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Determinants of Commercialization of Tef: The Case of Smallholder Farmers in Dendi District of Oromia, Central Ethiopia

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Abstract
In Ethiopia, *tef* is economically and socially important cereal crop, particularly in Dendi district it is source of food and cash income for majority of the smallholder farmers. However, the supply of *tef* in the study area still can't satisfy the existing market demand. The study aimed at analyzing the commercialization level and factors affecting the commercialization of *tef* producers. The study largely uses primary data that was collected from 210 randomly selected farmers through structured and semi-structured questionnaire. Both descriptive statistics and econometric models were used. Tobit model were used to identify the determinants of commercialization. Results of the descriptive statistics indicated that 12.38% of sample households are subsistent, 3.33% are less-commercial, 43.81% are semi-commercialized and 40.48% are commercialized farmers. The average commercialization level of *tef* producers in the district was 46%. The result of Tobit regression model revealed that educational level, livestock owned, land under *tef*, agricultural extension, sex of household head, household size and off/non-farm income significantly affect commercialization level of *tef* producers. Therefore, the findings suggest that strategies aiming at promoting *tef* producers' commercialization should focus on strengthening the technical, resource base and institutional capacity of smallholder farmers.
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1. INTRODUCTION

Agriculture continues to dominate the national economy of Ethiopia, accounting for 36.7% of overall GDP and 70% of foreign exchange earnings. The sector provides employment for 72.7% of the population and is a means of generating livelihood for about 83% of the rural population (ATA, 2017; ADEA, 2014; FAO, 2015). In Ethiopia 95% of the total area under agriculture is cultivated by smallholder farmers and contributes to 90% of the total agricultural output indicating the dominant contribution of smallholder farmers to the overall agricultural production (MoARD, 2010; Gebreslassie and Bekele, 2012).

According to MoFED (2010, 2015), the Ethiopian government, in its two-consecutive five-years Growth and Transformation Plan (GTP-I and GTP-II), has given much emphasis on agricultural commercialization, among which the second pillar intends to achieve growth and thereby improve people's livelihoods and reduce poverty. Commercialization of the smallholder farmers has been viewed by the government as the major source of agricultural growth in Ethiopia. The government of Ethiopia implemented agricultural commercialization clusters with the primary goal of commercialization of smallholders' agriculture and agro-industrial development, offering a strategic entry point for private sector engagement (Pauw, 2017).

Commercialization entails agricultural production decision intended for market based on market signals and produce offered for sale and use of purchased inputs (Berhanu and Moti, 2010). The welfare gain of agricultural commercialization can be achieved through specialization, comparative advantage, economies of scale and flow of ideas due to regular interaction (Barrett, 2008). In the agricultural sector, cereals cover about 80% of the total grain crop area (9.97 million hectares) and contribute about 87% (23.1 million tons) of the grain production (CSA, 2016). Among cereals, *tef* (Eragrostis *tef*) stands first in terms of land area, followed by maize and wheat (CSA, 2016). Ethiopia is the center of both origin and diversity for *tef* (Vavilov, 1951). *Tef* is a staple food and one of the most important crops for generating farm income, cultural heritage, national identity and nutritional security. The study area is found in West Shewa zone of Oromia region, central Ethiopia. West Shewa zone is potential area of *tef* production in central Ethiopia. The land area covered by *tef* in the zone was 205,573.1 hectares and from it 3,808,745.7 quintals of *tef* was produced during 2015/16 production year. The productivity of *tef* in the zone was (18.53 qt/ha) is higher than the national and regional average which was (15.6 qt/ha) (CSA, 2016). In spite of the conducive agricultural commercialization policy environment the return and incentive for growth in *tef* through

agricultural commercialization faces a number demographic and marketing challenges (ATA, 2017; Pauw, 2017). There is a dearth of information in terms of identifying the determinants of smallholders' commercialization of *tef* producer particularly in Dendi district West Shewa zone of Oromia region, one of the potential areas of *tef* production in Central Ethiopia. Such information is essential for making knowledge-based decision that are geared towards improving market participation of farmers in *tef* and contribute to the national development goals of eradicating poverty and improving food security.

In Ethiopia, *tef* is an important cereal crop that covers 22.95% area of land that is under grain crops (CSA, 2016). It is first among all cultivated crops in terms area coverage and second to maize in terms of its contribution to total grain production contributing 16.76% to grain production (CSA, 2016). For this study, *tef* is selected, because it is primarily grown and marketed by majority of the smallholder farmers in Dendi district and it is source of food and cash income for the smallholder farmers. According to ATA (2017), Dendi district is one of the agricultural commercialization cluster areas in *tef* production in West Shewa zone. However, the supply of *tef* in the study area still can't satisfy the existing market demand and the farmers are not benefited from *tef* price increment.

Since *tef* is the most economically and socially crucial crop, there is a strong need to address the prevailing information gap and contribute to proper understanding of determinants of commercialization of smallholder farmers in Dendi district. Such information is also required to contribute to the success of GTP-II plan of the country through improved decision of smallholder farmers in *tef* production and marketing. Therefore, this study analyzes the level of commercialization and identify factors affecting the level of commercialization of *tef* producers.

1.1. Objectives

1. To measure the level of commercialization of *tef* producers in the study areas;
2. To identify the determinants of commercialization of *tef* producers.

2. RESEARCH METHODOLOGY

2.1. The Study Area

Dendi district is one of the thirty-three districts in West Shewa zone of Oromia region, Central Ethiopia. and lies at about 80 km west of Addis Abeba. The district is geographically situated within 038^{0}10'54"E longitude and 9º 01'16"N latitude and at an altitude of 2200 meter above sea level. Dendi district is bordered on the south by Dawo and Wenchi, on the west by Ambo and Elfeta, on the north by Jeldu, and on the east by Ejersa Lafo districts (Figure 1).

