Impact of Farmers Training Centers Based Training on Major Crops Productivity and Households Welfare: the case of Gurage Zone, Central Ethiopia

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Research Article

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Abstract

The purpose of this paper is to identify the impact of Farmers Training Centers Based Training on Major Crops Productivity and Households Welfare in southern Ethiopia. To select the respondent households applied a multi-stage stratifying sampling method. First, 3 districts Were selected purposively. Then, 3 Rural Kebeles from Fully functional Farmers Training Centers and 2 Rural Kebeles from non-functional Farmers Training Centers Were randomly selected. In the third stage, a total of 360 sample household heads (151) modular training graduates and 209 non-graduates) were selected. The interview schedule, focus group discussions, and key informant interviews were data collection tools. The result indicates the frequency of extension contact and farmers Confidence in extension service significantly affects both trained and not trained farmer's crop productivity. I find that trained farmers have 124.27% more net cereal crop income per cultivated land size as compared to the counterfactual scenario of non-trained. I find that it increases the consumption expenditure per adult equivalent of trained farmers by about 204.83% compared to the counterfactual scenario of non-trained. The constraint which is considered by the respondents as a first-rank and important constraint was the fence problem which accounts for 21.63% of the total respondents. Farmer training center-based modular training could be considered as a key pathway that contributes to the improvement of agricultural production and Welfare of the rural community. The output of this study will give concrete information on intervention strategies to enhance the role of FTC-based training intervention strategies to improve farmers' livelihood in surrounding rural areas.

Background

Agricultural extension service prominent scholars argued that FTC-based training provides important benefits in a range of farming systems around the globe (Birkhaeuser et al. 1991; Swanson 2008; Dercon et al. 2009; Benin et al. 2012, Wordofa and Sassi, 2018). And it is a key to mobilize the farming community towards development for the betterment of their life and the country's development at large (Luchia, 2010). The contribution that training can make to agricultural development is substantial. Berhanu et al (2006) also argued that to bring real transformation in the agricultural sector, farmers must be trained to improve their knowledge, skill, and attitude towards deciding in their affairs, access to information, exposure to improved farming and living practices. This shows the role of FTC-based training in improving farmers' productivity and agricultural transformation from subsistence to market-oriented one, which contributes to the development of the sector and the economy. Particularly, GZBARD (2017) reported FTCs in the study area to provide different training services on compost preparation, manure preparation, use of the improved seed, tillage practice, row planting, irrigation water management practices, cropping calendar, soil water conservation practices, and use of credit, forage husbandry, animal housing, zero-grazing, and fattening.

For instance, Dercon et al (2009) study the blow of agricultural advisory services on-farm households' poverty and consumption growth, but the study considered only one component of agricultural advisor services (namely advice/visit) and did not take into account either training or demonstration. Furthermore, Wordofa and Sassi (2018) rigorously evaluated the impact of FTC-based training on households' farm income, but it focused on only one district (Haramaya district). Besides, they recommended the inclusion of more FTCs from different agro-ecological zones of the country to evaluate the nationwide, regional and zonal level impact of the FTC-based training.

Most importantly, despite its crucial implication for policymaking in agriculture and rural development, to the best of our knowledge, there is no careful empirical study conducted on the impact of the FTC-based training on farmers' productivity and Welfare in the study area. An FTC-based training stipulation is a to some extent recent advance (i.e., since the year 2000), and there is very superficial prose on it (Davis et al. 2010). Therefore, recognizing the gaps in empirical investigations, scarcity of evidence of the impact of FTC-based training, suggestions of Gebremedhin et al.

(2006) and Dercon et al. (2009) on the importance of further inquiries, in this research I investigated the causal effect of FTC-based training on smallholder farmers major crops productivity and Welfare in the study area. In doing so, this study provides insight into determinants of participation to evaluate the inclusiveness of FTCs; evaluate the impact of modular training on the productivity and Welfare of farmers quantitatively, and examine if modular training graduation has a heterogeneous impact on Well-being among its participant that allows understanding how training can be more effective in improving the well-being of the rural community. Thus, this study is filling the information gaps on the issue to recommend further intervention.

Methods

Description of the study area

Gurage Zone is one of the zones found in the Ethiopian Southern Nations, Nationalities, and Peoples Region (SNNPR). It is located in the Eastern part of central Ethiopia; it is bordered on the south by Hadiya on the Ist, North, and East by Oromia Region, Yem on the southeast, and the Southeast by Site Zone (Fig. 1).

Its land area is estimated at 593,200 hectares. The zone is divided into 13 woredas and two town administrations. These are Abeshgie, Cheha, Enemor-Ener, Endegagn, Kebena, Ezha, Geta, Gummer, Mareko, Kokir, MehurenaAklil, Meskan, SodoWoredas and Butajira and Wolkite town administrations.The total population of the zone is estimated to be 1,398,945 (Gurage Zone Finance and Economic Development Department, 2010 population projection) having a distribution of 680,047male and 718,898 female with percentages of 48.6 and 51.4, respectively

The majority of the population (90%) lives in rural areas leading an agricultural life. The nature of topography in the zone exhibits three categories. These are the mountainous high land (represented by the Gurage Mountain chain, dividing the zone east to Ist, having an elevation of 3600 m), the plateau flatlands, and the low stretching area (the Eastern fringe of the rift valley and the Wabe-Gibe valley having an elevation of 1000 m).

Sampling technique and sample size

The study was applied a multi-stage stratifying sampling method to select sample households. In the first stage, three districts, namely Abeshge, Cheha, and Eza of Gurage zone Were purposively selected based on their potential in the production of crops, availability of established and functional FTCs. In the second stage, teff & wheat-producing Pas in the selected districts Were stratified into two: Pas with FTCs delivering modular training and Pas without FTCs delivering modular training. Then, 3 PAs from Fully functional FTCs and 2 PAs from PAs without functional FTCs Were randomly selected. In the third stage, a total of 360 sample household heads (151modular training graduates and 209 non-graduates) Were selected.

