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Teff Production and Marketing Nexus: An Insight from Dera, North West Ethiopia

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Abstract. Although some production and marketing restrictions are barely defined, Dera area is a potential teff producer in Ethiopia's Southern Gondar zone. The study analysed teff production, focusing on factors that affect the volume of teff sold, based on data collected from household surveys, respondent interviews, and focus group discussions. Both descriptive and econometric analyses were used. The results show that teff grown in the study area is mixed, practised by 34.5% of households, followed by red teff (32.16%) with commonly used storage facilities such as Gota, Gotera, and Sack. In terms of marketing, the results show that 57.7% of teff produced in the 2019 sowing season was delivered to the market through rural retailers, wholesalers, and directly from producers to consumers. The result of the ordinary least squares estimates of the multiple linear regression model indicates the gender of the head of household, the experience of the head of household, the amount of teff produced, the lag in the market price of teff, on-farm income, in addition to payment outside the teff farm, positively affects the volume of teff sales. In contrast, livestock ownership and distance from the market have a negative and considerable impact. The paper also examines the main limitations and opportunities faced by farmers. The lack of an organised market and price setting is the most common limitation for farmers in the marketing system. Therewith, fraud and fluctuations in supply and demand, as well as insufficient working capital are considerable limitations for traders. However, the growth of urbanisation, continued price increases, and government investment in infrastructure development are great opportunities for both farmers and merchants. Thus, to have better results in the teff market, it is necessary to implement improved negotiation power, accurate market information, and infrastructure development. This study dictates a large number of further studies related to the impact of urbanisation on the consumption of processed teff products

Keywords: storage, price, revenue, ordinary least square, intensity

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INTRODUCTION

Agriculture remains the leading sector of the Ethiopian economy accounting for about 35.45% of gross domestic product (GDP) [1]. During 2010-2020, GDP grew by an annual average of 9.4% and the registered growth in GDP has been contributed by all sectors [2]. The smallholder agricultural sector: agriculture, manufacturing and service is the main source of employment, agricultural GDP, export earnings, supply of food and raw materials to urban areas and food industries. Crop production contributes more than 60% to agricultural GDP [3]. The most common agricultural crops grown in Ethiopia are grain crops (cereals, pulses and oil-seeds), fruits (banana, mango, avocado etc.) and vegetables (red pepper and Ethiopian cabbage), root crops (onion and garlic, potatoes, sweet potatoes) and stimulant crops (chat and coffee)[4]. Ethiopia is also the centre of origin and genetic diversity for many economically important crops including teff, niger seed, enset, coffee, khat, and Ethiopian mustard or gomenzer [5].

Teff is a small cereal grain indigenous to Ethiopia. The name was probably originated from the Amharic word "teffa" which means "lost" because of small seed size that is difficult to find once it is dropped. It takes the lion share of the total value of cereal production and it is because of its higher comparative price. It is the next most essential cash crop after coffee, whose commercial surplus equalled the combined commercial surplus of the other three main grains (wheat, maize and sorghum) in the country[4]. Teff grows mainly in Amhara and Oromia while Tigray and SNNP regions also produce lesser quantities in Ethiopia. Though, East Gojjam stands first (taking 10% of the national annual teff production). There are other potential teff production areas like Gondar, North Shewa, and West Gojjam in Amhara, as well as East, West, and South West Shewa zones in Oromia region, accounting five to ten percent of the national annual teff production [6].

Dera is one of the South Gondar woredas (the third level of administrational hierarchy in Ethiopia commonly known as district), where the livelihood system of its residents is based on both crop and livestock production. Agriculture in Dera is mainly dependent on rainfall while there are various surface and ground water resources that can be tapped into to maximise water utilisation for agriculture. Barely, finger millet and maize are the most consumed crops in the household while teff, oil seeds, and horticultural crops are marketed, making up an important source of cash income for farmers [7].