According to DDAO (2017), the total population of the district is 200715. Out of the total population 42953(21.4%) are urban dwellers and 157762(78.6%) are rural dwellers. The total area coverage of the district is 79,936.29 hectares of which 39,227.5 hectares are cultivated land. The district has two agro-ecologies; highland (29%) and midland (71%), indicating that the district is dominated by midland agro-ecology. In the district, mixed farming system of both crops and livestock is common economic activity (DDAO, 2017). Cereal crops grown in the district includes: *tef*, wheat, barley, maize and sorghum. *Tef* production takes the lion share of income generation to the farmers and the district is known for its highest production of *tef*.

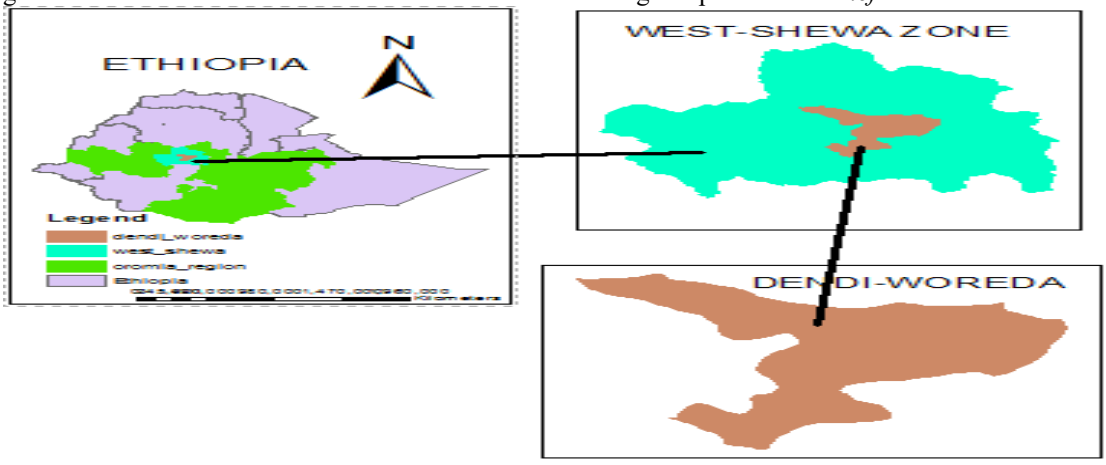

Figure 1. Location of the study area

2.2. Data Types, Sources and Methods of Data Collection

Both primary and secondary data were used for this study. Primary data were collected from randomly selected *tef* producers in five rural kebeles. Primary data were collected by structured and semi-structured questionnaires and

by well-trained enumerators using Computer Aided Personal Interview (CAPI). Secondary data was taken by reviewing secondary sources from published and unpublished documents of Central Statistical Authority (CSA), district agricultural and rural development office. In addition, journals and websites were visited to generate relevant secondary information focusing on the objectives of the study.

2.3. Sampling Procedure and Sample Size Determination

The target populations for this study were smallholder *tef* producers in Dendi district. Purposive and two stage random sampling procedure was used for the selection of sample household heads. Dendi district was selected purposively since it is the potential area of *tef* production in West Shewa zone, Central Ethiopia. In the first stage, five *tef* producing kebeles; namely, Dano Ejersa Gibe, Wamura Sako, Lokloka Abba, Werka Werabu and Yubdo Legabatu were selected randomly from a total of 24 *tef* producing kebeles of the district.

In the second stage, from the total of 2425 households in the selected five kebeles, 210 sample household heads were selected randomly, using probability proportionate to size of *tef* producer households in the kebeles. The total sample size (n=210) was determined following a simplified formula provided by Yamane (1967). Accordingly, the required sample size at 95% confidence level with degree of variability of 5% and level of precision equal to 6.6% were used to obtain a sample size required to represent the true population.

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where: n = sample size, N = population size (sampling frame) and e = level of precision.

Table 1: Sample distribution of *tef* producer households in selected kebeles

No	Kebeles	Total number of households	Number of sampled households
1	Dano Ejersa Gibe	618	54
2	Wamura Sako	585	51
3	Loqloqa Abba	310	27
4	Werka Werabu	452	39
5	Yubdo Legabatu	460	40
	Total	2425	210

Source: Dendi District Agriculture Office, 2017 and own computation result

2.4. Methods of Data Analysis

2.4.1. Descriptive statistical analysis

Descriptive statistical analysis method such as mean, proportions, percentages, and standard deviations were used in the process of examining and describing farm households' demographic characteristics, resource ownership, institutional and infrastructural service, production characteristics and farm input use. Household commercialization index (HCI) defined as the ratio of gross value of *tef* sold to the gross value of *tef* produced was used for indicating household level of commercialization. Mathematically, the HCI formula adopted from von Braun *et al.,* (1994) is expressed as:

$$HCI_i = \frac{\text{Gross value of } tef \text{ sold}}{\text{Gross value of } tef \text{ produced}} \times 100\% \quad (2)$$

Where: HCI_i = Commercialization index of i^{th} household in *tef* sales expressed as a percentage. HCI has a value between zero and one hundred, inclusive. A value closer to zero would indicate a subsistence-oriented household and a value closer to one hundred imply highly commercialized household (Govereh *et al.,* 1999; Berhanu and Moti, 2010; Osmani *et al.,* 2014).