Data Set and Methods of Collection

For this study, both primary and secondary data that are quantitative and qualitative Were used. Primary data on Welfare status indicators, major crop yield, types, and quantity of inputs used in the production of major crops, and other demographic, social, economic, institutional, and ecological factors will be collected. This data was collected using an interview schedule through enumerators and the researchers. The enumerators Were trained on how to conduct the interview questions and how to approach household heads during the interview. To revise and modify the questions Were for the final data collection, a pre-test was conducted on randomly selected respondents living in the sample Kebeles. In addition to this, FGD, and key informant interviews Were employed to supplement the research finding with qualitative information.

Secondary data on aggregate major crops production, aggregate inputs used, the status of improved variety use and major constraints in operating FTCs in the study area, etc., Were obtained from various sources such as records, reports, etc, of both governmental and non-governmental organizations such as both Gurage zone and sample districts office of agriculture and rural development, finance and economic office, regional offices, etc.

Methods of Data Analysis

To analyze the data to be collected, the study was employed descriptive statistics, inferential statistics, and econometric models.

Descriptive and Inferential statistics

The study was employed descriptive statistics such as mean, percentage, frequency, and standard deviation to describe farmers' cereal crops production status, Welfare indicator, input usage, constraints facing FTCs, and different demographic, social, economic, institutional, and ecological factors of the farm households in the study area. Besides, inferential statistics such as independent t-test Were used to compare train farm households and non-train households in terms of different characteristics.

Econometric models

To address the objectives, this study was employed stochastic production frontier models (to construct productivity outcome variables) and impact evaluation models (Endogenous switching regression models). Estimation of the impact of program intervention on agricultural productivity and Welfare of the farm households based on non-experimental observations is not trivial because of the need to identify the counterfactual situation had they not had to get involved in the program (Lajqi et al, 2017). In experimental studies, this problem is addressed by randomly assigning farmers to the treatment and control group, where the outcome variable observed on the control farmers is statistically representative of what would have occurred without participation for treated farmers.

However, farmers are not randomly distributed to the two groups (treatment and control), but rather farmers make their own choices or are systematically selected based on their tendency to participate in the program. Thus, in the absence of random assignments, selection bias may persist as observed and unobserved characteristics of individuals may affect the likelihood of receiving treatments as Well as outcome indicators (Wossen et al, 2017). Failure to account for this potential selection bias could lead to inconsistent estimates of the impact of program intervention on the outcome variables (Lajqiet al, 2017).

In this study, ESR econometric models Are estimated to address the objectives and to control selection and endogeneity bias in the estimation of the impact of the modular training on farmers' productivity and Well-being.

The study also employed endogenous switching regression that accounts for both observed and unobserved sources of bias (Lokshin and Sajaia, 2004; Shiferaw et al., 2014; Ma &Abdulai, 2016; Ahmed et al, 2017). The ESR approach addresses this endogeneity problem by estimating the selection and outcome equations simultaneously using the full information maximum likelihood (FIML) (Lokshin and Sajaia, 2004; Ma &Abdulai, 2016; Ahmed et al, 2017). But, it has its limitations and the limitations of switching regression (e.g. tri-variety normal distribution and lack of exclusion restriction) are acknowledged.

Specification of the models

The ESR framework follows two stages. The first stage is an estimation of the selection equation, the decision to participate in the program, which is estimated using a probit model (Equation 1), and in the second stage, an Ordinary Least Squares (OLS) regression (Equation 2) with selectivity correction is used to examine the relationship between the outcome variable and a set of explanatory variables conditional on the participation decision (Shiferaw et al, 2014; Khonje et al., 2015). ESR is specified as:

$$T_i^* = Z_i\alpha + \varepsilon_i \; with \; T_i = \begin{cases} 1 \;\; if \;\; T_i^* > 0 \\ 0 \;\; otherwise \end{cases} \qquad (1)$$

where T is a binary 0 or 1 dummy variable; T= 1if the household is graduated (participant) and T=0 otherwise, α is a vector of parameters to be estimated, Z is a vector that represents household-and farm-level characteristics, and ε is the random error term.

$$\text{Regime 1 (Participants):} \qquad y_{1i} = x_{1i}\beta_1 + w_{1i} \quad if \; T = 1 \qquad (2a)$$

$$\text{Regime 2 (Non} - \text{participants):} \qquad y_{2i} = x_{2i}\beta_2 + w_{2i} \quad if \; T = 0 \qquad (2b)$$

Where $y1i$ and $2i$ represent Welfare outcome variables such as major crop efficiency and consumption per capita, $x1i$ and $x2i$ are vectors of exogenous covariates, $\beta 1$ and $\beta 2$ are vectors of parameters; and $w1i$and $w2i$are random disturbance terms.

Definition of Variables

Outcome variables

Cereal crops productivity: To measure the impact of modular training on the cereal crops productivity; the study considered the net income from cereal crops per cultivated land as our outcome variable. Following the approaches used by Tesfaye et al (2019) and Matsumoto and Yamano (2010), this study used household's net income from crops per land covered by cereal crops.

Households Welfare: to represent the Welfare of the households the study used consumption expenditure per adult equivalent unit (AEU) which is regarded as a good proxy variable for the outcome variable.

Selection variable

Modular training Graduation: it is a dummy variable that takes 1 if the farmer is graduated with a green certificate (trained) and 0 otherwise.