Dera woreda stands 1st in teff production from south Gondar zone [8]. Almost all of the 29 rural kebeles (the last administration unit in Ethiopian administrational hierarchy) are potential teff producers. However, there are major constraints regarding agricultural problems in the study area. These include high fertiliser price (use of sufficient fertiliser has become difficult for most farmers and it lowers productivity), loss of soil fertility (declining crop production and application of high dose of fertiliser to have reasonable yield has become essential), land shortage, use of low yielding local cultivars, and crop pest (because of continuous sole cropping of the same land repeatedly). Besides, there are marketing problems of teff which are price fixing by wholesaler (selling agricultural products at low prices), selling farm outputs in harvest time for loan repayment, lack of government intervention, and weakness of cooperatives [9].

According to the information obtained from office of agriculture, pre- and post- harvest losses harm farmers' agricultural yield particularly in teff. Shattering brings huge yield loss. Threshing is also performed on the ground that leads to the mixing of grains with the soil, sand, and/or other foreign matter which plays its own role in loss of teff quality that ultimately affects its market. These problems in general deteriorate surplus of teff to be value added and supplied to the market, which would improve farmers' lives and profitability of each teff market chain actor [10].

Teff production is a potential engagement [8] and it is the livelihood of many farmers, despite the crop not giving due policy attention. Sufficient information concerning the factors determining the volume of teff marketing in the study area is still missing. Even though farmers produce the teff grain well, they do not bother about quality, standard, the use of improved variety[11]. T.M. Challa et al. [12], T.M. Abate et al. [13], T. Beyene [14], A. Feyso Ergetew [15], E. Oyka [16], and A. Workye et al. [17] made an attempt to investigate the predominant factors affecting farmers' supply of teff, honey, cotton, sesame, red pepper, and rice respectively. However, their study lacks details of teff production, storage, volume marketed, and determining factors precisely.

Hence, this paper aims to understand the extent of agricultural product marketing in Ethiopia regarding teff production and marketing status in the study area. It identifies the volume of teff marketed and its determinant factors, opportunities, and challenges of production and marketing in the study areas to understand better and set possible improvement strategies to upgrade teff productivity and marketability for the benefit of smallholder farmers.

The overall objective of this study was to analyse the factors that determine the volume of teff marketed and associated challenges and opportunities in Dera woreda while the particular purposes addressed were: to investigate the production storage and marketing of teff; to analyse the factors that determine the volume of teff marketed; to identify the opportunities and challenges of teff production and marketing.

MATERIALS AND METHODS

Description of the study area

Dera is one of the woredas in the south Gondar zone of the Amhara regional state, Ethiopia. It is bordered by

Abay River in the south separating from east Gojjam, Lake Tana in the west, Fogera in the north, east Estie in the northeast, and west Estie in the east. The woreda covers 158 948 ha, of which 35% is plain, 20% is mountainous, 18% is gorges, and 27% is undulating. The altitude of the woreda ranges from 1 560 m to 2 600 m above sea level, while the annual average rainfall is 1,250 millimetre. Regarding agro-ecology, 85% is *Woinadega* while 15% is *Dega*. There are 32 kebeles in the woreda, of which 29 are rural, and 3 are town kebeles. The total population of the woreda is 279 845, of which 142 851 are male, and 136 994 are female. The number of households in the woreda is 69 961, 58 767 are male-headed, and 11 194 are female-headed [10].

The woreda experiences annual rainfall ranging from 1 000-1 500 mm, which one of the most humid woredas in the country. It has one long rainy season, "Kiremt", from June to September. The main crops cultivated by farmers in the woreda are teff, finger millet, maize, sorghum, and rice in *Woinadega* (midland) areas. *In Dega* (highland) areas of the woreda, wheat and teff are grown. Households also grow crops and fruits like Irish potato, onions, tomato, sugarcane, mango, orange, spice, and chili pepper. Oil seeds, such as oats, flax, and niger seed are also cultivated using irrigation during the dry season. While finger millet and maize are used primarily for household consumption, teff, oilseeds, and horticulture crops are marketed, making up an essential source of cash income for farmers [7]. The geographical illustration of the studied area is pictured in Figure 1.

