Journal of Agriculture and Environment for International Development - JAEID 2023, 117 (1): 141 – 162
DOI: 10.36253/jaeid-12297

Commercialization of teff growers and determinants in west Ethiopia: Double hurdle model analysis

ZELALEM FIKADU[1], AMSALU MITIKU[2], GUTA REGASA MEGERSSA*[2]

[1] *College of Agriculture and Natural Resources, Assosa University, Ethiopia*

[2] *College of Agriculture and Veterinary Medicine, Jimma University, Ethiopia*

* *Correspondence details:* jiineguta2014@gmail.com

Submitted on: 2021, 15 November; accepted on 2022, 7 January. Section: Research Papers

Abstract: Promoting commercialization of agricultural production is a cornerstone of the rural development strategies of Ethiopia and commercialization of smallholder farming is not yet adequate enough to enable farmers be profitable. This study was designed to analyze the smallholder farmers' teff commercialization in Guduru District, Western Ethiopia. Two-stages sampling procedure was followed to select 154 teff producer farmers from four randomly selected *kebeles.* An interview schedule was used to collect household survey data during the 2016/2017 farming season. The Household Commercialization Index was used to assess the levels of market participation. Double Hurdle Model was used to identify the key factors that influence farmers' teff commercialization. The results revealed that about 78% of sampled farmers sold teff during a production year of 2016/2017. The model result indicated that education of household head, family size, land holding size, land allocated to teff, farm output, participation in off/non-farm activities, lagged teff market price, access to market information and cooperative membership were found to significantly influence the probability of participation in teff output market. Intensity of participation in the teff output market was significantly determined by sex of household head, age of household head, family size, family labor and distance to the nearest market. Based on the findings, the study recommends that government should give emphasize on rural education system, family planning program, productivity improving measures, access to communication facilities and institutional services, enhance the female headed households and improving rural roads.

Keywords: *smallholder farmers, teff commercialization, double hurdle model, Ethiopia*

Introduction

Smallholder family farming is the economic backbone in Sub-Saharan Africa (SSA), where smallholders, to a considerable degree, are oriented toward food production, primarily for their own consumption (AGRA, 2014). About 440 million farmers in developing countries practice subsistence production which is a large enduring misallocation of human and natural resources, and it is becoming less and less viable due to population pressure and natural resource constraints (Von Braun and Kenedy, 1994). The transition from low productivity, semi-subsistence agriculture to high productivity, commercialized agriculture has been a core theme of development and agricultural economics for half a century (Barrett, 2008).

In East African nations counting Kenya, Ethiopia, Uganda, and Tanzania smallholder cultivating accounts for around 75 percent of agrarian generation **(**Mazengia, 2016**).** In Ethiopia, roughly 95 percent of the entire range is developed by smallholder agriculturists and 90 percent of the whole rural yield comes out of them. This affirms the prevailing commitment of smallholder agriculturists to the generally rural development within the nation. It is progressively recognized that the commercialization of excess yield from small-scale cultivation is closely connected to higher efficiency, more prominent specialization, and a higher wage. Moreover, in a world of effective markets, commercialization leads to the division of households' generation choices from their utilization choices, supporting nourishment differences and in general solidness. At the large-scale level, commercialization has moreover appeared to extend nourishment security and, more for the most part, to make strides in allocative productivity (Timmer 1997). However, in the face of imperfect markets and high transaction costs, numerous smallholders are unable to misuse the potential gains from commercialization, and within the nonappearance of components to overcome these imperatives, smallholders are impossible to take part in markets or, when they do, to realize the total benefits of interest. These challenges are especially vital in Sub-Saharan African countries; among which Ethiopia is comprehended, where empirical evidence suggests that the proportion of farmers engaged in subsistence agriculture remains very high while those who participate in markets often do so only at the margins (Bernard *et al.,* 2007).

In Ethiopia, the agriculture sector remains a critical component of the government's economic development strategy, due to its central role in the life and livelihood of most of its population, where about twelve million smallholder farming households account for an estimated 95% of agricultural production (FAO, 2014). It remains the leading sector in terms of contribution to the country's overall economy as it accounts 38.8% share of GDP, contributes 73% of employment, and supplies 70% of the raw material requirements of local industries, 40% of output and exports (Wrold Bank, 2016). The country's aspiration for achieving overall economic growth largely depends on the performance of the agriculture sector (UNDP, 2015). The rate of agricultural growth in the country depends on the rate of transformation of the small-scale and subsistence agricultural sector to a market-led production system (MoARD, 2010). Thus, in Ethiopia agricultural commercialization is viewed as an

essential part of the process of agricultural modernization, specialization, and structural transformation of the economy toward more rapid and sustainable growth (Pender and Dawit, 2007).

In Ethiopia, teff is the most important crop which was grown on 22% of all cultivated land with the second most popular crop, maize, occupying 15% in 2013/14 (CSA, 2014). It is recognized that teff is a gluten-free, nutritious cereal whose consumption per capita has steadily increased over the last fifteen years, particularly in comparison to other cereals (Tafere *et al*., 2010; Hailu *et al.,* 2016). The same scholars confirmed that consumption increase has occurred primarily in urban households and annual urban consumption per capita was 81 kg as compared to 24 kg in rural areas. Thus, due to its high demand, income from teff is much higher than income from other cereals and makes teff the important cash crop in the country (Minten *et al*., 2013; Worku *et al*., 2014). Transforming the subsistence-oriented production system into a market-oriented production system has been in the policy spotlight of Ethiopia and commercialization of food crops has been given priority within growth and transformation plans. However, some sources showed that policy involvement in input and output marketing was weak (Alemu, 2010). Hence, it is not possible for the smallholder farmers to integrate with the market and enjoy the benefits of commercialization unless the already existing hurdles are removed and the policy formulation and implementation gap is narrowed.