Result And Discussion

Demographic and socio-economic characteristics of households

Tables 2 and 3 presents descriptive statistics result on different farmers demographic, social, economic and institutional characteristics.

Table 1
Definition of explanatory variables used in the study and their hypothesis

Explanatory Variables	Measurement	Hypothesis
Sex of the HH head	It is a dummy variable that takes the value 1 for male and 0 for female	-
Age squared of the HH head	It is a continuous variable measured in years	+
Education status of the HH head	It is a continuous variable measured in years of schooling	-
Spouse education	It is a dummy variable that takes value 1 if engaged in formal education and 0 otherwise	+
Experience in wheat production	It is a continuous variable measured in years	
Family size	It is a continuous variable that indicates the number of members living with the household	+
Livestock holding	It is a continuous variable measured in Tropical Livestock Unit (TLU)	-
Land size	The continuous variable measured in Hectare of land	-
Access to off/non-farm activities	It is a dummy variable, which takes the value 1 if yes and 0 otherwise	-
Frequency of extension contact	A continuous variable measured in the number of visits	-
Access to credit	It is a dummy variable, which takes the value 1 if the household had access to credit and 0 otherwise	-
Confidence in extension service	It is a dummy variable, which takes the value 1 if yes and 0 otherwise	-
Distance to market	It is a continuous variable measured in kilometers from home to the nearest market	+
Distance to FTC	It is a continuous variable measured in kilometers from home to the Farmers training center	-
Cooperative membership	It is a dummy variable, which takes the value 1 if the household is a member of any and 0 otherwise	+
Social responsibility	It is a dummy variable, which takes the value 1 if the household is a leader and 0 otherwise	

Table 2
descriptive and inferential statistics result on discrete variables

Independent Variables	Response	Total		Not-trained		Trained	
		N	**%**	**N**	**%**	**N**	**%**
Sex of household head	Female	63	17.78	44	22.01	19	11.93
	Male	293	82.22	156	77.99	137	88.07
Social responsibility of the HH	No	129	36.12	76	39.3	50	31.8
	Yes	227	63.88	121	60.7	106	68.2
Cooperative membership status	No	214	60.3	126	63.2	88	56.3
	Yes	142	39.7	74	36.8	68	43.7
Access to credit	No	223	62.78	126	63.16	97	62.26
	Yes	133	37.22	74	36.84	59	37.74
Confidence on extension service	No	35	9.73	27	13.4	7	4.7
	Yes	321	90.27	173	86.6	149	95.3
Access to off & non-farm activities	No	199	55.84	108	54.1	91	58.3
	Yes	157	44.16	92	45.9	65	41.7

Table 3
Descriptive and inferential statistics result on the continuous explanatory variable

Variables	Total		Not trained		Trained		t-value
	Mean	Std. err	Mean	Std. err	Mean	Std. err	
Age of Household head (Years)	45.758	9.584	45.492	9.673	46.125	9.479	-0.617
Education of HH heads (Years)	6.916	3.548	7.066	3.595	6.708	3.484	0.945
Spouse education	2.633	3.374	2.650	3.473	2.609	3.243	0.1148
Family size (No.)	5.688	2.893	5.600	2.849	5.811	2.959	-0.681
Farm size	3.09	3.187	2.977	2.592	3.246	3.867	-0.791
FTC experience	7.391	4.142	7.263	4.170	7.569	4.109	-0.692
Income crop	25867.22	2543.308	25499.04	3359.307	26376.82	3904.668	-0.170
Income livestock	6182.222	512.131	6268.852	690.5808	6062.316	9367.072	0.1987
Total income	35029.72	2704.827	34925.31	3568.133	35174.24	51124.59	– .0454
Off-farm &/or non-farm income (Birr)	2953.056	325.541	3038.995	426.327	2834.106	505..664	0.310
Livestock ownership (TLU)	7.166	5.661	7.339	5.739	6.925	5.561	0.684
Distance to market (km)	60.1	2.22	60.15	2.76	62.12	3.69	-0.44
Frequency of extension contact (No.)	2.186	2.024	2.129	1.922	2.264	2.161	-0.627
Distance to FTC(km)	25.430	21.331	24.545	19.578	26.655	23.556	-0.926
*, **, and *** indicates significant at 10, 5, and 1% probability level respectively.							

The result revealed that 82.22% of the respondents Were male-headed farmers, implying that the majority of the sampled farmers Were male-headed. More specifically, 77.99% and 88.07% of not trained and trained, respectively, Were male-headed households. Besides, 63.88% of the sampled household heads had leadership responsibility in the community, and the proportion of not trained farmers engagement in social responsibility was lolr (60.7%) compared to trained farmers proportion, which is 68.2%.

Further, the proportion of trained farmers' membership in cooperatives (43.7%) was higher than the proportion of total sampled farmers (39.7%) and not trained (36.8%) who Were members of cooperatives. Overall, it implies that the majority of the sampled households Were not a member of agricultural cooperatives. Furthermore, 37.22% of the sampled households had access to credit services. Specifically, 37.74% and 36.84% of trained and not trained farmers, respectively, had access to credit services. It also revealed that 44.16 % of the households had access to off-farm and/or non-farm income-earning opportunities, which implies that more than half of the farmers had no access to off-farm and/or non-farm opportunities. In this scenario, the off/non-farm activities participation status of not trained (45.9%) was higher than the trained 41.7% farmer's participation status (Table 2).

Moreover, the study confirmed that 90.27% of the households reported that they had confidence in the extension service provided to them, and 86.6% and 95.3% of not trained and trained farmers, respectively, reported that they had confidence in the extension service. These imply that the majority of the sampled households had confidence in the extension service provided in the study area.