In the woreda, the land is used for annual crops, perennial crops, grazing, forest, and construction of roads and settlements, while water bodies and other uses cover the rest. As the livelihood of individuals in the study area is farming, a large share of land is used to produce crops, followed by bushes and shrubs. However, the proportion of land covered by road is very small which confirms that infrastructure is not well developed. The fundamental insight of the balance of land use and its coverage is illustrated in Table 1.

Table 1. *Land use in Dera woreda*

Land Use	Area coverage (ha)	Percentage
Annual crops	68 071	42.83
Perennial crops	7 283	4.58
Grazing land	9 764	6.14
Forest land	13 221	8.32
Bushes and shrubs	15 372	9.67
Road	2 254	1.42
Westland	15 105	9.50
Covered by water	7 201	4.53
Construction and settlement	11 513	7.24
Others	9 164	5.77
Total	158 948	100

Source: *[10]*

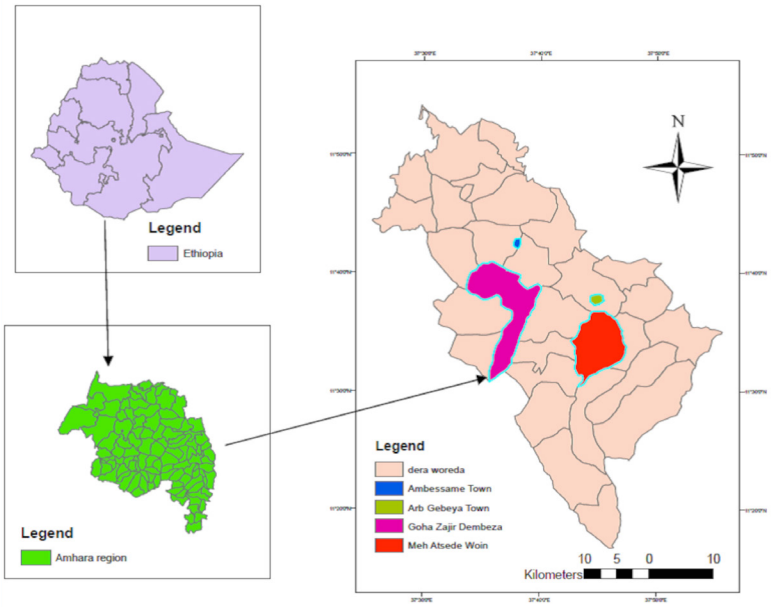

Figure 1. *Map of the study area*

Source: *[10]*

Types, sources, and method of data collection

The authors collected both primary and secondary data for the study. Household surveys, key informants, focused group discussions, and personal observations were the primary data collection. Besides, secondary data collected from different sources, including the Office of Agriculture, Trade and Industry, CSA, and Amhara regional agricultural research institute.

Before the data collection, the authors checked the content using a pilot survey by interviewing five households to limit the duration of the schedule and the validity of the semi-structured questionnaire content. After that, the semi-structured questionnaire constituting the preliminary insights was reorganised, the interview schedule was adjusted, and enumerators were trained about the questionnaire's range and system of gathering information and way of approaching respondents. Finally, the authors did the formal survey with randomly selected farmers. To check the validity of the collected data and complement the questionnaire survey, focus group discussions, key informant interviews, and field observation were applied.

This research was conducted according to the declaration of Helsinki and the legal requirements of the Ethiopian National Health Research Ethics Review Guideline. The ethical research committee approved this study at Debre Tabor University. Study participants were informed that clients have a full right to discontinue or refuse to take part in the study. Hence, all participants throughout the research, including survey households, enumerators, the supervisors, and key informants were fully informed of the objectives of the study. They were asked consent to do this research.