2.4.2. Econometric analysis

A Tobit model was used to identify determinants of commercialization of *tef* producers and the Tobit model was a statistical model proposed by James Tobin to describe the relationship between non-negative dependent variable and independent variable (Tobin, 1958). The dependent variable used in identifying determinants of commercialization of *tef* producing famers was commercialization index. The commercialization index is censored because some of its values cluster at the limit (i.e. 0 for subsistence *tef* producers and 100 for fully commercialized farmers). The censored regression model is an option for handling this limited dependent variable.

Since the value of the dependent variable, commercialization index ranges between 0 and 100 (i.e. values are bounded between 0 and 100), the Tobit model was used to identify its determinants. The general formula defining Tobit model is specified as follows:

$$y_i^* = \beta' x_i + \varepsilon_i \quad (3)$$

Where: y_i^* = is a latent variable, which is unobserved for values less than 0 and greater than 100 that representing subsistence or fully commercial index;

x_i = is vector of independent variables, which includes factors affecting level of commercialization;

β = is vector of unknown parameters to be estimated;

ε_i = is a disturbance term assumed to be normally distributed with zero mean and constant variance σ^2; and i = 1, 2, 3, ... n (n = the number of observation)

Given the observed dependent variable commercialization index (y_i), Tobit model is specified as:

$$y_i = \begin{cases} 0 \text{ if } y_i^* \leq 0 \\ y^* \text{ if } 0 < y^* < 1 \end{cases} \quad (4)$$

The Tobit model is estimated using maximum likelihood estimations. The log likelihood (LL) of the model is:

$$\ln L = \ln\left(\coprod_{yi>0} f(yi) \coprod_{yi=o} F(0)\right) = \sum_{yi>0} \ln f(yi) + \sum_{yi=0} \ln F(0) \quad (5)$$

Since y* is assumed to be normally distributed as error terms are assumed to be normally distributed, f(.), F(.) and hence the log likelihood functions can be written in the form of density function and cumulative density function of the standard normal distribution as: ∅ (.) and Φ(.) and the log likelihood function is rewritten as:

$$\ln L = \sum_{yi>0}\left(-\ln\sigma + \ln\phi\left(\frac{yi - xi\beta}{\sigma}\right)\right) + \sum_{yi=0} \ln\left(1 - \Phi\left(\frac{xi\beta}{\sigma}\right)\right) \quad (6)$$

However, the Tobit coefficients can't be interpreted directly as estimates of the magnitude of marginal effects of changes in the explanatory variables on the expected value of the dependent variable, because there are three main conditional expectations of interest in the Tobit model. These are: the conditional expectation of the underlying latent variable (y*); the conditional expectation of the observed dependent variable (*y)*; and the conditional expectations of the uncensored observed dependent variable ($y|y>0$). Following (McDonald and Moffitt, 1980; Greene, 1997; Johnston and Dinardo, 1997) the marginal effects of these conditional expectations, respectively are given as:

$$\frac{\partial \mathrm{E}(y^* / x)}{\partial x} = \beta \quad (7)$$

$$\frac{\partial \mathrm{E}(y / x)}{\partial x} = \beta\Phi\left(\frac{x\beta}{\sigma}\right) \quad (8)$$

$$\frac{\partial \Pr(y > 0 / x)}{\partial x} = \phi\left(\frac{x\beta}{\sigma}\right)\frac{\beta}{\sigma} \quad (9)$$

The interpretations of these marginal effects depend on the point of interest based on the focus of the study (Greene, 2003). If the interest is to make statements about the conditional mean function in the population despite the censoring, equation 7 is used. If a researcher is interested on average value of the population of study, and how those values vary with covariates, equation 6 is used. If the interest is to interpret about the determinants of average values of the dependent variable among those who have already participated, equation 9 is used. In this study, the three marginal effect results were computed to identify the significant effects of the independent variables on the probability and extent of *tef* producers' commercialization.

2.5. Hypothesis and Definition of Variables

In order to identify factors determining commercialization of *tef* producers, the following dependent and independent variables were defined and hypothesized.

Dependent variables

Commercialization index (COMINDX): It is a limited dependent variable, which is measured as the ratio of the gross value of *tef* sales to gross value of *tef* produced by the household in 2016/17 production year, expressed in percentage. Definition and hypothesis of independent variables are indicated on Table 2.

Table 2. Definition and hypothesis of independent variables

Variables	Notation	Type	Measurement	Expected effect
Sex of the household head	SEXHH	Dummy	0 if the hh is male; 1 otherwise (being female)	-
Education level of hh	EDUHH	Continuous	Grades completed	+
Household size	HHSIZE	Continuous	Number of household members	-
Farming experience	FREXP	Continuous	No of years	+
Livestock owned	LIVOWN	Continuous	TLU	+
Number of equines owned	NEQUIO	Continuous	TLU	+
Size of land allocated to *tef*	AREA*TEF*	Continuous	Hectare	+
Distance from the nearest market	MRKTDIS	Continuous	Minutes of walk	-
Access to credit service	ACREDIT	Dummy	1 if the hh has access to credit; 0 otherwise	+
Frequency of extension contact	FRQEXT	Discrete	Frequency	+
Non/off-farm income	NONFARIN	Continuous	ET Birr	-
Lagged market prices of *tef*	LMKTPRT	Continuous	ET Birr per quintal	+
Cooperative membership	COOPMEM	Dummy	1 if the hh is member of coop.; 0 otherwise	+

3. RESULT AND DISCUSSION

3.1. Demographic and Socio-economic Characteristics of Sample Households

Table 3 and Table 4 revealed the results of descriptive statistics for the entire variables used in the study. As indicated in Table 3, out of total sample respondents, 172 (81.9%) were male-headed and 38(18.1%) were female-headed households. Regarding cooperative membership, 104(49.52%) of the sample households were members of cooperatives and 106(50.48%) were not organized under cooperatives whereas 57(27.14%) of the sample households has access to credit and 153(72.85%) doesn't have credit access.