In Ethiopia commercialization of smallholder farming is not yet adequate to enable farmers benefit from increased income and farmers are not yet out of the subsistence-oriented agriculture (Mahelet, 2007). Agricultural product markets are characterized by seasonal gluts and shortages which in turn affect the marketing behavior of producers, traders, and consumers (Jema, 2008). Other empirical studies have shown that average crop output sold is not more than quarter of what is produced from year to year (Leykun and Jemma, 2014). Despite efforts made to commercialize and transform Ethiopian agriculture from subsistence to production of high value crops, the sector's performance has been below expectations (Alelign, 2017). Thus, to ensure that farmers are consistent with the market where the large proportion of farmers engaged in subsistence agriculture remains very high and those who participate in markets often do so only at the margins several issues need to be analyzed. Even though high prices ensured that adoption of modern inputs brought high returns and poverty reduction for those well connected to markets, poor market access for farmers is binding constraint to rural income growth among a wide range of constraints to progress in Ethiopia (World Bank, 2016). The degree of commercialization at the local market level varies from market to market and from crop to crop, and ability for farmers to make investments in productivity-enhancing inputs and production methods (Barrett, 2008). The location and commodity-specific approaches work well in commercial transformation where numerous smallholders grow a variety of crops often both for subsistence and for sale in their survival which are diverse with varying farm and household characteristics (Delgado and Siamwalla, 1997). To this regard in the current policy push for smallholder commercialization, teff is one of the selected priority crops under the Ministry of Agriculture and Rural

Development's 2004 master plan for enhanced market-oriented production (Samuel and Sharp, 2008).

Teff is selective enterprise as it has become an important market-oriented crop, grown mainly as a cash crop by most farmers in Ethiopia (Demeke and Marcantonio, 2013); it is the most important crop for farm income and food security in Ethiopia (Minten *et al.,* 2015); It is the second most important cash crop after coffee and generating almost 500 million USD incomes per year for local farmers (Reda, 2015). As commercialization of subsistence agriculture may not instantly move onto high-value cash crops, increased market-orientation of staple food crop production offers a more pertinent option to smallholder farmers (Berhanu and Hoekstra, 2009). However, there is significant variation in marketed teff volume in the country from time to time and from place to place and the marketed surplus of teff across the country is far less than the volume of production (Mabratom, 2014; Efa *et al*., 2016; Gutu, 2017). Therefore, given the agriculture-based economy of Ethiopia and the dominance of the smallholder sub-sector, coupled with diverse agro-ecologies, it is imperative to conduct a study that focuses on identifying factors determining smallholder farmers' teff commercialization which was the main objective of the study.

Research methodology

Description of the study area

Guduru district is one of ten rural districts of Horro Guduru Wollega zone of Oromia national regional state in Ethiopia. The district town, Kombosha is found 282 kilometers away from capital city of Ethiopia, Addis Ababa. The district consists of 31 rural and 8 urban Kebeles and is bounded by Jimma-rare district at south, Jimma-Ganati district at west, Abbay-choman and Hababo-Guduru district at north, and Gindabarat district at east (AOGD, 2017) (see Figure 1). According to the Guduru District Agricultural office (2017), Agro-climatic classification of the district is 21% Kola (lowland) and 79% Weinadega (mid-highland) coverage. The total number of households in the district is about 15,472 of which 14,594 are male headed and the rest 878 are female headed. The land area of the district is about 159,689 Hectare among 53,406 hectare is under cultivation (AOGD, 2017). Mixed crop-livestock farming system is the main livelihood base of the population in the district. Crop production is one of the main activities in the districts and is dominated by small holdings practiced predominantly under rain-fed farming system. Teff production takes the lion share and is the main source of income generation to farmers in the district. According to CSA, (2016/2017), teff constituted the largest area in hectares at national level, Oromia regional state and Horro Guduru Wollega zone, 3,017,914.36, 1,441,029.78, 91,939.17, respectively.

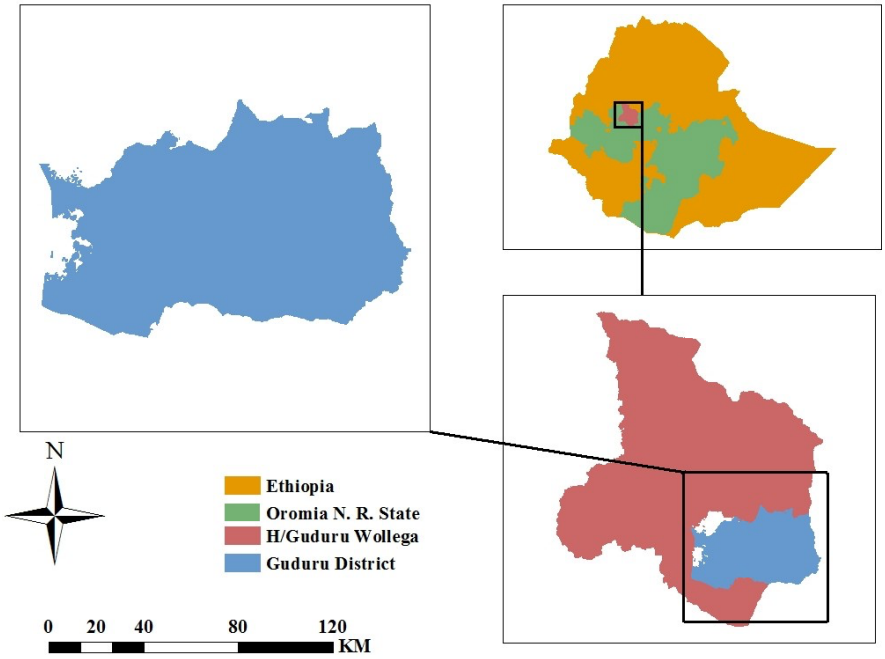

Figure 1 - Map of the study area

Type, source, and methods of data collection

The study used data from both primary and secondary sources. The interview schedule was used as a data collection tool. Accordingly, primary data that contains both quantitative and qualitative were collected by interviewing smallholder farmers producing teff during the 2016/2017 production season. Two focus group discussions (FGD) of six members each at two closer kebeles into a single group for synthesis and confirmation of the issues discussed at the group level. The FGD was used to elicit information on constraints in teff production and marketing with carefully constructed checklist. This was followed by a formal survey in which data were collected through interviews using structured questionnaires. Data collection was made with local trained enumerators. These local enumerators were recruited and trained to administer the interview under close supervision of the researcher. In addition to this, key informant interview and personal observation were employed to supplement the research finding with qualitative information. The secondary data from different sources such as records, regulations, and reports, were collected from Guduru district agricultural office, administration, CSA and organizations operating in the district to support the primary data and published and unpublished documents were reviewed to secure pertinent secondary information.