Focus Group Discussion (FGD): Focused group discussions were used to validate the information given by an individual farmer and to receive essential points that respondent farmers did not raise. Focus group discussion was conducted with community representatives, including elders, women, model farmers, and youth who have experience in teff production. The participants were selected to discuss issues related to the purpose of the study and members shared their background, opinion, and experience in the matters under research. A total of two focus group discussions were performed in sampled kebeles. Each group had seven members. The purpose of this discussion was to understand the bottlenecks farmers faced in commercial teff production, identify the existing marketing practice commonly presented in the study area, and what type of information farmers need in participating in teff market.

Key Informant Interview: Key informant interviews were carried out with individuals who had lived in the community for a long time and have sound knowledge about the area's existing teff production and marketing situation. For this discussion, a checklist developed for this purpose was prepared and used.

The purpose of the critical informant interview was to obtain the views, opinions, and suggestions of the key informants about teff production and marketing to better understand the pattern of production and marketing in the study area. For this purpose, key informants were selected from each peasant association (Pas) through kebele leaders, and enumerators and a personal dialog was conducted. Besides, experts at the woreda level, development associations (Das), and Kebele administration were included in the critical informant interview, and a total of 14 key informants' interviews were conducted.

Household survey: A household survey was undertaken by developing a structured questionnaire with closed and open-ended questions to generate information at a household level, managed through face-to-face contact and interviewing the head of the sample households. The pilot was oriented by the kebele administrator about the purpose of the survey. The information collected from the household questionnaire included demographic characteristics, economic factors, institutional activities, information source of farmers, and constraints of effective farming practices of this study area.

Field observation: In addition to data collected through structured questionnaires, an essential part of the survey was the practical observation on the production and marketing of teff with an informal survey. As a result, the field observation was applied to clearly understand the natural environmental setting and socio-economic activities, financial institutions (rural credit services), infrastructural facilities like communication services, road and transport facilities, production and marketing situations of the study area.

Sample size and sampling procedure

The selection of sample respondents for the study engaged a three-stage sampling. In the first stage, Dera woreda was selected among 13 woredas of the south Gondar zone. The underlying principle for the choice was woreda-level crop production rankings. Dera woreda stands first in teff production compared with the rest of woreda. In consultation with the Agriculture and Natural Resources Development Office in the second stage, two kebeles were selected from Dera woreda purposively based on their teff production and marketing potential. In the third stage, using probability proportional to size (PPS), the number of respondents was selected from each kebele using a simple random sampling technique. Accordingly, 171 teff producers were chosen randomly. The maximum number of respondents (farmers) determined by using a formula developed by [18] was:

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

where n – the sample size for the research; N – the population size (total number of households in the selected kebeles); e – the level of accuracy.

To determine the required sample size at a 95% confidence level, with a 0.5 degree of variability and a 7.5% level of precision, 2136 household heads from Meha-Atsedeweyine and 2797 households and Goha kebeles were employed. The number of male and female-headed families was 1867, 269, 2462, and 335 in Meha-Atsedeweyine and Goha kebeles. Respondent farmers:

$$n = \frac{4933}{1 + 4933(0.075)^2} = 171$$

Methods of data analysis

Descriptive statistics and econometric analysis were actively employed for data analysis. This analysis was performed using Microsoft Office Excel 2013, SPSS 20, and STATA (Statistical & Qualitative Data Analysis Software), 15 statistical software packages.

Descriptive Statistics. The descriptive analysis is essential in providing better understanding of specific features of sample units. It allows comparing different categories of the sample unit for the desired characteristics by using tables, minimum, maximum, frequency, percentages, means, ratios, and standard deviations. It explains and interprets the data obtained from sampled households' socioeconomic characteristics. Appropriate statistical tests such as t-test (for continuous variables) and (Chi-square test) for discrete variables were applied to compare and verify the mean or proportion difference between selected characteristics.