Regarding continuous variables, the result should that the average age of the sample farmers was 45.76 years. More specifically, trained respondents and not trained respondents have an average age of 46.1 and 45.5 respectively. Besides, the average year of schooling of the sampled farmers was 6.9 years, with mean years of schooling of 7.1 and 6.7 for not-trained and trained farmers, respectively. It also indicates that the mean family size of the trained households' was 5. 8 members, which was higher than the average family size of sampled farmers (5.7 members) and not-trained farmers (5.6 members). Moreover, the mean experience of households in FTC experience of sampled farmers, not trained and trained was 7.4, 7.3, and 7.5 years, respectively.

It also should that the average farm size of the trained households was 3.23 hectares, and it was higher than the mean farm size of not trained farmers (2.97hectare) and sampled households (3.09 hectares). The mean distance of households from the nearest market and farmers' training center was 60.1 and 25.43 kilometers, respectively. The result also pointed out that the average frequency of extension contact of sampled households with extension agents in the study area was 2.186 times per month. It was lolr than the mean frequency of extension contact trained farmers (2.264 visits) and higher than not trained farmers average contacts (2.129 visits). It also revealed that the mean livestock holding of the sampled households, not trained and trained was 7.166, 7.339, and 6.925 tropical livestock units, respectively. The average amount of total income of respondents was 35029.72 birr. This average was higher than the mean amount of total income of not trained 34925.31and lolr than the mean applied by trained farmers 35174.24 birrs (Table 3).

In general, the Descriptive and inferential statistics result in continuous explanatory variables of trained and not-trained households. The result shows that statistically there is no significant difference between the two groups in terms of age, education level of household, spouse education level, family size, farm size, FTC experience, total income, and frequency of extension contacts. Compared to not-trained households, trained households had larger income from crops. Similarly, compared to not trained households, trained households encountered far distance to market.

Determinants of farmer's participation in FTC modular training in the study area

The Probit model was estimated the log-likelihood of the explanatory variables that influence the farmer's participation in FTC modular training, the level of significance and true relationship of this influence was also appropriately estimated and indicated by the model.

The finding reveals that an increase in the level of any of the explanatory variables with positive sign Cooperative membership, Sex of the household head, family size, farm size, Confidence in extension service, Social responsibility, and Livestock ownership, in this case, has a positive effect on the farmer's participation in FTC modular training, whereas those explanatory variables with a negative sign, Age squared of the household head, Education, Access to credit, Distance from the market center, Distance from FTC and Access to off and/or non-farm activity exert a negative relationship on farmer's participation in FTC modular training. Among these variables Household size in AE, Cooperative membership, and Confidence in extension service significant at 5 percent and 1 percent significant level. This indicates that it is a strong factor considered for farmer participation in FTC modular Training although its

coefficient being positive is contrary to a priori expectation because it is expected to be contributing negatively to participation, the positive sign could be attributed to more emphasis being placed on FTC modular Training (Table 4).

Table 4
Probit model result on the determinants of households' participation in modular FTC training.

Variables	Coefficients	Std. error	P>|z|
Constant	0.3520	1.8715	-3.316
Age squared of the hh head	-0.3183	0.2687	0.236
Cooperative membership	0.4575	0.2250	0.042**
Sex of the hh head	0.4196	0.2245	0.062
Education	-0.0281	0.1156	0.807
Household size in AE	0.4038	0.1972	0.041**
Farm size	0.0817	0.1618	0.073
Access to credit	-0.2622	0.1992	0.188
Distance from the market center	-0.0074	0.1104	0.946
Distance from FTC	-0.0345	-0.0345	0.731
Livestock ownership	0.0147	0.1081	0.891
Access to off and/or non-farm activity	-0.0923	0.1745	0.597
Social responsibility	0.1802	0.1931	0.351
Spouse education	0.0110	0.0244	0.651
Confidence on extension service	0.8057	0.2871	0.005***
Number of observations	356		
LR chi2(14)	35.30		
Log-likelihood	-224.3644		
Prob > chi2	0.0087		

Impact Evaluation Result

As specified in the estimation strategy part, the study employed endogenous switching regression (ESR) model to estimate the impact of modular training on outcome variables. The full information maximum likelihood (FIML) estimates of the ESR model are presented in Tables 5 and 6. The Wald tests presented in Tables 7 and 8 confirm the joint significance of the error correlation coefficients in the selection and outcome equations.

Table 5
switching regression model on the impact of modular training on crop productivity

Variables	Selection			Non-trained			Trained		
	Coef.	Std. err	P>|z|	Coef.	Std. err	P>|z|	Coef.	Std. err	P>|z|
Constant	0.049	1.939	0.980	8.039	4.378	0.066	9.544	2.575	0.000
Ln of age squared of the hh head	-0.464	0.286	0.005***	-0.549	0.587	0.349	-0.261	0.342	0.443
Cooperative membership	0.463	0.236	0.050**	0.139	0.682	0.839	0.200	0.329	0.543
Sex of the hh head	0.402	0.226	0.076	1.553	0.542	0.004***	0.014	0.391	0.972
Education	0.024	0.129	0.853	0.047	0.303	0.877	-0.430	0.173	0.013**
Ln of hh size	0.508	0.169	0.003***				-0.021	0.058	0.710
Ln of farm size	-0.266	0.161	0.100	-0.195	0.471	0.678	-0.556	0.255	0.030**
Access to credit	-0.254	0.207	0.221	-1.186	0.588	0.486	-1.038	0.294	0.000***
Ln of distance from the market center	0.045	0.113	0.687	0.377	0.311	0.224	0.606	0.160	0.000***
Ln of distance from FTC	-0.045	0.100	0.647	-0.443	0.279	0.087	-0.427	0.149	0.004***
Ln of livestock ownership	0.060	0.114	0.600	0.663	0.273	0.015***	0.661	0.175	0.000***
Access to off and/or non-farm activity	-0.085	0.175	0.628	-0.405	0.476	0.394	-0.418	0.266	0.117
Ln of frequency of extension contact	0.310	0.114	0.006***	-0..018	0.328	0.957	-0.129	0.192	0.499
Experience in FTC	-0.066	0.185	0.721	-0.442	0.492	0.369	-0.869	0.283	0.002***
Soil fertility status	0.158	0.150	0.293	0.257	0.369	0.486	0.670	0.216	0.002***
Social responsibility	0.070	0.197	0.723	0.096	0.567	0.865	-0.260	0.275	0.344
Spouse education	0.009	0.028	0.733	-0.015	0.069	0.823	0.094	0.043	0.033**