Sampling procedure and sample size determination

Two-stages sampling procedure was followed for the selection of sample household heads. At the first stage, simple random sampling technique was employed to select four representative kebeles, among the 31 rural kebeles in district, since all are producers and predominance of teff production in the district. At the second stage, from the total of 2247 teff grower households in the selected four kebeles, 154 sample household heads were selected randomly, using probability proportional to size. The maximum number of respondents for this research was determined by using a formula developed by Yamane (1967), with an 8% level of precision.

$$n = \frac{N}{1 + N(e)^2} = \frac{10{,}436}{1 + (10{,}436 \times 0.08^2)} = 154 \qquad (1)$$

Where:
n = is the sample size of teff producer households
N= is the total teff producer households in the district (N = 10,436)
e = maximum variability or margin of error 8%

Methods of data analysis

Estimation method, descriptive and econometric analyses were employed using the primary data to meet the objectives of the study. The estimation of the market participation and intensity models represented in equations 3a and 3b can be achieved by first estimating the levels of participation for the teff output market. This was to achieve the first specific objective of the study. The Household Commercialization Index (HCI) was used but modified for the targeted single crop to estimate the levels of teff Commercialization Index (TCI). The HCI proposed by Govereh et al., (1999) and Strasberg et al., (1999) estimate a single index for all crops cultivated by a household. Estimating the index follows the formula:

$$HCI_{it} = \left[\frac{Gross\,value\,of\,teff\,sold\,by\,HH_{ij}}{Gross\,vaue\,of\,teff\,\,production\,by\,HH_{ij}} \right] * 100 \qquad (2)$$

Where HCI_{it} is the i-th household commercialization index for teff; the numerator is the total amount of teff sold by the ith household in the j-th year (j = 2016/17 farming season) and the denominator is the total value of the output of teff by the ith household head in the j-th year (j = 2016/17 farming season).

Descriptive statistics such as frequency, percentages and means were employed in describing household characteristics. In addition, inferential statistics, t-test and chi-square tests were used to make comparisons between market participant and non-participant with respect to continuous and dummy variables specified, respectively.

The Double Hurdle model was employed with assumptions that allow zero observations to arise in both the participation hurdle and sales hurdle. It postulates

that individuals must pass two separate hurdles before they are observed with a positive level of sales. The first hurdle corresponds to factors affecting participation in the market and the second corresponds to the volume of marketed surplus. A different latent variable is used to model each decision process. Double hurdle model originally formulated by Cragg, (1971), postulates that individuals must pass two separate hurdles before they are observed with a positive level of sales. A different latent variable is used to model each decision process, with a Probit Model to determine participation and a Truncated Regression Model to determine the intensity of volume of sale. The Double Hurdle Model can be specified as follows:

$$P_i^* = Z_i\alpha + u_i \qquad Participation\ equation \tag{3a}$$

$$P_i = \begin{cases} 1\ if z_i\alpha + u_i > 0 \\ 0\ if z_i\alpha + u_i \leq 0 \end{cases}$$

$$Y_i^* = X_i\beta + \varepsilon_i \qquad Intensity\ \ equation \tag{3b}$$

$$Y_i = \begin{cases} Y_i^* if Y_i^* > 0\ and\ P_i = 1 \\ 0\ \ Otherwise\big(or P_i = 0\ or (Y_i^* \leq 0\ and\ P_i = 1)\big) \end{cases} \tag{3c}$$

P_i^* is a latent endogenous variable representing households' participation decision,
Y_i^* is a latent endogenous variable representing households' level of sells decision,
P_i and Y_i are their observed counterparts,
α and β are parameters of the models,
z_i is the vector of variables (table 1) explaining participation decision,
x_i is a vector of variables (table 1)
explaining marketed surplus,
u_i and e_i are respective error terms assumed to be normally distributed,

Table 1 - Hypothesized definition of dependent and independent variables for analyses

	Type	Measurement	Hypothesis	Model *
Dependent variables				
Participation decision (TEMPAR)	Dummy	1=participant, 0=otherwise		PBT
Percentage of total output sold (HCI)	Continuous	HCI		TM
Independent variables				
Sex of the household head (SEHH):	Dummy	1= male, 0=female	+	PBT/TM
Age of the household head (AGHH)	Continuous	Number of years	-	PBT/TM
Education household head (EDHH)	Continuous	Years of schooling	+	PBT/TM
Distance of household home from the nearest market (DISMAR)	Continuous	Kilometer	-	PBT/TM
Credit use (CREDIT)	Dummy	1 = If user, 0= otherwise	+	PBT/TM
Size of landholding (LANDSIZE)	Continuous	Hectare	+	PBT/TM
Farm output (OUTPUT)	Continuous	Quintal	+	PBT/TM
Family size (FAMSIZE)	Continuous	Adult equivalent	-	PBT/TM
Livestock owned excluding oxen (TLU)	Continuous	TLU	+	PBT/TM
Number of oxen owned (OXEN)	Continuous	Number of oxen	+	PBT/TM
Participation in off/non-farm activities (OFNCOMEH)	Dummy	1 = if engaged, 0 = otherwise	-	PBT/TM
Extension contact (EXTEN)	Continuous	Number of visit days	+	PBT/TM
Land allocated to teff (LATEFF)	Continuous	Hectare	+	PBT/TM
Lagged market price of teff (PRTEFF)	Continuous	Price of previous year (ETB)	+	PBT/TM
Access to market information (MKTINFO)	Dummy	1 = if have information, 0 = otherwise	+	PBT/TM
Family labor (FMLABOR)	Continuous	Man equivalent	+	PBT/TM
Cooperative membership (MCOOP)	Dummy	1 = if member; 0 = otherwise	+	PBT/TM

*denotes model in which variable is applied: PBT is Probit model (Participation/Tier1), TM is Truncated model (intensity model/Tier2)

Results and Discussion

Characteristics of surveyed households over discrete explanatory variables

As indicated in (Table 2) Male headed households constitute 88.3% among 17.5% were non-commercialized while 70.8% were commercialized of the sampled households and the remaining 11.7% were female headed households among 4.5% were non-commercialized and 7.2% were commercialized. The chi square test of variability between the two groups is significant indicating there was variability at 10% significance level between market participants and non-participants. Majority of

household heads (79.9%) among commercialized households constituted 63.6% and non-commercialized accounts 16.3% were not engaged in off/non-farm activities in the 2016/2017 farming season and about 20.1% households (5.8% non-commercialized and 14.3% commercialized) engaged in off/non-farm activities. From the total sampled household's majority of sampled households (86.4%) had access to market information through access to communication facilities. Disaggregation also showed that among those who had market information access 20.2% were non-commercialized and 66.2% were commercialized households. Those households who had no access to market information constituted small percentages (13.6%) among 1.9% were non-commercialized households and 11.7% were commercialized. About 87% of the total sample households were not credit users, where non-commercialized and commercialized households constituted 15.6% and 71.4%, respectively. The rest 13% were credit users with 6.5% score each group of sampled respondent. The statistical test results revealed that there was statistically significant percentage difference between non-commercialized and commercialized households at 1% significance level in terms of credit using available in the study area. About 84.4% of the total sample households were cooperative member, among non-commercialized and commercialized households were 17.5% and 66.9%, respectively while the rest 15.6% were not member of cooperative (about 4.6% were non-commercialized and 11% were commercialized.