Econometric Analysis. This method of data analysis refers to the use of different economic and statistical tools or models for testing hypotheses related to the study's objective. Hence, a multiple regression model was used to identify the marketing volume factors. The model consists of a dependent variable, also called the left-hand side variable, independent variable(s), also called explanatory or right-hand side variable(s), and error terms (stochastic disturbance term) that stand for unobservable random variables not explicitly included in the model.

To address the determinants of the volume of teff marketed, a multiple regression model was used in the study. The underlying reason for selecting the model is its practical applicability, simplicity, and compatibility with the data [19]. Hence, the Ordinary Least Squares (OLS) method was used to estimate the approximate parameters when the dependent variable is continuous. The specification of the multiple linear regression model looks as follows:

$$Y = \alpha + \beta_i X_i + U_i \quad (2)$$

where Y – quantity of teff supplied to market; α – intercept; β_i – vector of parameters to be estimated; X_i – vector of explanatory variables; U_i – disturbance term.

Before taking the selected variables into the model, the necessary diagnostic tests for the existence of multicollinearity (among the continuous variables) problem and the degree of association (among discrete variables) were employed by using Variance Inflation Factors (*VIF*) and Contingency Coefficient (*CC*), respectively. The larger the value of *VIF*, the more troublesome or collinear is the variable X_i and those explanatory variables with *VIF*>10 would be excluded from the regression analysis [20]. The variance inflation factor is specified as:

$$VIF(X_j) = (1 - R_j^2)^{-1} \quad (3)$$

R_j^2 denotes multiple correlation coefficients. A higher value of R_j^2 shows the higher value of *VIF* (X_j), indicating higher collinearity among continuous explanatory variables (X_j).

Similarly, there might also be an interaction between two discrete variables, which would lead to the problem of high association. The contingency coefficients were computed from the survey data to detect the problem, and a contingency coefficient greater than 0.75 indicates multicollinearity among qualitative variables.

$$CC = \sqrt{\frac{X^2}{N + X^2}} \quad (4)$$

CC is the contingency coefficient, χ^2 chi-square test, and N is the total sample size[20].

RESULTS AND DISCUSSION

Socioeconomic characteristics of teff producers

Table 2 shows the results of the descriptive statistics of the continuous variables investigated in this study. Accordingly, the age structure of the sample households shows that the average age of the sample household was 51.3 years. These families include people of 28-84 years old which falls in the productive age category. Regarding the family size, the survey result indicates that the average family size of sample households was 5.37, which ranges 1 to 10 members with a standard deviation of 1.63. It confirms that sample households in the study area have a medium-size family [10].

Education is essential in improving producer attitude towards modern technology in production. It allows farmers getting innovative ideas on improved productivity, post-harvest handling, and marketing strategies related to different options. The highest level of education followed by households reaches up to grade ten. Based on categorisation, about 25.1% of the respondents did not get formal education, while 60% got formal education up to grade four and can read and write. Only less than 16% of sample producers had a full-cycle primary education in the study area.

The result shows that the households in the study area have an average teff growing experience of 26.27 years, implying that respondent farmers have enough knowledge and competence in teff production and marketing and

make informed farm management practices. The survey results also show that farming is the primary source of household income in the study area. The sample household's average annual farming other than teff farm income for 2019 was Birr 15585.72 per household with a standard deviation of 6851.50. The off-farm yearly income of farmers ranges from 1200 to 15000 birr, at off-season farmers engaged in both off-farm and no-farm activities like handicraft, trade and production, sale of firewood and charcoal raised their level of income.

Resource ownership is characterised in terms of livestock and landholding size. Livestock is an essential asset that farmers heavily depend on to support their families in any crisis. Livestock is considered a measure of wealth in the rural area, and it is kept as generating additional income and traction power for farmers. The livestock species found in the study area are oxen, cows, goats, sheep, donkeys, and poultry. The total number of livestock owned by the sample households was converted into Tropical Livestock Unit (TLU) to determine household livestock ownership. The average livestock holding size of farmers was between 2.7 and 28.64.

