes that individuals have incomplete information and limited mental capacity and because of this, they face uncertainty about unforeseen events and outcomes and incur transaction costs to acquire information [15]. The higher the asymmetric information, the higher the transaction costs [10]. When contract farming is applied, smallholders have a guarantee that their products will be purchased and there is some certainty of income. For the contractor, the risk of bad quality products can be reduced by including standards of quality in the contract [10].

In Ethiopia, CF has been in existence for many years. Contractual arrangement made between Guder Agro-industry Private Limited Company with wheat producing farmers [9]; Mama Fresh Injera with teff grain from Erer Cooperative Union [1]; Wonji Sugarcane Factory with sugarcane farmers adjacent to Awash River [16]; EthioFlora and Meki-Batu cooperative union with fruits and vegetable farmers [3]; farmers around Bushoftu contracted with grain suppliers and food industries [2]; castor bean contract farming in Wolaita and Gamo Gofa administrative zones in the SNNPR region [14]; Contract and Farming Arrangement (CFA) between a chickpea processing firm and farmers' cooperative union in central Ethiopia [25] are some of the CF arrangements in Ethiopia.

Despite the growth of contract farming in Ethiopia, few empirical studies have been conducted to assess the

impact participation in vegetables' contract farming on farm household's income. Thus, the main objective of this study is to examine the impact of vegetables' CF on household's income.

2. Data and Research Methodology

2.1. Data and Description of the Study Area

This research was carried out in the central Rift Valley of Ethiopia, which is located in East Shewa zone of the Oromia National Regional State. The zone is endowed with rivers like Awash, which is best-utilized river for irrigation. Irrigation systems have been taking place around the coast of lakes and Awash River. The total number of households involved in irrigated agriculture is 10257 of which 9190 are male headed and the remaining are female headed [19]. Due to the high potential of water for irrigation, various vegetables have been produced in the area 2 or 3 times throughout the years. Location of the study area is given in the map below.
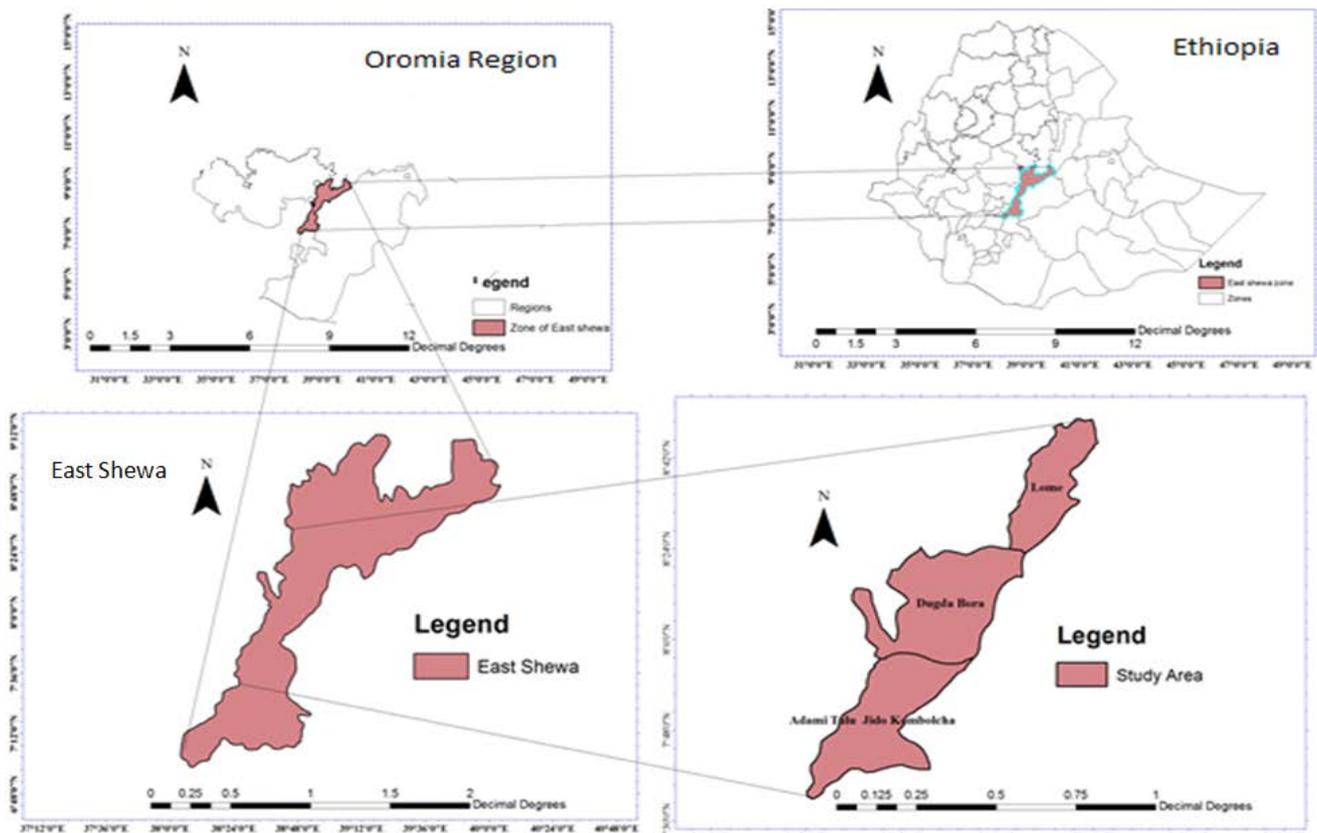