Table 2 - Summary statistics for dummy variables

Variables	Non-Commercialized		Commercialized		χ^2 value	Total	
	No	%	No	%		No	%
Sex of Household heads							
Female	7	4.5	11	7.2	3.348*	18	11.7
Male	27	17.5	109	70.8		136	88.3
Off/non-farm activities							
Not engaged	25	16.3	98	63.6	1.091	123	79.9
Engaged	9	5.8	22	14.3		31	20.1
Market information access							
No	3	1.9	18	11.7	0.858	21	13.6
Yes	31	20.2	102	66.2		133	86.4
Credit							
Non-users	24	15.6	110	71.4	10.417***	134	87
Users	10	6.5	10	6.5		20	13
Cooperative membership							
Non-members	7	4.6	17	11	0.830	24	15.6
Members	27	17.5	103	66.9		130	84.4

*Note: *** and * show 1% and 10% significance level.*

Characteristics of respondents over continuous explanatory variables

As indicated in Table 3 below, the mean age of the total sampled household heads is about 45.56 years. This implies that farm households in the study area can be described as relatively young and within the economically active population. The mean age of non-commercialized and commercialized households was about 44 and 46 years, respectively. Mean family size of total respondents is about 6.86 in adult

equivalent, and disaggregation shows that 6.37 and 6.30 were the mean age of non-commercialized and commercialized respondents, respectively. The mean year of education also shows that on average the highest level of education attained for total sampled household head 4.49 means is primary education (about grade 5) whereas grade 4 and grade 5 were average education level of non-commercialized and commercialized households. The study showed that the average annual production of the respondents was 92.56 quintal. The average total crop output score of 68.23 and 98.04 quintals were the average annual farm output of non-commercialized and commercialized households, respectively. Statistical analysis showed there was a significant mean difference in terms of farm output between teff output market participants and non-participants in the sampled households at 1% significance level. Family labor is the major labor source in smallholder farm households. As indicated in table 4, on average the total sample households were supplied a family labor of 3.9 (in man equivalent) persons per household while for commercialized and non-commercialized households were supplied 4.06 and 3.36 per household, respectively. Statistical test of mean difference showed that there was significant mean difference between family labor of teff market participants and non-participants at 1% significance level.

The most important resources of farmers are land and livestock. The total land size owned by sampled households was 6.87 hectare on average. The difference in average area of land owned by the two groups was statistically significant at 1%significance level. On average commercialized households owned 7.3 hectare while non-commercialized owned about 5.2 hectare of land. The land size under teff production cultivated by sampled households was about 2 hectares on average while non-commercialized and commercialized respondents cultivated teff over an average land of 1.19 and 2.31 hectare respectively. Statistical test of mean difference showed that there was significant difference among the two groups in terms of land under teff production at 1% significance level. Livestock is another crucial physical capital for farmers by serving as, land preparation, threshing, transportation and also means of asset saving to indicate wealth in addition to serving as source of food and cash income. Sampled households own on average 9.66 tropical livestock unit (TLU) animals excluding oxen. There was statistically significant mean difference of total livestock owned between commercialized and non-commercialized households at 1% significance level and the mean livestock that commercialized and non-commercialized sample household owned was 10.32 and 7.32, respectively. An ox is an important and the only draught power used in the study area. The total sampled households owned on average about 4 oxen while disaggregation showed that the average number of oxen commercialized and non-commercialized households owned was about 5 and 3, respectively. There was a statistically significant mean difference between commercialized and non-commercialized households at 1% significance in terms of the number of oxen owned. Survey result indicated that, the average extension contact total households made during the production season was about 8 times and it was almost similar to the whole sample for non-commercialized (8) and commercialized (8.25) households. The average lagged price of teff output sold received by farmers was about 998 Ethiopian birr per quintal for the whole

respondents. While average lagged teff price received by commercialized and non-commercialize was about 1260 and 73.52 Ethiopian birr. The average distance to be traveling from total surveyed households' home to the nearest market center was 11.98 kilometers while it was 11.64 kilometers and 13.18 kilometers for commercialized and non-commercialized households, respectively. The statistical test showed that there was a significant difference between the two groups by distance to the nearest market at a 1% significant level.

Table 3 - Summary statistics for continuous variables

Variables	Non-commercialized		Commercialized			Total	
	Mean	Std.Dev	Mean	Std. Dev	t-test	Mean	Std. Dev
Age (years)	43.765	9.2836	46.075	9.8391	1.223	45.5649	9.7370
Education (number)	4.4118	3.5770	4.5167	3.7077	0.224	4.4935	3.668
Family Size (AE)	6.3721	1.5562	6.3012	1.6448	-0.147	6.3169	1.6209
Land size (ha)	5.1949	1.4199	7.3396	2.5145	4.756***	6.8661	2.4797
Land under teff (ha)	1.1912	0.4769	2.3104	1.3040	4.903***	2.0633	1.2604
FM Labor (ME)	3.3618	1.0921	4.0642	1.3033	2.868***	3.9091	1.2899
Output (in Ku)	68.235	26.7808	98.042	43.9802	3.754***	92.5649	42.0199
Livestock (by TLU)	7.3282	4.1428	10.322	5.1168	3.131***	9.6614	5.0614
Oxen (no)	3.1765	0.9035	4.6583	1.6977	4.889***	4.3312	1.6727
Extension contacts (no)	8	1.9694	8.25	1.7692	0.709	8.1948	1.8116
Lagged teff price (in Birr)	73.529	300.8159	1260	150.2938	31.608***	998.052	529.9489
Distance to market (km)	13.177	4.8019	11.638	4.3322	-1.785*	11.9773	4.4700

*Note: *** and * shows 1% and 10% significance level, respectively*

Marketing characteristics and level of household teff commercialization

As presented in Table 4, the study revealed that about 78% of the surveyed households were participants or commercialized in teff market and the remaining 22% were non-participant (non-commercialized) sample households in teff output market. This implies that about 78% of sampled teff farmers sold teff output during 2016/2017 production season while about 22% did not. This result reflects that in study area teff is produced for household consumption and for sale. It was revealed that households do not just decide to produce teff for consumption alone in study area.