Land ownership is an indispensable factor for the production of crops, rearing livestock, and other ancillary agricultural activities. The proper utilisation of landholdings under different components contributes to the farmer's agricultural teff production increment. The livelihood of the farmers in the study area is highly attached to the land and land-related resources. The mean landholding size of the household was 1.77 ha, whereas the area used for teff production ranges from 0.13 to 1.75 hectares. The average national and regional teff farm size was (0.24 and 0.15) ha per household [4].

***Table 2**. Descriptive statistics of continuous variables*

Variables	N	Minimum	Maximum	Mean	Std. Dev.
Age of the household head (years)	171	28	84	51.32	9.65
Family size (number)	171	1	10	5.37	1.63
Education of the household head	171	0	10	2.35	2.96
Number of livestock owned (TLU)	171	2.70	28.64	8.29	2.61
Experience in teff production (years)	171	1	52	26.27	9.36
Total Landholding Size (Hectare)	171	0.50	3.00	1.77	0.56
Total farm size (hectares)	171	0.13	1.75	0.88	0.33
Amount of teff produced (Kg)	171	250	1900	1035.09	358.34
Amount of teff marketed (kg)	171	50	1200	597.66	243.72
Distance to the nearest market (km)	171	2.50	15.00	8.12	3.41
Lagged market price of teff (birr/kg)	171	7.50	12.00	9.0000	0.88
On-farm income (birr)	171	1900.00	32150.0	15585.7	6851.50
Off-farm income (birr)	42	1200	15000	6364.29	3316.76

***Note**: items in the brackets are measurement units*
***Source**: survey result, 2019*

Concerning the gender of the respondents, the result shows that out of the total respondents of the two kebele, 87.7% were male-headed; a considerable proportion like other parts of Ethiopia. Since the majority of the households belong to married categories, males automatically assume the headship. Credit access plays a vital role in developing livelihood by building the farmers' capacity to purchase improved agricultural inputs and technologies in time, which maximises productivity and commercialisation. Farmers in rural areas of Dera woreda get most of their financial requirements from the Government/woreda office and Amhara Credit and Saving Institution (ACSI). About 64.3% of the sample respondents replied that they had access to credit for improving agricultural production and marketing, including teff. Key informants also affirmed that most of these farmers take credit and pay back in cash.

Large numbers of sampled households have access to extension services in the study area. The survey result shows that only 2.3% of the sample households have no access to agricultural extension services. The frequency of extension contact was not much different among the families, as discussions with focus groups indicated. An efficient market information system needs to address information flows smoothly between consumers and producers. According to the study results, 69.1% of sample households got accurate market information as shown in Table 3.

***Table 3**. Descriptive statistics of dummy variables*

Variables	Categories	Frequency	Percent
Gender of household head	Male	150	87.7
	Female	21	12.3
Marital status	Married	150	87.7
	Divorced	8	4.7
	Widowed	13	7.6
Extension service	No	4	2.3
	Yes	167	97.7
Credit access	No	61	35.7
	Yes	110	64.3
Market information	No	51	30.9
	Yes	114	69.1

***Source**: survey result, 2019*

Respondents were asked about where they obtain the market information, 28.5%, 20% and 2.4% of the total sample households pointed out that they obtain market information from neighbour, traders, and mass media respectively. More producers (49%) got information from trader and neighbour in combination in which 32% of them get the information in a week as depicted in Figure 2.