Figure 1. Map of the study area

In this study, both primary and secondary data were gathered. Both qualitative and quantitative data were collected using semi-structured questionnaire, focus group discussions, and an in-depth interview. For implementing the household level questionnaire, the following procedure was followed. First, a pilot study was carried out to learn more the contract arrangement systems in the study area. Second, the results from the pilot survey enabled to develop the questionnaire. Third, random sampling technique was followed to pick sample respondents based on the lists obtained from respective kebele offices. Finally, survey was carried out at a household level. Secondary data that were collected from such sources include agricultural inputs supplied and consumed, physical characteristics, and population size. These types of data were collected from different governmental and non-governmental bodies that are found at district, zonal, regional, and national levels.

Representative sample household heads were selected using multistage techniques. In the first stage, Dugda, Lume, Bora, and Adami Tullu Jiddo Kombolcha districts were purposively selected. This is because these districts are relatively better endowed with irrigation for vegetables production and availability of vegetables' CF. In the second stage, three kebele [1] were selected from each district of Lume and Adami Tulu Jido Kombolcha and four kebeles were selected from each district of Dugda and Bora. In the third stage, simple random sampling technique was used to obtain sample respondents from each Kebele. Sample size was determined per each kebele proportionally to the total number of farm households.

Representative sample size is always determined by taking into account the level of precision, the level of confidence and the degree of variability in the attributes being measured. It is typically determined using statistical calculations. Following Kothari [13] sample size was determined using the following formula as:

$$n = \frac{Z^2 \times P(1-P)}{e^2} = \frac{1.96^2(0.5)(0.5)}{(0.05)^2} = 384$$

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[1] the kebele administration (peasant association) is the lowest government administrative unit

Where, n - desired sample size

Z - Values of standard variant at 95% confidence interval (Z = 1.96).

P - Estimated proportion of households in vegetables' CF

As the exact proportion of farmers in vegetable CF is not known a *prior*, P= 0.5 was used to obtain maximum number of sample household heads. The formula by Kothari gives sample size of 384 households, the researcher added 10 percent as reserve for possible errors and omissions, and thus 423 sample vegetable farm household heads were selected and interviewed to achieve the objectives of the study.