Variables	Selection			Non-trained			Trained		
	Coef.	Std. err	P>|z|	Coef.	Std. err	P>|z|	Coef.	Std. err	P>|z|
Confidence on extension service	1.364	0.282	0.000***						
Sigma					1.255416		2.894945		
Rho					-0.23345		-0.787		
Number of observations					356				
Wald chi2(16)					135.88				
Log-likelihood					-931.21182				
Prob > chi2					0.0011				
LR test of indep. eqns. :					chi(1) = 22.07 Prob > chi2 = 0.0000				

Table 6
switching regression model on the impact of modular training on household Welfare

Variables	Selection			Non-trained			Trained		
	Coef.	Std. err	P>|z|	Coef.	Std. err	P>|z|	Coef.	Std. err	P>|z|
Constant				7.730	3.730	0.038**	8.693	1.754	0.000
Ln of age squared of the hh head	-0.179	0.292	0.539	-0.424	0.500	0.397	-0.627	0.225	0.005***
Cooperative membership	0.446	0.225	0.047**	0.917	0.590	0.122	0.173	0.235	0.460
Sex of the hh head	0.377	0.221	0.088	1.759	0.473	0.000***	0.129	0.258	0.616
Education	0.019	0.025	0.433	0.085	0.259	0.743	0.120	0.114	0.292
Ln of hh size	0.440	0.390	0.260						
Ln of farm size	-0.282	0.167	0.091	0.291	0.413	0.481	0.354	0.181	0.050**
Access to credit	-0.291	0.201	0.147	-0.417	0.489	0.394	0.441	0.193	0.023**
Ln of distance from the market center	0.040	0.116	0.726	-0.067	0.267	0.802	0.360	0.105	0.001***
Ln of distance from FTC	-0.025	0.101	0.808	-0.009	0.243	0.969	0.210	0.099	0.033
Ln of livestock ownership	0.064	0.109	0.556	0.250	0.232	0.281	0.109	0.116	0.347
Access to off and/or non-farm activity	-0.095	0.180	0.596	-0.471	0.411	0.621	0.354	0.178	0.047**
Ln of frequency of extension contact	0.277	0.114	0.015***	0.270	0.284	0.340	0.556	0.134	0.000***
Experience in FTC	-0.071	0.195	0.716	-0.640	0423	0.130	-0.158	0.188	0.402
Soil fertility status									
Social responsibility	0.119	0.211	0.572	0.872	0.481	0.070	0.465	0.177	0.009***
Spouse education	0.019	0.246	0.433	0.020	0.054	0.706	0.100	0.025	0.000***
Confidence on extension service	1.224	0.399	0.002***						
Sigma					0.8367		2.40655		
Rho					0.22139		-0.62845		

Variables	Selection			Non-trained			Trained		
	Coef.	Std. err	P>|z|	Coef.	Std. err	P>|z|	Coef.	Std. err	P>|z|
Number of observations				356					
Wald chi2(14)				211.30					
Log-likelihood				-853.897					
Prob > chi2				0.0011					
LR test of indep. eqns. :				chi(1) = 10.58 Prob > chi2 = 0.0011					

Table 7
Endogenous switching regression-based treatment effects

Outcomes	Household type and treatment effects	Decision stage		ATEs
		To train	**Not to train**	
Ln Net cereal crops income per cultivated land	Trained (ATT)	11.05318	5.37442	6.67876(0.65459)***
	Non-trained (ATU)	9.554462	5.164292	4.39017(0.314171)**
	Heterogeneous effects	1.498718	0.210128	2.28859

Note: ATT – Average Treatment Effect on the Treated, ATU – Average Treatment Effect on the Untreated, ATE – Average Treatment Effects; Standard errors in parentheses;

Table 8
Endogenous switching regression-based treatment effects

Outcomes	Household type and treatment effects	Decision stage		ATEs
		To train	**Not to train**	
Consumption expenditure per adult equivalent	Trained (ATT)	91.67432	30.0739	61.60042(4.59535)***
	Non-trained (ATU)	75.6088	22.0562	53.5526(11.61507)**
	Heterogeneous effects	16.06552	8.0177	8.04782

Note: ATT – Average Treatment Effect on the Treated, ATU – Average Treatment Effect on the Untreated, ATE – Average Treatment Effects; Standard errors in parentheses; consumption expenditure per adult equivalent is log-transformed.

Factors Affecting Crop Productivity and Household Welfare

The finding of the study indicates that Access to credit, household head education, distance from the market center, distance from FTC, livestock ownership, Experience in FTC, Soil fertility status, Spouse education, farm size, significantly affect Crop Productivity(Table 5).

The finding of the study indicates that cooperative membership significantly affects crop productivity of trained and not trained farmers (Table 5). Membership in cooperatives increased trained and not trained farmer's crop productivity. This could be due to cooperative organizations engage in the provision of inputs and collecting final outputs produced, which improves farmers' efficiency in production.