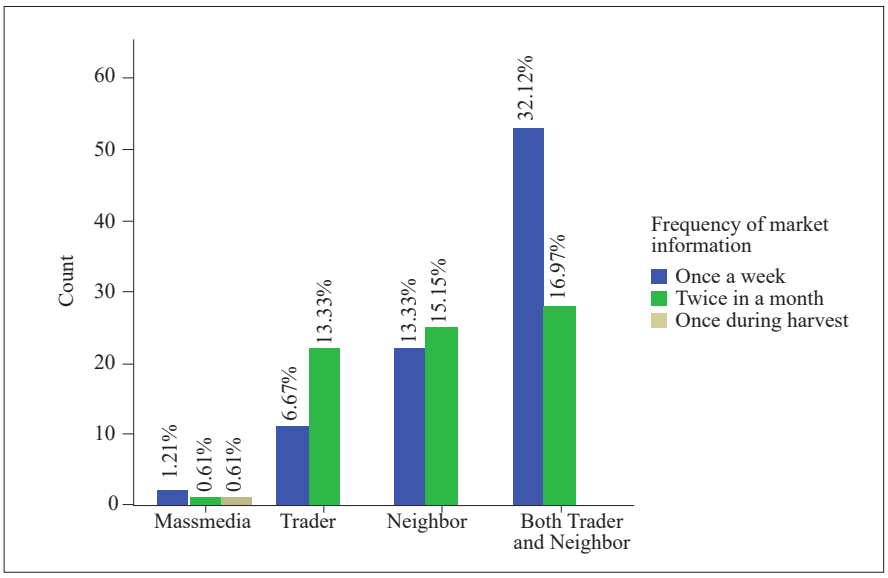

***Figure 2**. Source of teff producers market information*

***Source**: survey result, 2019*

Farm inputs utilisation. Utilisations of improved variety come first in the adoption of innovated technology. It strengthens the productivity in intensive farming as farm size goes fragmented from time to time. However, the number of farmers that use improved seed is limited in the study area. The result shows that a small proportion of sample households used improved sources (30.4%). Due to a supply shortage from farmers' cooperatives, most farmers bought them from the market. However, Table 4 suggests that more Goha farmers (45.4%) used improved seed than Meha-Atsedeweyine farmers (10.8%). There was a difference at less than 1% significance level on various teff used.

***Table 4**. Farm inputs used for teff production*

Variable		Kebele (N=97) Goha		Kebele (N=97) Meha-Atsedeweyine		Total (N=74)		T-test/χ^2 Value
		N	%	N	%	N	%	
Variety of teff crops	Local	53	54.6	66	89.2	119	69.6	23.678***
	Improved	54	45.4	8	10.8	52	30.4	
Type of teff grown	White	9	9.28	1	1.35	10	5.85	8.985**
	Red	24	24.74	31	41.89	55	32.16	
	Seregegna	35	36.0	24	32.43	59	34.50	
	White and red	29	29.9	18	24.32	47	27.49	
DAP used for teff (kg)		129.28 (60.264)		132.703 (52.96)		130.760 (57.08)		29.956***
Urea used for teff (kg)		24.33 (23.38)		34.93 (19.646)		28.92 (22.41)		16.874***

***Note**: (***) and (**) are significant at less than 1% and 5% significance level respectively, parenthesis indicate standard deviation*
***Source**: survey result, 2019*

The main types of teff grown in the area are locally mixed teff (Seregegna) (34.5%) followed by Red (32.16%), though significant variation exists at less than 5% precision level. According to the survey, all of the total sample farmers used diammonium phosphate (DAP) for *teff* production. Moreover, sample households in Goha used about 24.33 kg of urea and 129.28 kg of DAP. The survey shows that Meha-Atsedeweyine farmers used higher urea and DAP production than Goha farmers. The t-test indicates a difference at less than 1% significance level in the area used for teff production.

Production, storage, and marketing of teff

Production of teff is high, and it is an important crop in the study area. The average land cultivated for teff production in Meha-Atsedeweyine farmers (1.032 ha) was higher than Goha farmers (0.76 ha). The average quantity production of teff per sample household was 1035.93 kg. However, Meha-Atsedeweyine farmers produce 1154.05 kg more than Goha farmers, who make only 942.23 kilograms per household. The study suggests a statistical difference between the two kebeles in average production quantity at a 1% significance level. Information from key informants and focus groups confirm that the reason for production difference was differences in soil fertility.