Table 4 - Farmers' participation in teff output market

Description	Frequency	Percent
Participant	120	78
Non-participant	34	22
Total	154	100

The levels of market participation or commercialization of smallholder teff farmers from the data gathered indicate that 39.08% average commercialization

index. The result shows a moderate teff commercialization index in the study area during 2016/2017 production season. Among teff market participants (120 households), the average level of commercialization is 50.16%, ranging from 13.33% to 83.33% (Table 5)

Table 5 - Teff commercialization index of households

	Average TCI	Min	Max
Overall sample	39.08	0	83.33
Commercialized	50.16	13.33	83.33

The farmers' level of commercialization was used to categorize farmers according to subsistent, less-commercialized farmer, moderately commercialized farmer, highly commercialized farmers and fully commercialized farmers even if fully commercialized farmers were not found in surveyed samples. As indicated in the table 9, the level of commercialization of teff farmers in the area is between medium and high level as the two categories constitute the highest percentage of surveyed households (34.4% and 37%) respectively (Table 6).

Table 6 - Extents of smallholders' commercialization in teff output market

Level of commercialization	Frequency	Percentage
Not supply at all(subsistent)	34	22.1
Supply less than 25% of their produce (less commercialized)	10	6.5
Supplying 26 - 50% of their produce (moderately commercialized)	53	34.4
Supply more than 51% of their produce (highly commercialized)	57	37.0
Supply 100% of their output (fully commercialized)	0	0.0
Total	154	100.0

Econometric results

STATA version 13 was used to estimate the probability of market participation and intensity of smallholder farmers' teff output market participation using the written command *'craggit'* used by Burke (2009). This command estimates the first and second hurdles of DHM simultaneously. Since the dependent variable in the first hurdle of the DHM was binary, the coefficients of the explanatory variables just indicated the direction of the relationship and not their marginal effects on the dependent variable. Therefore, further post-estimation analyses were carried out to compute the average partial effects (APE) of the explanatory variables. These APE were computed at three levels i.e. on the probability of teff commercialization (selection model), on the expected value of commercialization intensity conditional on the household having commercialized, and on unconditional expected value of commercialization intensity (overall average commercialization intensity in the sample regardless of household commercialization status). These all were obtained

by one step command on STATA package, following the procedure proposed by Burke (2009)

Additionally, the source by Burke (2009) indicated that the standard deviation of the predicted partial effects should not be used as standard errors (SE) for drawing prediction on the average partial effects. For that matter, standard errors used to draw inferences on the average partial effect were computed using the delta method (Burke, 2009; Geoffrey, 2015). The computed average partial effects (APE) are presented in table 8. The first column of table 8 (Tier 1) presents the APE on the probability of a household commercializing while the second column (Tier 2a) presents the conditional expected values of commercialization intensity. On the other hand, the third column (Tier 2b) presents the APE on the unconditional expected values of commercialization intensity.

Determinants of market participation of smallholder households

The results for the determinants of market participation (estimated by the Probit Model, Tier 1 of DHM) are displayed in table 7 below. The Wald chi-square value of 69.27 is statistically significant at 1% indicating that the explanatory variables in the model explain the probability of participating in the markets. Out of the seventeen explanatory variables included in the model, nine variables were found to significantly influence the probability of participation in teff output market of producers in the study area are discussed as follows.

Education level of the household head: The model result showed that education of household head has a positive effect on participation decision which is statistically significant at 1% significance level (table10). A household whose household head had one more year of formal education was about 0.25% more likely to participate in teff output market compared to household with one year less of formal education (Table 7). This means that a higher level of education is associated with an increase in the probability of participating in the teff output market. This finding is in conformity with Yallew (2016), that educated farmers' tendency to accept different agricultural technologies is high, so that they can produce more surplus for market.

Family size: family size found that significant and negatively associated with the probability to participate in teff output market at 5% level of significance (Table 7). A household with one more adult equivalent was likely to be less teff market participant by about 1.4% compared to a similar household with one less adult equivalent (Table 8). The implication is that households' participation decision in teff market strongly depend on family size as consumption requirement is satisfied from own production. Thus, the probability of being a seller in teff market decreases for households with larger family size and increases for households with smaller family size. This finding is consistence with the finding of Dube and Guveya (2016) and Yallew (2016) that households decide to sell when they cannot consume all they have produced and hence, the more members the household has the more likely that most the produce will be consumed thereby decreasing the possibility of selling.

Size of landholding: The total land size household owned had a positive effect on the probability of participating in the teff output market and statistically significant at 10%significance level (Table 7). A household with one hectare more was likely to be more participant by about 1.5% compared to a similar household with one hectare less (Table 8). This means that farmers with larger land sizes are more likely to

participate in teff market. The result implies that households with a bigger land size are likely to diversify their production into cash and have a higher probability of producing more food crops beyond their subsistence consumption. According to Simiyu, (2015) households with bigger land holding sizes have a higher probability of producing more food crops beyond their subsistence consumption levels thus selling the surpluses.

Land allocated to teff: The model result showed that the land allocated to teff by households has a positive effect on the probability of participating in the teff output market and statistically significant at 10% (Table 7). Households with one hectare more of land allocated to teff is more likely to be participant in teff output market by about 1% than household with one hectare less of land allocated to teff (Table 8). This reveals that, the larger the land size under teff production the larger the quantity produce and thereby increasing the quantity of produce available for sale. Finding of the present study is consistent with Adam and Dawit (2015), that the cultivated land had greater positive impact on household's market participation.

Farm output: The total volume of farm output was found with significant positive effect on the likelihood of participation in teff output market at 10% significance level which is consistent with expectation since a higher output ensure marketable surplus (Table 7). The household with one more quintal of farm output is more likely to be participant by about 0.4% than household with one quintal less of farm output (Table 8). This result is due to the fact that whatever is taken to the market is always what is in excess of household consumption and thus the volume of product is critical in allowing households to participate in crop output market. This confirms the findings of Gutu, (2017), who forwarded that the total volume of farm product is critical in allowing households to participate in a market.