Table 3. General characteristics of sample *tef* producers (dummy variables)

Variables	Frequency	Percent
Sex of household head		
Female	38	18.1
Male	172	81.9
Cooperative membership		
Yes	104	49.52
No	106	50.48
Access to credit		
Yes	57	27.14
No	153	72.85

Source: Own survey result, 2017

Accordingly, with regards to the educational level of sample household heads, the average number of formal schooling completed was 4.17 years with a standard deviation of 3.61. The average household size of sample respondents in adult equivalent was 4.40 with standard deviation of 1.58 (Table 4). The average farming experience of sample respondents that an individual continuously engaged in *tef* production was 18.35 years with standard deviation of 7.33 (Table 4).

Table 4. General characteristics of sample *tef* producers (continuous variables)

Variable	Mean	Std. Dev.	Min	Max
Education level (years of formal schooling)	4.17	3.61	0	15
Household size (Adult equivalent)	4.40	1.58	1	8.15
Farming experience (No of years)	18.35	7.33	4	37
Livestock owned (TLU)	4.18	2.30	0	9.85
Number of equines owned (TLU)	1.20	0.94	0	3
Size of land under *tef* production (Hectare)	1.15	0.59	0.2	2.5
Distance to the nearest market (Minutes)	67.02	26.88	30	150
Frequency of extension contact (Count)	7.559	5.772	0	18
Non/off-farm income (ET Birr) [a]	3.899	5.106	0	16
Lagged market prices of *tef* (ET Birr/qt) [a]	1.645	0.230	1.2	2.2

Source: Own survey result, 2017

Note: 'a' indicates the amount of non/off-farm income obtained and lagged market prices of *tef* in thousands (000) of ETB.

3.1.1. Resource ownership of sample households

Ownership of physical resources is an important factor that determines commercialization of smallholder farmers. Land, labor, capital and other resources are the major resources that farmers used to enhance commercialization of *tef* that provide a greater return. The analysis of survey data depicts that the average total land size owned by the sample households was 1.84 hectare with standard deviation of 1.30. Out of the total sample households 48(22.8%) owned less than a hectare of land whereas 34(16.2%), and 128(61%) owned one hectare and above one hectare respectively. The average area of land under *tef* production by sample households was 1.15 hectare with standard deviation of 0.59 (Table 4). The minimum and maximum land allocated for *tef* production was 0.2 and 2.5 hectares, respectively.

Livestock ownership

In the district, mixed crop and livestock farming system is dominantly used by farm households. Livestock resources are useful in the livelihoods of smallholders, oxen are the major contributors to crop production by serving as a draft power. Farmers in the study area used oxen to undertake different agronomic practices, out of which ploughing and threshing are the major ones. The mean livestock owned by sample households excluding equines was 4.18 TLU with a standard deviation of 2.3 (Table 4).

Equine ownership

In the study areas equines are used as a means of transport by smallholder farmers. Equines provide transport services for farm inputs from market to home, harvested farm produce from field to threshing center and for marketing of output. Out of total sample households 57(27.14%) of them do not own equines. The rest 73(34.76%), 62(29.52%), and 18(8.57%) of sample households owned one, two and three equines, respectively. The mean equines owned by sample households was 1.2 TLU with a standard deviation of 0.94 (Table 4).

Off/Non-farm income activities

The major off/non-farm income generating activities in which sample households were participating in the study areas includes: animal cart, daily laborer, remittance and petty trade. From the total of sample households 118(56.19%) were participating on off/non-farm income generating activities and 92(43.81%) were not participating on off/non-farm income activities. The mean cash income obtained from off/non-farm income was 3899 ET Birr with standard deviation of 5106 (Table 4).

3.1.2. Institutional and infrastructural services of farm households

Having institutional services services are important factors that encourage the commercialization of smallholder farmers through a positive impact on technology transfer.

Frequency of extension contact

The agricultural extension service providers in the district are office of agriculture experts, development agents and researchers. The average frequency of extension service provided for sampled households was 7.56 day/year with standard deviation of 5.77 (Table 4). The minimum and maximum frequency of extension provided for farmers was 0 and 18 days, respectively.

Distance from the nearest market

The distance from home to the nearest market place where farmers sold their *tef* produce was an average of 67.02 minutes of walk with standard deviations of 26.88 (Table 4). The minimum and maximum distance that *tef* producing households travel to the nearest market were 30 and 150 minutes, respectively.

3.1.3. Crop production characteristics of sample households

Allocation of land resources and other farm inputs for crop production is a common practice by smallholder

farmers. As seen from Table 5, out of total land they have sample households in the study areas allocated 88.94% of land for crop production, 8.42 % for livestock grazing, and 2.65% for eucalyptus and homestead. This is an indicator that the agro-ecology of the district is conducive for crop production. The mean area of land allocated for crop production by sample households was 2.31 hectares with standard deviation of 1.44.

Table 4. Allocation of land resources by sample households

Land allocated	Total areas (hectare)	Proportion (%)	Mean	Std. Dev.
Crop production	485.63	88.94	2.31	1.44
Grazing for livestock	45.95	8.42	0.22	0.32
Eucalyptus and homestead	14.45	2.65	0.068	0.15
Total	546.03	100		

Source: Own survey result, 2017

The major cereal crops grown in the district include *tef*, wheat, and maize. The major pulse crops grown are Chickpea and Grass pea. Potato was grown from vegetable crops. In the study area crop rotation (rotation of cereal with pulse crops) is common agronomic practices used by smallholder farmers to increase productivity and to maintain soil fertility status. Accordingly, from the total sample respondents all 100% of them produced *tef*, 59.05% of them produced maize, 37.62% of them produced wheat, 67.14% of them produced chick-pea, 53.81% of them produced Grass pea. As shown in Table 6, *tef* stands first in terms of cultivated area coverage (54.84%) and chickpea occupies the second (15.48%).