2.2. Methods of Data Analysis:-Propensity Score Matching

Propensity score matching (PSM) and double difference or difference-in-difference (DID) are the common methods for program impact evaluations.

Under the difference-in-difference approach, the impact of the project is the difference between the outcomes in the second less the first period (Baker, 2000). DID methods are advantageous in the sense that they relax the assumption of conditional exogeneity or self-selection on observed characteristics. Moreover, they provide an appealing and intuitive way to account for selection based on unobserved characteristics. This method is not suitable for the current study, as difference-in-difference approach needs a baseline survey.

The choice of PSM for this study was motivated by the lack of observational data for the control group, thus requiring construction of a statistical comparison group based on a model of the probability of participating in vegetables' CF using observed characteristics. The propensity score approach can reduce bias in observational studies [21,23,24] through identification of non-participants who are similar to participants in all relevant pre-participation characteristics. Matching helps to find a group of treated individuals (participants) similar to the control group (non-participants) in all relevant pretreatment characteristics where the only difference was that one group participated in vegetables' CF and the other group did not. Detail specification of PSM is found in Caliendo and Kopeinig [8]. The estimation process was done using psmatch2 in STATA 13.

In PSM estimation, the following steps were performed: First, a probability model of participation in vegetables' CF was estimated to calculate the propensity score of each sample household head. Second, selection of the best matching algorithm was made from the alternative matching algorithms, based on the performance criteria such as number of insignificant variables after matching, low pseudo R^2

after match, large sample size, and lower standard bias. Third, after checking for the overlaps, a common support condition was imposed upon the propensity score distribution of treated and untreated households. Then, observations whose predicted propensity scores fell outside the range of the common support region were discarded. Lastly, various methods were applied to check for the matching quality, sensitivity analysis and the results were duly reported.

In the present study, explanatory variables of the logit/probit model were identified using the findings of Jony [12]; Miyata *et al.* [18]; Cai *et al.,* (2008) and Arumugam *et al.,* (2011). The explanatory or the matching variables are sex, age, education, access to credit, membership of "equb", family size, livestock ownership, distance to all weather roads and market information.

3. Results and Discussions

3.1. Socio-economic and Demographic Characteristics of the Respondents

There are ample socio-economic and demographic variables associated with participation contract farming. Among the different socio economic, institutional, and demographic factors that have relation with contract farming participation, some of them are discussed as follows.

The average age of the household head for the entire sample is 41.71 years. The mean ages of non-participants and participants in vegetables contract farming are 42.38 and 40.89 years, respectively. The t-test for equality of means is found to be statistically insignificant. This indicates that there is no age restriction for joining vegetables' contract farming in the study area. The average family sizes for non-participants and participants were 6.1 and 5.66 persons, respectively. The average school attended by non-participant household heads is 4.3 while the corresponding figure stands at 4.9 for the participants. The mean distance from the road for contract farmers was 3.33 km and 4.58 km for non-contract farmers. The t-test result reveals that there is a significant difference between vegetables contract participants and non-participants. Thus, those farmers located in distant and remote villages had less likelihood to participate in vegetables' contract farming. In order to standardize the livestock holdings of the sample households, TLU was calculated based on conversion factors. Based on TLU measure, the average livestock holding per household is 13.62 for sample households. Average livestock holding for the non-participant and participant farm households are 11.39 and 16.38 TLU, respectively.

Table 1. Descriptive statistics of continuous variables

Variable	Total		Non-participant		Participant		t-test
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Education	4.58	4.31	4.3	4.35	4.9	4.26	-1.44
Age	41.7	12.2	42.38	12.58	40.88	11.7	1.26
Family size	5.91	2.62	6.12	2.57	5.65	2.67	1.8*
Livestock ownership	13.6	16.2	11.38	14.66	16.38	17.59	-3.18***
Distance to all weather road	4.02	4.85	4.58	5.98	3.33	2.87	2.65***

Note: ***, **, and * represent level of significance at 1%, 5% and 10%, respectively
Source: Survey Data (2016).