Participation in off/non-farm activities: The model result showed that participation in off/non-farm activities has a negative effect on likelihood of teff output market participation at 5% significance level (Table 7). The probability to be market participant decrease by about 3.6% for households who participated in off/non-farm activities than households who did not engage in off/non-farm activities (Table 8). This implies that farmers who had engaged in off/non-farm activities earn more cash from these sources and are able to satisfy their needs by income earned that reduce the probability to participate in teff output market. This recognizes that the negative coefficient in the probability model is that teff farming and off/non-farm activities in the study area are to some extent substitutes since teff is staple food crop produced more likely for consumption. This result confirms the finding of Musah (2013) that off-farm income triggers off-farm diversification, a situation that reduces the probability of farm households from participating in the market.

Lagged market price of teff: The regression coefficient was significant and positively influenced the probability of teff output market participation at 1% significance level (Table 7). This implies that as households who perceived the lagged market price of teff was high enough, producers would be interested to produce and supply more than those who perceived the lagged market price as not as such. As lagged market price of teff increase by one birr, the probability to be participant in teff market increases by about 3%, other factors held constant (Table 8). This finding confirms Yallew (2016) and Shewaye (2016) who concluded that where the household perceives previous year price was good the decision to participate will increase.

Access to market information: The regression result showed that those households who have access to market information, especially price information have more probability to be teff market participant as the coefficient is positive and statistically significant at 10% significance level (Table 7). Average partial effect result indicates that a unit increase in access to communication facilities for households who have access to market information, the probability to be market participant increase by about 4.6% than their counterparts (Table 8). Access to price information and communication services are key in prompting the market participation decision and encourage the degree of commercialization. This confirms Showaye (2016), who found that those households who have high access to communication facilities have increased information flow which enables farmers to link to buyers at a lower cost.

Membership in cooperative: The model result showed that cooperative membership has positive influence on probability to be participant in teff output market and statistically significant at 5% level of significance (Table 7). The probability to be market participant increases by about 0.01% for households who have cooperative membership than who were not cooperative members (Table 8). The implication is that membership in cooperative could have better access of market information, inputs, extension services and/or technical advice, and access to credit facilities important to production and marketing decisions. Findings by Gani and Adeoti, (2015) showed that agricultural cooperatives enhance members' market participation by easing access to productive inputs and facilitating extension linkages.

Table 7 - Double Hurdle Regression Result

	Tier 1: Probit regression		Tier 2: Truncated regression	
	Coef.	Robust Std. Err.	Coef.	Robust Std. Err.
SEHH	-1.2075	0.7938	10.1302**	4.8074
AGHH	0.0034	0.0185	-0.3155**	0.1577
EDHH	0.1193*	0.0651	0.1285	0.3967
FAMSIZEAE	-0.6679**	0.3014	-3.6941***	1.1771
LANDSIZEHE	0.7113*	0.4187	1.6491	1.3034
LATEFF	0.4579*	0.2356	1.2495	1.6535
FMLABOR	-0.2036	0.1691	2.2199*	1.2343
OUTPUT	0.0178*	0.0102	-0.0583	0.0584
OFNCOMEH	-1.7414**	0.7156	1.0593	3.3986
LIVESTOCK	-0.0108	0.0399	0.0550	0.3424
OXEN	0.1654	0.2244	0.4497	1.2493
EXTEN	0.0558	0.0589	1.2391	0.7784
PRTEFF	0.0052***	0.0011	0.0010	0.0084
DISMARKM	-0.0527	0.0321	-0.5034*	0.2967
MKTINFO	1.4877*	0.8317	2.9546	8.6767
CREDITACCE	0.9892	0.8140	-3.0480	6.1860
MCOOP	2.1769**	0.9660	10.4494	9.5171
_cons	-7.7513***	2.7931	38.0191**	18.9768
sigma_cons			12.59152***	0.7119006

Obs. = 154 Wald $chi^2(17)$ = 69.27 Prob > chi2=0.000 Log pseudolikelihood = -480.22268

*Notes: ***, **, and * shows significant at 1%, 5%, and 10% significance level, respectively.*

Determinants of the intensity of teff farmers market participation

The model results for the determinants of intensity of farmers' teff output market participation (estimated by the truncated regression model, Tier2 of DHM) are also displayed in Table 7. The intensity of participation in the teff output market is significantly determined by five variables out of the seventeen explanatory variables. The identified determining factors were sex of household head, age of household head, family size, family labor and distance to the nearest market.

Sex of the household head: The second tier of model output announce that sex of the household head was household characteristic that affect teff marketed surplus of households positively in the study area which was statistically significant at 5% significance level (Table 7). The conditional and unconditional commercialization intensity was found to increase by about 10 and 7 times, respectively, for male households (Table 8). Yallew (2016) had reasoned out that most of the time female household heads are more concerned about feeding their families rather than taking their production out to the market.

Age of the household head: Result indicated that age of household head is negatively influenced by teff marketed surplus at 5% significance level (Table 7). This implies that household that is younger is likely to be more intensively commercialized compared to a similar household that is older. Average partial effect results showed that a one year older household head was likely to be 31% less conditional marketed surplus of teff and about 24% less unconditional marketed surplus of teff (Table 8). This relation of age with teff marketed surplus has most likely resulted from resource redistribution among household that resulted in low surplus produced and also increased demand for home consumption as family size increases over time coupled with loss of power. This finding is supported by Tekalign (2014), finding that as the ability of younger farmers to produce more output raising larger marketable surplus and the tendency of having smaller household sizes permitting them to have a higher likelihood of selling than older farmers.

Family size: Household size was found that significantly and negatively affected teff marketed surplus at 1% significance level (Table 7). The average partial effect showed that increase in family size by one adult equivalent decrease the conditional marketed surplus of teff by about 3.67 on average and unconditional marketed surplus of teff by about 3.46 on average (Table 8). The result is expected because large family needs more teff to consume and less to sell as compared to the small one. This also confirms the result of Musah *et al*., (2014) that households with large family sizes need to feed their family first and take the remaining small portion surplus to the market especially if the crop is consumable at home.

Family labor: Family labor was found that it has positive effect on the quantity of teff marketed and statistically significant at 10% significance level (Table 7). The positive and significant relationship between the variables indicates that as the family labor increases, the proportion of marketed surplus of teff sold at the market also increases. The average partial effect showed that one additional family labor in man equivalent increase the conditional marketed surplus of teff by 220% and unconditional marketed surplus of teff by 154% (Table 8). Thus, farmers who have more access to family labor were more intensively commercialized than those who have less family labor. Tigist (2016) reported that as, an important input for

agricultural activities, labor supply is positively correlated with marketed surplus of cereal crops market participation.