Table 5. Area coverage of major crops of sampled households

Crops cultivated	Areas cultivated in 2016/17 (ha)	Area proportion (%)	Mean	Std. Dev.
Tef	266.3	54.84	1.15	0.59
Wheat	38.88	8.01	0.19	0.33
Maize	32.16	6.62	0.15	0.19
Chickpea	75.18	15.48	0.36	0.39
Grass pea	50.31	10.36	0.24	0.33
Others (Lentil, Potato, Nug and Sorghum)	22.79	4.69	0.11	0.25
Total	485.63	100		

Source: Own survey result, 2017

3.2. Farm Inputs Used in Tef Production by Sample Households in 2016/17

The common farm inputs used in *tef* production includes: fertilizers, improved seed, and herbicide. Commercialization level of smallholder farmers' can also be analyzed from input side, from the ratio of purchased inputs to the total inputs used. Thus, describing of farm inputs used by sample households in *tef* production are important point because commercialization of the output side is often realized with the precondition on commercialization in the input side (Berhanu and Moti, 2010). Adoption of improved high-yielding varieties (HYVs) and chemical fertilizer have a positive effect on smallholders marketed surplus (Tigist, 2015).

The use of improved agricultural inputs increases output side commercialization and improve smallholders' livelihood. Farmers in the study area used different types of inputs for *tef* in 2016/17 production year. The major agricultural inputs and technologies used by sample households include inorganic fertilizer (NPS and Urea), improved *tef* seed, herbicide and row planter. The survey result indicates that even if it's not at full recommendation rate out of total sample households 100% of them use NPS fertilizer and herbicide; 85.2%; 92.8% and 54.7% of them used Urea fertilizer, improved seed, and row planter in *tef* production, respectively.

Additionally, farmers in the study area used leased-in and shared-in land; hired and daily laborer for *tef* production in 2016/17 production year. As seen from Table 7, by individual households the mean improved seed used per hectare was 23.38 kg with standard deviation of 6.92; the mean NPS fertilizer used per hectare was 117.63 kg with standard deviation of 33.92; the mean Urea fertilizer used per hectare was 52.17 kg with standard deviation of 23.97; the mean herbicide used per hectare was 0.64 litter with standard deviation of 0.28.

Table 6. Farm input use of sample households for *tef* in 2016/17 production year

Inputs used	Mean	Std. Dev.
Improved seed (kg)	23.38	6.93
NPS fertilizer (kg)	117.63	33.92
Urea fertilizer (kg)	52.17	23.97
Herbicide 2-4-D (litter)	0.64	0.28

Source: Survey results, 2017

The transition towards commercial agriculture requires improved inputs and better agronomic practices. Out of improved seed used by sample households Quncho *tef* variety is a popular one which most of households 121(57.62%) of them cultivated Quncho variety in 2016/2017 production year and Enatit (DZ-01-354) 66(31.43) is second one. This was indicated by Kebebew *et al.* (2011) as the good performance of Quncho brought together the coordinated efforts of researchers, extension personnel, district administrators and others involved in the process of seed multiplication and distribution, and technology promotion.

3.3. Level of Commercialization of Tef Producers

Following the classification commercialization by Samuel and Sharp (2008) and Tadele *et al.* (2017) smallholders level of commercialization is grouped into three categories: Less commercialized farmers (those who sold up to 25% of output), semi-commercialized farmers (those who sold between 25% and 50% of output they produce) and commercialized farmers (those farm households who sold more than 50% of what they have produced). The results from the survey revealed that 26(12.38%) of sample households' commercialization index is zero indicating that they are fully subsistent in terms of *tef* output, 7(3.33%) are less-commercialized, most of the sample households 92(43.81%) fall in semi-commercialized category and 85(40.48%) are commercialized farmers with the high commercialized sample households who sold 75% of the gross value of its *tef* output (Table 8).

Table 7. Level of commercialization of *tef* producers in 2016/17 production year

Extent of commercialization	Frequency	Percent
Subsistent/ Non-commercial (0%)	26	12.38
Less-commercialized farmers (1 - 25%)	7	3.33
Semi-commercialized farmers (25 – 50%)	92	43.81
Commercialized farmers (>=50%)	85	40.48
Total	210	100

Source: Survey results, 2017

The overall average level of commercialization of *tef* producers in the district is 46% in terms of the gross value of *tef* sold. The average value of *tef* commercialization indicates that the level of commercialization of *tef* producers in the study areas was in semi-commercial level. This degree of commercialization in the district is considerably lower than regional average which is about 52% as reported by ATA (2016). The survey revealed that the supply of *tef* in the study area shows seasonal variation which is high at harvest and low in August. Figure 2 below shows the kernel density estimates of commercialization index.