The majority of the sampled farm households were male-headed (87 percent). Only 24 (43.64%) of the sampled female headed households did participate in CF and this number indicates that there is low participation of females in vegetable contract farming due to the riskiness and capital intensive nature of the vegetable farming business.

The farmers who get credit from financial institutions have an opportunity to participate in contract farming more than the farmers who have access to credit. The binary coded access to credit has chi2 result of 5.58, which indicated that there is a difference between contract farmers and non-contract farmers in terms of access to credit. Membership in saving groups 'equb' helps households to accumulate more money for further investment that enhances participation in contract farming. At the time of the survey, 55.8 percent of the equb members of the sample households had participated in contract farming. Membership in equb has shown a chi-square result that is statistically significant at 5 percent significance level. Access to market information enables producers to seek out and compare the information available for different market outlets to realize the full potential profit by getting the best prices.

3.2. Propensity Score Matching Result

A binary discrete choice regression model (logit or probity) should be used for estimation of propensity score. Both logit and probit regression models were compared. The probit model fits the data well. The Wald chi-square test statistic was statistically significant at 1% significance level, which indicated that the hypothesis of no explanatory power of the model was strongly rejected. The pseudo-R^2 is 0.083, which is lower, indicating that there was no systematic difference in the distribution of covariates between vegetables' CF participants and non-participants in the study area.

Table 2: Summary statistics of dummy variables

Variable		Total		Non-participants		Participants		chi^2 (1)
		Freq.	%	Freq.	%	Freq.	%	
Sex	Female	55	13	31	56.36	24	43.64	
	Male	368	87	202	54.89	166	45.11	0.04
	Total	423	100	233	55.08	190	44.92	
Equb	No	303	71.63	180	59.41	123	40.59	
	Yes	120	28.37	53	44.17	67	55.83	8.07***
	Total	423	100	233	55.08	190	44.92	
Access to credit	No	275	65.01	163	40.73	112	59.27	
	Yes	148	34.98	70	47.3	78	52.7	5.58**
	Total	423	100	233	55.08	190	44.92	
Access to market information	No	100	23.64	72	72	28	28	
	Yes	323	76.36	161	49.85	162	50.15	15.15***
	Total	423	100	233	55.08	190	44.92	

Note: *** and ** represent level of significance at 1% and %, respectively
Source: Survey Data (2016).

Table 3. The probit regression estimate of vegetable CF participation

Independent variables	Coeff.	Z-value	dy/dx
Sex	-0.12	-0.57	-0.046
Education	0.006	0.36	0.002
Credit	0.25*	1.85	0.100
Membership of "equb"	0.26*	1.81	0.100
Family size	-0.21**	-2.57	0.080
Distance to all weather roads	-0.04**	-2.09	0.141
Market information	0.47***	3.00	0.182
Age	-0.002	-0.43	0.001
Livestock	0.01**	2.13	0.003
Constant	0.19	0.46	

LR chi2(9) = 48.09***

Pseudo R^2 = 0.083

Log likelihood = -266.968

Note: ***, **, *, represent a level of significance at 1%, 5% and 10% respectively.
Source: Survey Data (2016).

Among the factors assumed to affect household's participation in the CF scheme, family size, and distance to all-weather road negatively and significantly affected participation in the scheme. Membership to equb, ownership of livestock, access to market information and credit affected participation in vegetables' CF schemes positively and significantly at less than 10 percent significance levels. The positive significant coefficient of credit indicates that access to credit positively influences farmers' participation in CF as credit fills the cash requirement gaps of farmers for purchasing agricultural inputs. Membership to equb has a positive and a significant coefficient indicating that it increases participation in CF. Equb membership might show the economic status of the farmer, which can attract contracting partners. The significant and positive effect of access to market information indicated that farmers who have more access to market information might be able to understand the importance of participating in CF than those who do not have market information. Market information is necessary on what to produce, when to produce and where to sale, especially for fresh vegetables, which is a risky business. The amount of livestock owned by a household has a positive, significant impact for participating in vegetables' CF. Livestock has a multitude of social and economic functions, and accumulation of livestock indicates prestige, which might help them to join vegetable CF easily. In the same vein, an increase in family size decreases the probability of participation in vegetables' contract farming.