Distance of household head home to the nearest market: Distance of household head home to the nearest market was found that negatively affects intensity of teff output market participation and is statistically significant at 10% significance level (Table 7). As distance between household head home and nearest market increase by one kilometer, conditional intensity of teff commercialization decreases by 50% and unconditional intensity decreases by about 44% (Table 8). Distance can separate farmers from accurate and recent price information which exposes farmers to for cheaters resulted in sale of their produce by low price (Tekalegn, 2014).

Table 8 - Average Partial Effects (APE) of DHM explanatory variables

	Tier 1: Market participation (N=154)		Tier 2a: Conditional intensity (N=120)		Tier 2b: Unconditional intensity (N=154)	
Variables	Mean	Std.Dev.	Mean	Std.Dev.	Mean	Std.Dev.
SEHH	-0.0256	0.0674	10.0693	0.1584	6.7783	5.1212
AGHH	0.0001	0.0002	-0.3136	0.0049	-0.2418	0.1282
EDHH	0.0025	0.0067	0.1277	0.0020	0.2069	0.2679
FAMSIZEAE	-0.0142	0.0373	-3.6719	0.0578	-3.4672	2.0063
LANDSIZEHE	0.0151	0.0397	1.6392	0.0258	1.9189	1.6684
LATEFF	0.0097	0.0256	1.2420	0.0195	1.3811	1.0994
FMLABOR	-0.0043	0.0113	2.2066	0.0347	1.54023	1.0445
OUTPUT	0.0004	0.0010	-0.0579	0.0009	-0.0293	0.0483
OFNCOMEH	-0.0370	0.0973	1.0529	0.0166	-0.7419	3.9761
LIVESTOCK	-0.0002	0.0006	0.0547	0.0009	0.0330	0.0345
OXEN	0.0035	0.0092	0.4470	0.0070	0.4977	0.3970
EXTEN	0.0012	0.0031	1.2317	0.0194	1.0120	0.5029
PRTEFF	0.0316	0.0831	0.0010	0.0001	0.0055	0.0116
DISMARKM	0.0210	0.0553	-0.5004	0.0079	-0.4381	0.2246
MKTINFO	0.0462	0.1216	2.9369	0.0462	3.6296	3.4343
CREDITACCE	-0.0256	0.0674	-3.0297	0.0477	-1.4773	2.6432
MCOOP	0.0001	0.0002	10.3867	0.1634	10.0659	6.1293

Conclusion and recommendations

Teff commercialization Ethiopia is influenced by different factors. To identify these factors the research was conducted to study the determinants of smallholder teff farmers' commercialization in the study area. Accordingly, the findings show that education, family size, land size, land size, farm output, off/non-farm income engagement, lagged teff market price, market information and cooperative membership were identified as those factors that affect teff commercialization. Thus, to appreciate or reduce these factors the following suggestions were forwarded for the concerned stakeholders either GOs or NGOs:

- Training might be stimulated to equip teff producers with market orientation production system.
- Enhancing productivity and output directly through investments such as irrigation equipment and technology (improved seed).

- More focus should be on provision of sustainable and timely availability of inputs, increasing the farmers' awareness on production packages.
- Promoting of better access to communication facilities and institutional services may significantly contribute to promoting market participation and hence commercialization of smallholders.
- It will be good if policies strengthen the support being given to the female headed households by providing active policies that support women's access and participation.

Limitations and significance of the study

This study was restricted to one district which limited area coverage to draw conclusions at macro level due to, diverse agro-ecological and socio-economic assortment in the country. The other limitation of the study is the use of cross-sectional data and single crop due to the fact that households may change their marketing decisions from year to year depending on production and market conditions and the findings may not show changes that may occur over time. However, this research will have great significance, since the result of the study can assist to make relevant decisions to intervene in the development of teff production, and marketing to improve income and livelihood of smallholder farmers through market participation and designing of appropriate policies and strategies.

References

Abraham, R. 2015. Achieving food security in Ethiopia by promoting productivity of future world food teff: a review. *Adv Plants Agric Res*, *2*(2), 00045.

Abu, B. M. 2013. Market Participation of Smallholder Farmers in the Upper West Region of Ghana, *M.Sc Thesis*, Department of Agricultural economics and Agribusiness, University of Ghana.

Adam, B. & Dawit, A. 2015. Farm-level determinants of output commercialization: In haricot bean based farming systems. *Ethiopian Journal of Agricultural Sciences*, *25*(1), 61-69.

Agricultural Office of Guduru district. 2017. District data recording of animal and crop production.

Alelign, A. M. 2017. Crop Productivity, Efficiency and Commercialization of Smallholder Farmers in The Highlands of Eastern Ethiopia. *PhD Dissertation*. Haramaya University, Haramaya, Ethiopia.

Alliance for a Green Revolution in Africa (AGRA). 2014. Africa agriculture status report: climate change and smallholder agriculture in Sub-Saharan Africa, Nairobi, Kenya.

Barrett, C.B. 2008. Smallholder market participation: Concepts and evidence from eastern and southern Africa. Food Policy, 33(4): 299–317.

Berhanu, G. & Hoekstra, D. 2007. Cereal Marketing and Household Market Participation in Ethiopia: The Case of Teff, Wheat and Rice. African Association of Agricultural Economists (AAAE). Second International Conference, August 20-22, 2007, Accra, Ghana. pp 243-252.

Bernard, T., Gabremadhin, E. Z. & Taffesse, A. S. 2007. Smallholders' commercialization through cooperatives: *A diagnostic for Ethiopia* (No. 589-2016-39794).

Burke, W.J. 2009. Fitting and Interpreting Cragg's Tobit alternative using Stata. *The Stata Journal, 9(4), 584 – 592.*

Cragg, J. 1971. Some Statistical Models for limited Dependent Variables with application to the demand for Durable Goods. *Econometrica*, 39(5): 829-844.

CSA (Central Statistical Agency). 2014. Agricultural Sample Survey 2013/2014. Report on area and production of major crops (private peasant holdings, meher season). Addis Ababa.

CSA (Central Statistical Agency). 2016. Agricultural Sample Survey: Area and Production of Crops, Main Season. Addis Ababa, Ethiopia.

Delgado, C. L. & Siamwalla, A. 1997. Rural economy and farm income diversification in developing countries. In 1997 Conference, August 10-16, 1997, Sacramento, California (No. 197035). International Association of Agricultural Economists.