Crop productivity, of both trained and not trained farmers, was lolr for households in the lolr and higher age of years, whereas it was higher for households in middle years of age. This shows that as the age of the farmers increases first crop productivity increases and then starts declining. This finding supports the findings of (Chauke P et al., 2014), who argued that young households earn more income from crop production than older ones.

The finding of the study indicates that Frequency of extension contact and farmers Confidence in extension service significantly affect both trained and not trained farmer's crop productivity.

It also should that owning more TLU of livestock increases Trained and not trained farmers' crop productivity. This finding is in line with (Abafit, J. and Kim K., 2014) and suggested that more TLU of livestock ownership helps to cultivate more land through the provision of traction post, manure, and provides transport service to market the produce. Also, the finding indicated that household size positively affects adopter farmers' income from crop production. This could be due to households with larger family size

Besides, the finding indicated that household size positively affects both trained and not trained farmers' crop productivity. This could be due to households with larger family sizes accept high risks in experimenting with technologies to attain the maximum possible production from their farm to meet family demands (Khonje, M. et al., 2015).

Education of the farmers positively affected crop productivity of modular trained farmers. This is because educated farmers access information (both print and electronic) on the benefits and potential risks of improved varieties much easier (Chauke P et al., 2014). Furthermore, the finding of the study pointed out that more experience in FTC enhanced crop productivity of trained farmers. This is due to experience in FTC enables farmers to better understand and exploit the means of increasing production and obtaining more yield from crop production.

The estimated ESR model result of the impact of modular training on household Welfare pointed out that cooperative membership, frequency of extension agent contact, and confidence in extension service Were significantly affected the Welfare of both trained and not trained farmers. Besides, it figured out that age squared, farm size, distance from the market center, access to credit, access to off and/non-farm activity, frequency of extension contact, social responsibility, and spouse education significantly affected modular trained farmers Welfare (Table 6). The welfare of trained farmers was lolr for households in the lolr and higher age of years, whereas it was higher for households in middle years of age. This shows that as the age of the farmers increases first Welfare increases and then starts declining. The finding of the study also pointed out that more experience in modular training enhanced the Welfare of trained and not trained farmers. The Welfare of female-headed households was lolr than male-headed households among not-trained farmers.

It is similar to (Baten and Khan's, 2010) finding, which should that female-headed households have less access to valuable resources and earn less farm income than males. Farm size positively affected the Welfare trained farmers in the study area. This is because farmers with large farm sizes are more likely to have more opportunities to adopt modern technologies and earn more income to have Welfare (Ahmem M. et al., 2017. and, Chandio, A. A. and Yuansheng J., 2018). It also indicated that distance from the market center positively determined Welfare among

trained farmers. Besides, the result of the study revealed that access to off-farm and/or non-farm activities increases trained farmers Welfare.

Impact of Modular Training on Productivity in the Study Area

The Wald test presented in Table 5 confirms the joint significance of the error correlation coefficient in the selection and outcome equation. A significant correlation coefficient of the selection equation and some of the outcome equation indicates the presence of self-selection in the modular training participation. This also suggests that access to modular FTC training had a significant impact on net income from cereal crops per cultivated land (Table 7). I find that modular training has a positive impact on net income from cereal crops per cultivated land at $p < 0.01$. The finding indicates that participation in modular training increases net cereal crop income per cultivated land size by about birr 795.33 per hectare for training compared to a counterfactual scenario of non-trained. I find that it increases the net cereal crop income per cultivated land size of trained farmers by about 124.27% compared to the counterfactual scenario of non-trained. Furthermore, modular training had increased non-trained households' net cereal crop income per cultivated land size by birr 80.65 had they decided to train.

The positive base heterogeneity effect implies that trained households have higher net cereal crop income per cultivated land size not possible due to their decision to participate in the training, but possibly due to unobservable. Adjusting for the potential heterogeneity in the sample, there is evidence that households who decided to participate in the training tend to have benefits higher than the average if they participate (Di Falco et al., 2011). The positive transitional heterogeneity effect also indicates that the effect is lolr for non-trained households had they decided to use it.

Impact of modular training on households Welfare in the study area

The full information maximum likelihood (FIML) estimates of the ESR model are presented in Tables 6 and 8. The overall model is significant at 1%. The Wald tests confirm the joint significance of the error correlation coefficients in the selection and outcome equations (Table 6). Significant correlation coefficients of the selection equation and the outcome equation for households with modular training indicate the presence of self-selection in the participation of the training. This also suggests that participation in modular FTC training had a significant impact on the corresponding outcome among trained, and trained households would have gained greater Welfare from the training than non-trained had non-trained chosen to participate in the training (Wordofa and Sassi, 2018). I find that modular training has a positive impact on consumption expenditure per adult equivalent at $p < 0.01$. The finding indicates that modular training increases consumption expenditure by about birr 61.60042per adult equivalent for training compared to a counterfactual scenario of not to train.

I find that it increases the consumption expenditure per adult equivalent of trained farmers by about 204.83% compared to the counterfactual scenario of non-trained. Furthermore, modular training would have increased non-trained farmers' consumption expenditure per adult equivalent by 242.8% had they decided to train. A positive effect on consumption expenditure is expected since FTC modular training would help households increase their production and productivity through capacity building and provision of technical information related to different agronomic, animal health and husbandry, and natural resource conservation. Besides, relaxing risk-aversion to postharvest loss and encouraging farmer’s production of diverse crops, enhances households’ agricultural production (Oluwatoba et al, 2016). The result is in agreement with Wordofa and Sassi (2018) that report a positive link between modular training and household Welfare.