This probably means that households with large family sizes tend to produce fewer vegetables as they focus on staple food crops to cover household consumption.

The second step in PSM estimation is to ensure that propensity scores are balanced across treatment and comparison groups. In setting the common support conditions, the minima and maxima comparison was made. The estimated propensity scores as shown in Table 4, varies between 0.130 and 0.813 with a mean of 0.402 for participating households and between 0.006 and 0.768 with a mean of 0.342 for non-participating households. Therefore, the common support region would then lie between 0.130 and 0.768. Because of this restriction, 15 households (4 participants and 11 non-participants) were dropped from the analysis in estimating the average effect of CF on the household's income.

Having completed estimation of the propensity scores and the common support region, the next step is seeking an appropriate matching estimator (or algorithm).

Based on the above stated criterion, the best matching estimator was Kernel matching with bwidth (0.1) was chosen since it balances all of the explanatory variables (i.e. results in insignificant mean differences between the two groups), bearing a low pseudo-R^2 value, and results in a large matched sample size.

Results in Table 6 show that after matching, the differences are no longer statistically significant, suggesting that matching helps reduce the bias associated with observable characteristics.

Table 4. Distribution of estimated propensity scores

Groups	Observation	Mean	Std. Dev.	Minimum	Maximum
All households	423	0.450	0.162	0.006	0.813
Participants	190	0.508	0.149	0.130	0.813
Non–participants	233	0.402	0.157	0.006	0.767

Source: Survey Data (2016).

Table 5. Performance of the different matching algorithms

Matching Estimator		Matching performance criteria			
		Balancing test*	Pseudo-R2	Matched sample size	Means bias
Nearest neighbor	neighbor(1)	9	0.007	408	4.3
	neighbor(2)	9	0.004	408	3.9
	neighbor(3)	9	0.006	408	4.4
	neighbor(4)	8	0.004	408	3.9
	neighbor(5)	9	0.007	408	4.8
Kernel	bwidth (0.1)	9	0.002	408	2.4
	bwidth (0.25)	9	0.011	408	7.8
	bwidth (0.5)	4	0.039	408	14.5
Caliper or Radius	Radius caliper (0.1)	9	0.002	408	3.0
	Radius caliper (0.25)	8	0.022	408	10.8
	Radius caliper (0.5)	5	0.054	408	17.1

* Number of independent variables with no statistically significant mean difference between the matched groups of households.

Source: Survey Data (2016).

Table 6. Balancing test

Variable	Matching sample	Mean		%reduct		t-test		V(T)/V(C)
		Treated	Control	%bias	Bias	t	P>|t|	
Sex	U	0.88	0.87	2		0.20	0.838	.
	M	0.871	0.87	0.8	57.6	0.08	0.935	.
Education	U	4.92	4.31	14.1		1.44	0.151	0.96
	M	4.81	4.67	3.3	76.8	0.32	0.751	0.97
Credit	U	0.41	0.30	23.1		2.37	0.018	.
	M	0.40	0.39	2.7	88.1	0.26	0.797	.
"equb[a]"	U	0.35	0.23	27.8		2.86	0.004	.
	M	0.345	0.34	0.3	98.9	0.03	0.977	.
Family size	U	3.04	3.42	-40.7		-4.09	0.000	0.48*
	M	3.06	3.03	3.2	92.1	0.37	0.710	0.83
Distance to road	U	3.33	4.58	-26.7		-2.65	0.008	0.23*
	M	3.35	3.45	-2	92.5	-0.33	0.739	1.29
Market information	U	0.85	0.69	39.2		3.95	0.000	.
	M	0.85	0.826	5.8	85.2	0.62	0.534	.
Age	U	40.89	42.38	-12.3		-1.26	0.210	0.87
	M	41.01	40.89	1	92.1	0.10	0.924	0.93
Livestock	U	16.38	11.39	30.9		3.19	0.002	1.44*
	M	15.55	15.13	2.5	91.7	0.23	0.818	0.82