Demeke, L. & Haji, J. 2014. Econometric Analysis of Factors Affecting Market Participation Of Smallholder Farming In Central Ethiopia.

Demeke, M. & Di Marcantonio, F. 2013. Analysis of incentives and disincentives for teff in Ethiopia. Technical notes series, MAFAP, FAO, Rome.

Dube, L. & Guveya, E. 2016. Determinants of agriculture commercialization among smallholder farmers in Manicaland and Masvingo Provinces of Zimbabwe. *Agricultural Science Research Journal*, *6*(8), 182-190.

Efa, G., Degye, G., Tinsae, D. & Tadesse, K. 2016. Determinants of market participation and intensity of marketed surplus of teff producers in Bacho and Dawo districts of Oromia State, Ethiopia. *Journal of Agricultural Economics and Development, 5*(2), 020-032.

Eleni, G. & Goggin, I. 2006. Does Ethiopia need a commodity exchange? An integrated approach to market development. Paper presented at the Ethiopian Strategy Support Program 2006 Policy Conference, Addis Ababa.

FAO. 2014. Socio-economic context and role of agriculture; country fact sheet on food and agriculture policy trends, Ethiopia.

Gani, B. S. and Adeoti, A. I. 2015. Analysis of market participation and rural poverty among farmers in northern part of Taraba State, Nigeria. *Journal of Economics*, *2*(1), 23-36.

Geoffrey, S. M. 2015. Determinants of Agricultural Commercialization and Its Impacts on Welfare among Smallholder Farmers in Kenya, Ph.D Dissertation, University of Nairobi.

Govereh, J., T.S, Jayne. & Nyoro, J. 1999. Smallholder commercialization, interlinked markets and food crop productivity: cross country evidence in eastern and southern Africa, the Department of Agricultural Economics and the Department of Economics, Michigan State University.

Gutu, T. B. 2017. Climate Change Challenges, Smallholders' Commercialization, and Progress out of Poverty in Ethiopia, Working Paper Series N° 253,African Development Bank, Abidjan, Côte d'Ivoire.

Hailu, G., Weersink, A. and Minten, B. 2016. Determinants of the Productivity of Teff in Ethiopia. *The European Journal of Development Research*, *29*(4), 866-892.

Jema, H. 2008. Economic Efficiency and Marketing performance of Vegetable Production in the Eastern and Central Parts of Ethiopia. *Doctoral Thesis,* Swedish University of Agricultural Sciences, Uppsala

Mahelet, G. F. 2007. Factors affecting commercialization of smallholder farmers in Ethiopia: The Case of North Omo Zone, SNNP region. *Paper Presented at the Fifth International Conference on the Ethiopian Economy*, June, 7-9, Addis Ababa, Ethiopia.

Mebrahatom, Medhane. 2014. Determinants of Commercialization of Teff and Its Factor Productivity Outcome: The Case of Tahtay Qoraro Woreda, Northwest Zone of Tigray Regional State, Ethiopia. *M.Sc. Thesis*. Haramaya University, Haramaya.

Minten, B., Seneshaw, T., Ermias, E. & Tadesse, K. 2013. Ethiopia's Value Chains on the Move: The Case of *Teff*. ESSP II Working Paper 52. International Food Policy Research Institute (IFPRI). Addis Ababa, Ethiopia.

Minten, B., Tamru, S., Engida, E. & Kuma, T. 2015. Transforming staple food value chains in Africa: The case of teff in Ethiopia. *The Journal of Development Studies*, *52*(5), 627-645.

MoARD (Ministry of Agriculture and Natural Resources). 2010. Ethiopia's agricultural and Sector Policy and Investment Framework (PIF): 2010-2020, Addis Ababa.

Musah, A.B., Bonsu, O.A.Y. & Seini, W. 2014. Market participation of smallholder maize farmers in the upper west region of Ghana.*African journal of agricultural research*, *9*(31); 2427-2435.

Pender, J. and Dawit, A. 2007. Determinants of smallholder commercialization of food
crops: Theory and evidence from Ethiopia, IFPRI (International Food Policy Research
Institute), Discussion Paper No. 75, Washington DC, USA.

Samuel, G. & Kay, S. 2008. Commercialization of Smallholder Agriculture in Selected Teff-Growing Areas of Ethiopia. Future Agriculture, discussion paper.

Showaye, Abera. 2016. Determinants of Haricot Bean Market Participation, Misirak
Badawacho District, Hadiya Zone, SNNNP, Ethiopia.

Strasberg, P.J., Jayne, T.S., Yamano, T., Nyoro, J.K., Karanja, D.D. & Strauss, J. 1999. Effects of agricultural commercialization on food crop input use and productivity in Kenya. Michigan State University, Department of Agricultural, Food, and Resource Economics.

Tafere, K., Taffesse, A.S . & Tamru S. 2010. Food Demand Elasticities in Ethiopia: Estimates Using Household Income Consumption Expenditure Survey Data, Addis Ababa, Ethiopia.

Tekalign, D. 2014. Determinants and Welfare Outcomes of Commercialization of Smallholders' Farming: The Case of Anchar Woreda, West Hararghe, Ethiopia. *M. Sc. Thesis.* Haramaya University.

Tigist, M. 2015. Agricultural Technology Adoption and Market Participation under Learning Externality: Impact Evaluation on Small-scale Agriculture from Rural Ethiopia. Working Paper No. 2015/06.The Maastricht School of Management.

United Nations Development Programme (UNDP). 2015. Agricultural Growth and Transformation Strengthening; National Capacity through Sustainable Increases in Agricultural Production and Productivity.

Von Braun, J. & Kennedy, E., 1994. *Agricultural Commercialization, Economic Development and Nutrition*. The Johns Hopkins University Press, Baltimore and London.

Worku, I., Dereje, M., Berhane, G., Minten, B. & Taffesse, A. 2014. *Teff* and its Role in the Agricultural and Food Economy. Ethiopian Research Institute.

World Bank. 2016. Federal Democratic Republic of Ethiopia. Priorities For Ending Extreme Poverty And Promoting Shared Prosperity Systematic Country Diagnostic.

Yallew, M. 2016. Smallholders' commercialization of maize production in Guangua district, northwestern Ethiopia.*World Scientific News*, *58*, 65-83.

Yemane, M. 1967. Elementary Sampling Theory, Prentice-Hall Inc. *Englewood Cliffs, New Jersey, USA*.