The positive base heterogeneity effect implies that trained households have higher Welfare not possible due to their decision to participate in the training, but possibly due to unobservables. Adjusting for the potential heterogeneity in the sample, there is evidence that households who decided to participate in the training tend to have benefits higher than the average irrespective of participation, but they are better off participating than not participating (Di Falco et al, 2011). Table 8 presents the expected values of the various outcomes under the actual and counterfactual conditions and the resulting treatment effects.

Major challenges facing the effective functioning of FTCs in the study area

To identify the lists of constraints that impede the effective functioning of FTCs extension agents', supervisors', experts' and team leaders' suggestions, formal and informal discussions with farmers and extension personnel, and the SWOT analysis Were considered.

The constraints list included ten items (Fig. 2) and among these, the constraint which is considered by the respondents as a first-rank and important constraint was the fence problem which accounts for 21.63%, for the second more than two problems which account for 15.73%, for the third lack of awareness about FTC by farmers accounts 12.08% and the last rank was a budget problem which accounts 5.05%.

Fence problem

the respondents stated the FTC demonstration site didn't have a fence. Due to this all demonstrated activity was damaged by wild and tame animals. FTC which has enough demonstration fields (3-5ha) will have a better status and good output. If not the result will be the opposite. It is measured in terms of effective functioning (Fisseha T., 2009).

Budget problem

It has been reported by numerous Respondents that due to inadequate financial investment to extension, the recruitment and retention of competent extension personnel, plus adequate provision for in-service training of staff and training of farmers, transportation, housing, and the conduct of extension programs cannot properly be carried out (Bahal, 2004). Therefore, an FTC which has a better status in budget allocation per year will have better status and good performance otherwise, it will be the reverse. The budget is measured in terms of Birr allocated for the FTCs per annum.

Lack of awareness about FTC by farmers

This reflects the involvement of the community from inception up to the evaluation of FTCs. In an FTC where the community participation is high the status of FTCs will be high (Fisseha T., 2009). In poor community participation, the status of FTCs will be poor. The participation is measured on an ordinal scale as poor, good, very good, excellent.

More than two problems(Infrastructure facilities, Equipment/material): the study FGD group member result revealed that the FTC has a shortage of different materials such as seats for trainees, chairs, tables, shelves, field equipment, and other facilities that are necessary for the teaching-learning process. An FTC which has fulfilled different internal facilities and field equipment will have better status. Infrastructure includes different buildings and services found in the FTC like classrooms, offices, residence, exhibition center, workshop, clinic, telecenter, etc. An FTC which has different buildings and services will have a better status and output. It is measured by the number of these services.

Conclusion

FTC modular training could be considered as a key pathway that contributes to the improvement of agricultural production and Welfare of the rural community. Using data collected from 356 households, the study analyzed cereal crops productivity and Welfare impacts of modular training in the Gurage Zone of central Ethiopia. The study used net cereal crop's income per area covered by cereals to capture productivity and used consumption expenditure per adult equivalent as an indicator of Welfare of households. The study finding indicated that cooperative membership, sex of the household head, family size, farm size, confidence in extension service, social responsibility, and Livestock ownership encourage households participation in modular training, while age squared of the household head, education, access to credit, distance from the market center, distance from FTC and access to off and/or non-farm activity negatively affect households participation decision.

Regarding impact evaluation, modular training has a positive impact on both productivities as Well as the Welfare of farmers. The positive impact implies that the modular training provides important technical and practical knowledge on agronomic practices that improve farmers' efficiency of production and enable them to earn more income from the allotted land. The more income farmers earn per cultivated land size, the more they spend on consumable items. Thus, it improves the Welfare of households by improving consumption expenditure per adult equivalent. Besides, the study evidence confirmed that fence problems, poor infrastructure, constraint in improved technology, and lack of awareness about FTC by farmers Are the major barriers to the effective functioning of FTCs.

Based on the evidence obtained from this finding, there is a need for urgent action aimed at addressing the need for improving household's access to FTC modular training to enhance their productivity and well-being in the study area. Policymakers need to consider the role of access to public infrastructure (cooperative membership and market center), extension (confidence on extension service), and education of the household head, household size, and livestock ownership in enabling the household's decision to participate in modular training. Improving middle age household's awareness, enhancing awareness of off and/or non-farm activity participating households should be a major part of any effort aimed at promoting household participation in modular training.

In terms of the impact of training on productivity, although a positive and significant impact was found, there is a need to strengthen and support farmer's participation in the training programs. The FTC-based modular training needs to encourage farmers to produce more cereal crops by providing training and production inputs. Moreover, there should be an increased effort towards the promotion of the provision of modular training as it improves the overall Welfare of cereal crop producer households.

Further research using detailed panel data is suggested to provide better evidence on the topic and to improve our understanding of the viability of modular training and its Welfare impact. Future studies could extend the scope of the analysis by using carefully planned household surveys that capture in-depth and detailed data using panel data.

Abbreviations

ATE: Average Treatment Effects; **ATT**: Average Treatment Effect on the Treated; **ATU**: Average Treatment Effect on the Untreated; **FGD**: focus group discussion; **FTC**: farmer training center; **HH**: household; **SWOT**: strength weakness opportunity and threat; **fig**: figure;

Declarations

Competing interests: The author declares no competing interests.