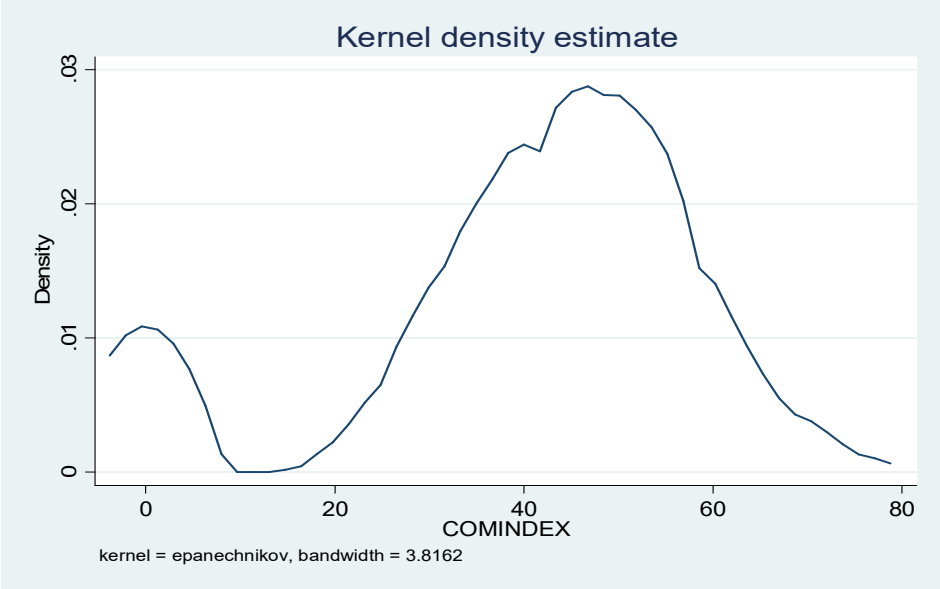

Figure 2. Kernel density estimate of commercialization index

3.4. Econometric Results

Prior to the econometric analysis essential tests that verify the model to employ for the analysis were under taken on hypothesized variables. Heckman two-step is an econometric model developed to correct for sample-selection bias (Heckman, 1979). In this study, the result from the Heckman two-step indicated that there is no sample selection bias, because the inverse mills ratio (IMR) which (mills lambda 0.85) was statistically insignificant. This suggested that there is no sample selection bias. Hence, no need to use the Heckman two-step model (Appendix Table 3). As to the survey result of this study, out of total 210 sample households 26(12.38%) of them didn't sell

tef even if they produce in 2016/17 production year and the data are censored. Since the commercialization index which is the dependent variable of this study is censored, the maximum likelihood estimation Tobit regression model was used and the analysis of the survey data was carried out by using STATA version 13.

3.4.1. Determinants of commercialization of *tef* producers

The factors determine commercialization level of *tef* producers was analyzed by Tobit regression model. Before running and fitting the Tobit regression model necessary tests that verify the hypothesized independent variables and existence of econometric problems were performed using appropriate test statistics. For all variables outliers were checked using the box plot graph, so that there were no problems of outliers and no data get lost due to outliers.

The Tobit regression model estimated results in Table 9, showed that the likelihood function of commercialization index was highly significant at 1% level (LR $chi^2 = 247.09$ with Prob > $chi^2 = 0.000$) indicating a strong explanatory power of independent variables to explain factors determining commercialization level of *tef* producers (goodness of fit of the model). The model result indicated that, out of explanatory variables used in the model, sex of household head, educational level of household head, household size, livestock owned (TLU), land under *tef* production, frequency of extension contact and non/off-farm income were found to significantly influence the commercialization of *tef* producers in the study areas (Table 9).

Sex of the household head: Sex of the household head being female was found to negatively influence the level *tef* commercialization at 10% significance level. The marginal effects showed that being female headed household decrease the probability of being commercialized by 0.079% while it decreases the level of *tef* commercialization by 2.821%, as compared to male headed households. This result was due to the fact that activities accomplished at home like cooking, washing and child care fall upon the females. This specifies that empowering of female household head by proving a continuous and practical training on *tef* production and marketing is crucial to improve *tef* commercialization. This result is in line with the findings of Leykun and Jemma (2014) and Tekalign (2014) which found that male-headed households have a better access to information who would provide them with better ability to manage their farms and produce more output for market as compared to female headed households.

Education level of the household head: As it was hypothesized educational level of the household head was found to have positive and significant effect on the level of *tef* commercialization at 10% significance level. The marginal effect indicated that as the level of formal education of the household head increased by one grade, increase the probability of being commercialized by 0.009% whereas it increases the level of *tef* commercialization by 0.34%. This indicates that attending formal education improves the productivity and amount of *tef* marketed by adopting improved agricultural technologies. Thus, improving access to formal education of *tef* producing farmers is required particularly in the study areas and its indispensable for smallholder farmers in general. This result is in line with the findings of Tadele *et al.* (2017) that found as the level of formal education of the household head increased the level of wheat commercialization.

Household size: Household size measured as adult equivalent was found to have negative and significant influence on *tef* commercialization at 1% significance level. The marginal effect shows that as the member of household increased by one adult equivalent decrease the probability of being commercialized by 0.034 while it decreases the level of *tef* commercialization by 1.213%. This result is expected because households with more household member tend to consume more of *tef* output produced and less is available for sales. This result is similar with findings of Efa *et al.* (2016) and Girma (2015) who showed that the larger household size consumes more output of *tef* produced, have the lower marketed surplus and less is available for sales.

Size of land under *tef* production: Size of land under *tef* production was positively and significantly affect the level *tef* commercialization at 1% significance level. The marginal effect shows that allocating one additional hectare of land to *tef* production would increase the probability of being commercialized by 0.129% whereas it increases the level of *tef* commercialization by 4.643%. This result implies that those households allocating one more additional hectare of land from self-owned, by rented-in or shared-in land raises the level of commercialization. This result is consistent with the findings of Efa *et al.* (2016) and Leykun and Jemma (2014) who reported that land size cultivated has a positive significant outcome on being transition and commercial farmer and the larger area allocated to production increases the quantity of produce available for sale.