* if variance ratio outside [0.75; 1.33] for U and [0.75; 1.34] for Matched sample

Source: Survey Data (2016).
[a]Equb is a communal type of saving arrangement whereby people raise capital for their business.

The final step in the PSM process is to estimate treatment effects on the outcome variable in the matched sample through a t-test. After controlling for pre-participation differences, it has been found that, on average, participating CF have increased income by 8533.68 Ethiopian Birr. This means that CF has increased the income of participating households by 32%. Focus group discussions also confirmed that participants are enjoying considerable benefits in terms of livestock and other asset ownership since they started producing vegetables on contractual basis. This finding is consistent with the findings of Saigenji and Zeller (2009) where farmers participating in CF earn significantly higher income compared to non-contract farmers. Begum (2005) also compared non-contract and contract poultry farms' income and concluded that if small farmers enter into the CF system, they obtain substantial income gains.

Table 7. Effect of CF on household's income

Sample	Treated	Controls	Difference	S.E.	T-stat
Unmatched	27296.80	16155.70	11141.05	2114.55	5.27
ATT	26679.50	18145.80	8533.68	2347.89	3.63

Source: Survey Data (2016).

The sensitivity test is the final step used to investigate whether the causal effect estimated from the PSM is susceptible to the influence of unobserved covariates.

The legitimacy of propensity score analysis is based on the assumption of strongly ignorable treatment assignment that assumes all relevant covariates are employed in the treatment assignment and the bias due to the unmeasured covariates is ignorable. The sensitivity analysis in Table 8 shows that the impact result estimates are insensitive to unobserved selection bias. That means for all outcome variables estimated, at various level of critical values of gamma, the p-critical values are significant which further indicate that we have considered important covariates that affected both participation and outcome variables. We could not get the critical value gamma where the estimated ATT is questioned even if we have set largely up to 10. Thus, we can conclude that our impact estimates (ATT) are insensitive to unobserved selection bias and are a pure effect of participation in vegetable contract farming.

Table 8. Rosenbaum bounds sensitivity analysis

Gamma*	sig+	sig-
1	0	0
2	0	0
3	8.90E-16	0
4	2.80E-12	0
5	3.50E-10	0
6	9.20E-09	0
7	9.40E-08	0
8	5.50E-07	0
9	2.20E-06	0
10	6.50E-06	0

* gamma - log odds of differential assignment due to unobserved factors
sig+ - upper bound significance level
sig- - lower bound significance level

Source: Survey Data (2016).

4. Conclusion and Recommendations

Contract farming is a system for the production and supply of agricultural produce under agreement between producer and buyer. This study mainly focused on impact of vegetables' CF on household's income. The data were generated from both primary and secondary sources. The primary data were generated from 423(190 participants and 233 non-participants) randomly selected vegetable farmers through a formal survey using semi-structured pre-tested questionnaire and focus group discussions. Data were collected from four potential vegetable producing districts in East Shewa zone. PSM was used to evaluate the impact of vegetables' CF on smallholder farmers' incomes. The findings of the study indicate that farmers who participated in CF had a higher income than farmers who did not participated in vegetables' CF. Probit model indicated that credit, equb membership, access to market information and livestock ownership were found to significantly increase the probability of farmers' participation in CF. However, family size and distance to all weather road were found to significantly reduce participation CF. The transmission of information, financial constraints, assets and infrastructural development are the key factors influencing CF participation. Moreover, further study should be conducted to evaluate the relation between risks and CF in Ethiopia.

Acknowledgments

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