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Figures

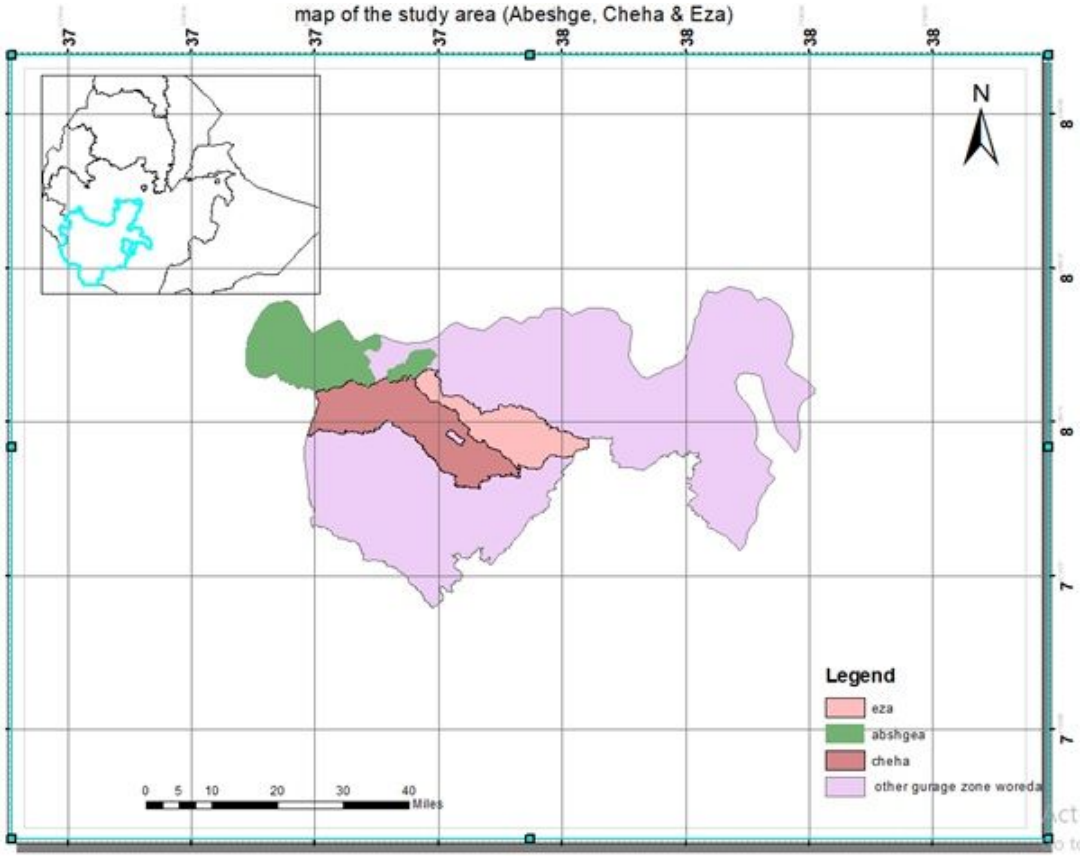

Figure 1

Map of the Study Area Source: Arc Map output, 2021

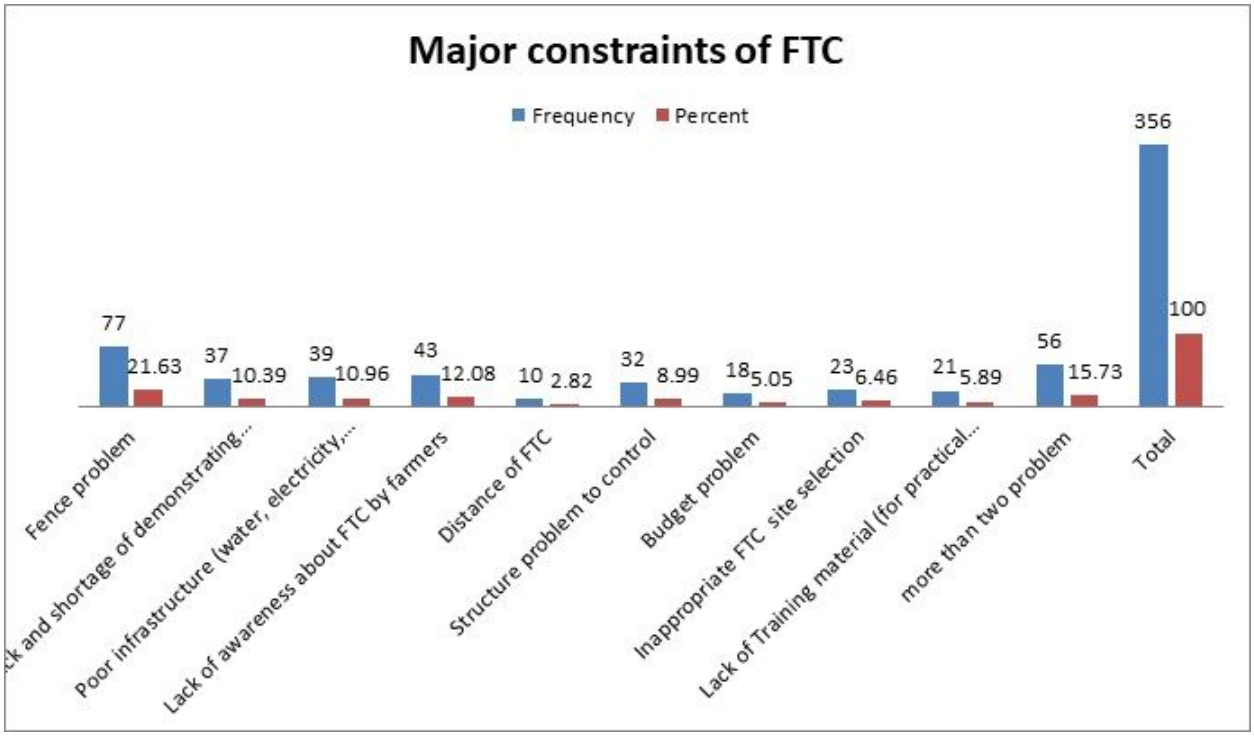

Figure 2

Major constraints of FTC around the study area Source: own survey result, 2021