Table 8. Determinants of sample households' commercialization of *tef*

Independent Variables	Coefficient	Robust Std. Err.	Marginal Effects $\frac{\partial E(y^*/x)}{\partial x}=\beta$	Marginal Effects $\frac{\partial P(y>0/x)}{\partial x}=\phi\left(\frac{x\beta}{\sigma}\right)\frac{\beta}{\sigma}$
Sex of household head	-4.175*	2.153	-0.079	-2.821
Education level of household head	0.504*	0.299	0.009	0.340
Household size (Adult Equivalent) [a]	-1.795***	0.553	-0.034	-1.213
Farming experience of household	0.178	0.130	0.003	0.121
Livestock owned (TLU)[b]	1.197**	0.497	0.023	0.809
Equines owned (TLU)	1.973	1.202	0.037	1.333
Land area under *tef* production (ha)	6.872***	1.945	0.129	4.643
Distance from the nearest market	-2.450	2.064	-0.046	-1.655
Access to credit service	0.714	2.323	0.013	0.482
Frequency of extension contact	1.309***	0.210	0.025	0.884
Non/off-farm income (ETB)c	-0.342**	0.170	-0.006	-0.231
Lagged market prices (ETB) [c]	0.018	3.401	0.0003	0.012
Cooperative membership	-2.540	2.169	-0.048	-1.716
Constant	22.972***	6.924		
/Sigma	10.863	0.590		

Number of observation = 210
Left-censored observation = 26
Uncensored observation = 184

Log pseudolikelihood = -731
LR chi^2 (13) = 247.09
Prob > chi^2 = 0.000
Pseudo R^2 = 0.144

Pr(COMINDEX>0) = 0.999
E(COMIND|COMIND>0) = 39.62

Source: Own computation result, 2017

Note: Symbols ***, ** and * indicates significant at 1%, 5% and 10% levels, respectively.
'a' indicates adult equivalent conversion factor of household size shown in Appendix Table 1.
'b' indicates conversion factor of Tropical Livestock Unit presented in Appendix Table 2.
'c' indicates the amount of non/off-farm income obtained in thousands (000) ETB.

Livestock owned: Number of livestock owned measured in TLU was found to positively and significantly contribute to the level of *tef* commercialization at 5% significance level. The marginal effect indicates that excluding equines, increasing the number of livestock by one TLU increase the probability of being commercialized by 0.023% whereas it increases the level of *tef* commercialization by 0.809%. This is due to the positive impact of livestock on the crop production enterprises by providing cash to purchase improved seed and in-organic fertilizer for *tef* production, and oxen serve as a traction power. This result is in line with Mebrahatom (2014) and Tadele *et al.* (2017) found that the positive effect of livestock ownership on the level of commercialization due to significant effect on production.

Frequency of extension contact: The result shows that frequency of extension contacts significantly and positively related with *tef* commercialization at 1% significant level. The marginal effect shows that an increase in frequency of extension contact by one day would increase the probability of being commercialized by 0.025% whereas it increases the level of *tef* commercialization by 0.884%. This result implies that the technical advice provided for farmers by development agent, experts of agriculture and researchers on *tef* production (on improved seed, fertilizer application, row planting) and *tef* marketing enhance the level of *tef* commercialization and this indicates the importance of professional advice on being commercial farmer. This result is consistent with the findings of Tekalign (2014) and Girma (2015) who found that extension contact and advice significantly and positively influence crop commercialization and marketed surplus of *tef*, respectively.

Non/off-farm income: As expected income obtained from non/off-farm activities influenced the level of commercialization negatively and statistically at 5% significant level. The marginal effect shows that an increase in the amount off/non-farm income by one thousand ET birr decrease the probability of being commercialized by 0.006% while it decreases the level of *tef* commercialization by 0.231%. This result is due to the reason that households obtained income from non/off-farm activities were not encouraged to cultivate *tef* on more area of land and they used the amount produced for home consumption. This result is supported by the findings of

Tekalign (2014) who found that participation in non/off-farm activities negatively impacts the degree of crop commercialization.

4. CONCLUSION AND RECOMMENDATIONS

The study was aimed at analyzing the level of commercialization of *tef* and on identifying the factors affecting commercialization of *tef* producers in Dendi district of Oromia region, Central Ethiopia. Commercial transformation of smallholder farmers is vital to improve the well-being of farm households. Results of the descriptive statistics revealed that 26(12.38%) of sample households are subsistent producer, 7(3.33%) are less-commercial, 92(43.81%) are semi-commercial and 85(40.48%) are commercial farmers in *tef* production in 2016/17 production year. The average level of commercialization of *tef* producers in the study area is 46%. The result of Tobit regression model shows that educational level of household head, livestock owned (TLU), size of land under *tef* production and frequency of extension contact were found to positively and significantly contribute to the commercialization of *tef*, whereas sex of household head, household size (adult equivalent) and non/off-farm income were found to negatively and significantly affect it.

From the findings of this study the following relevant recommendations are drawn, in order to help to design appropriate intervention strategies to improve the smallholder farmers commercialization level. The result of the study showed that being female household head negatively affect the level *tef* commercialization as compared to male household head. This is due to the fact that different activities accomplished at home for the wellbeing of the household consumes more time and hinder female household heads to attend their farm land for improved *tef* production that is required to increase the proportion of *tef* sold. Hence, support given to female household head and empowering of female household head through training and supply of improved technology that encourage them to patriciate in *tef* marketing is indispensable.

Education level of the household head was found to have positive and significant effect on the level of *tef* commercialization. Thus, improving access to education should be focused to enhance commercialization of *tef* producers and government should give emphasis on encouraging farmers to learn adult and formal education and providing intermediate practical based training on market-oriented production. An increase in household size was found to have negative and significant influence on *tef* commercialization. This is because households with large household member consume more proportion of *tef* produce and reduce the amount that is going to be sold. Since production resources are limited intervention on family planning based on interest of farmers by showing its negative impact is important in the study areas. In addition, provision of rural employment opportunities is essential to reduce high dependence on farm output and to increase the proportion outputs sold.

Livestock owned in TLU contribute to the level of *tef* commercialization positively. Thus, efforts are required in improving number of livestock ownership is essential for smallholder farmers as source of cash to purchase improved seed and inorganic fertilizers and provide a traction power to enhance commercialization of *tef* producers. Size of land allocated to *tef* production positively and significantly affected the level *tef* commercialization. However, increasing the size of landholding was impossible since land is a limited resource. Interventions are needed to increase productivity of *tef* per unit area of land through delivering appropriate and improved *tef* production technology that increase smallholder farmers commercialization. Hence, proper utilization of land resource requires intensifying the farm practices through provision of sustainable and timely supply of inputs, increasing the farmers' awareness on agronomic practices like row planting and proper application of inputs helps the farmer to produce and supply more *tef* to the market.

Extension contact is a significant contributor to the commercialization of *tef* producers. Provision of technical advice to the farmers on *tef* production and marketing enhance the level of *tef* commercialization. Therefore, joint effort of development agent, agricultural experts, researchers and other stakeholders on identifying and solving problems, availing of new agricultural technology, transfer of improved technology and information to farmers are compulsory to enhance commercialization. Income earned from non/off-farm activities negatively influenced commercialization *tef* producers. This was due to the fact that households obtained income from non/off-farm activities were not encouraged to cultivate more area of land and consume *tef* produced at home. Therefore, interventions intended at raising the efficiency of farmers to reduce farmers involvement in non/off-farm activities and changing the attitudes of farmers to use cash income obtained from non/off-farm activities to strengthen their agricultural production and market orientation is crucial.

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7. APPENDIX

Appendix Table 1. Conversion factor used to compute household size in adult equivalent

Age group (years)	Male	Female
< 10	0.6	0.6
10 – 13	0.9	0.8
14 – 16	1	0.75
17 – 50	1	0.75
> 50	1	0.75

Source: Samuel and Sharp, 2008

Appendix Table 2. Conversion factors used to estimate Tropical Livestock Unit equivalents

Livestock category	Tropical Livestock Unit (TLU)
Camel	1.25
Horse	1.10
Ox and Cow	1.00
Weaned Calf	0.34
Heifer	0.75
Calf	0.25
Donkey (adult)	0.70
Donkey (young)	0.35
Sheep and Goat (adult)	0.13
Sheep and Goat (young)	0.06
Chicken	0.013

Source: Storck, *et al*., 1991

Appendix Table 1. Heckman two-step result for sample selection bias

Heckman selection model -- two-step estimates (regression model with sample selection)

Number of obs = 210
Censored obs = 26
Uncensored obs = 184
Wald chi2(12) = 18498.52
Prob > chi2 = 0.0000

	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
Mkt Particip.						
SEXHH	0.021588	0.021868	0.99	0.324	-0.02127	0.064449
EDUHH	0.007419	0.002601	2.85	0.004	0.002322	0.012516
HHSIZE	0.017042	0.004928	3.46	0.001	0.007384	0.0267
FRQEXT	-8.3E-05	0.001205	-0.07	0.945	-0.00245	0.00228
LIVESTO	0.004719	0.004691	1.01	0.314	-0.00448	0.013913
EQUINE	-0.0208	0.010815	-1.92	0.054	-0.04200	0.000394
AREATEF	0.025506	0.017394	1.47	0.143	-0.00859	0.059598
MRKTDIS	0.001495	0.00033	4.53	0.000	0.000848	0.002142
ACREDIT	0.070876	0.015994	4.43	0.000	0.039528	0.102223
EXTTEFF	0.096281	0.017601	5.47	0.000	0.061784	0.130779
LMKTPR	0.000308	2.45E-05	12.56	0.000	0.00026	0.000356
COOPME	0.023021	0.020971	1.10	0.272	-0.01808	0.064123
Quantity Sold						
SEXHH	-0.00416	1.511194	0.00	0.998	-2.96605	2.957721
EDUHH	1.208018	1.11725	1.08	0.280	-0.98175	3.397788
HHSIZE	-1.34563	0.713111	-1.89	0.059	-2.7433	0.052044
FRQEXT	0.31099	0.219181	1.42	0.156	-0.1186	0.740576
LIVESTO	0.810179	0.423933	1.91	0.056	-0.02071	1.641073
EQUINE	2.862274	2.31905	1.23	0.217	-1.68298	7.407529
AREATEF	16.00782	10.36319	1.54	0.122	-4.30367	36.3193
MRKTDIS	0.015807	0.016659	0.95	0.343	-0.01684	0.048457
ACREDIT	1.057309	1.503292	0.70	0.482	-1.88909	4.003706
EXTTEFF	0.903822	1.257879	0.72	0.472	-1.56158	3.369219
LMKTPR	0.004396	0.003315	1.33	0.185	-0.0021	0.010894
Constant	-21.8463	14.26831	-1.53	0.126	-49.8117	6.119094
Mills lambda	-0.00979	0.055059	-0.18	0.859	-0.1177009	0.0981253
rho	-0.09995					
sigma	0.09792					

Source: Own computation from survey result, 2017