Table 5 also demonstrates that the average production per hectare in the total sample was 1317.50 kg. Data gathered from sample respondents show that 57.7% of teff produced in the cropping year is supplied to the market. According to the survey report, all sample respondents of the study area were potential market suppliers during the survey period. The average amount of teff marketed per household in Goha kebele was 527.32 kg, less than the amount sold in Meha-Atsedeweyine farmers (689.86 kg). The t-test statistics indicated a difference at less than 1% significance level concerning area allocated to teff, amount of teff produced and sold, and the productivity of teff between the two kebeles.

***Table 5**. Area cultivated, teff production and productivity*

Variables	N=97 Goha	N=74 Meha-Atsedeweyine	N=171 Total	t-value
Total area allocated for teff (ha)	0.76 (0.2816)	1.032 (0.3304)	0.879 (0.3315)	34.627***
Quantity produced (kg)	944.33 (346.7)	1154.05 (340.1)	1035.93 (358.34)	37.773***
Productivity per ha	1351.72 (590.77)	1272.64 (676.58)	1317.50 (628.65)	27.406***
Amount of teff sold (kg)	527.32 (208.89)	689.86 (256.42)	597.66 (243.72)	32.067***

***Note**: (***) significant at less than 1% significance level, parenthesis indicates standard deviation*
***Source**: survey result, 2019*

Selecting a storage system is a considerable farming activity to avoid post-harvest losses. The survey shows that *Gota* and *gotera (local store made up of mud and wood, respectively)* were necessary storage facilities, but the farmers used sacks as temporary storage facilit*ies when Gota* and *gotera* were filled during harvesting. Farmers stated they use sacks as packaging material for teff to be transported from threshing field (locally called Awudima) to home and from home to either market or millhouses. The advantage of this storage facility is that it is locally made and less costly. However, these facilities are susceptible to rats, floods, dampness, and fire damages.

The data shows that the storage system in the study areas was not identical. As summarised in Table 6, 75.3% of the sample households in Meha-Atsedeweyine and 24.7% of Goha store their teff using *Gotera*. It also confirms the motive for storage where 49.1% of the participant households store their products expecting a high price in the future, 26.3% store for saving purposes, and 7.6% remain in the absence of market demand. The chi-square test indicates a significant difference in the storage system and underlying reason for storing teff between the two areas at less than 1% significance level. The study results show that almost all sample farmers avoided sales immediately after the harvest in both regions and stored for 11.38 months. Farmers in Goha kebele kept their teff production until 10.65 months which is smaller than Meha-Atsedeweyine (12.34).

***Table 6**. Type of storage facility, purpose and duration of teff storing*

	N=97% Goha		N=74% Meha-Atsedeweyine		N=171% Total		t/χ^2 Value
Ways of teff storage Store/*Gotera*	24	24.7	21	75.3	45	26.3	0.286
Gota	73	28.4	53	71.6	126	73.7	
Storage time (months)	10.65 (4.648)		12.34 (4.516)		11.38 (4. 654)		31.975***
Reasons for storing Expecting high price	40	41.2	44	59.4	84	49.1	30.02***
Lack of market demand	8	8.2	5	6.8	13	7.6	
Saving purpose	28	28.9	17	23.0	45	26.3	
Expecting high price & saving	21	21.6	0	0.0	21	12.3	

***Note**: (***) significant at less than 1% significance level, parenthesis indicates standard deviation*
***Source**: survey result, 2019*

Constraints and opportunities of teff producers

As depicted in Table 7, several factors constrain teff marketing in the study area. These include lack of organised market, pricing, shortage of land, high input price, and infrastructural challenges. Lack of organised demand and cost setup is the most dominating constraint in the teff marketing system, accounting for 26.3% and 22.8% of sample households, respectively. The time-to-time price increments of agricultural inputs affect the level of production in terms of the purchase of improved varieties and fertiliser, which indirectly affects marketing. Hence, the survey result indicates that 18.1% of sample farmers faced a high agricultural input price. The other infrastructural problem is that village markets are connected with the woreda town markets by poorly paved roads. Human portages and pack animals are the most frequently used transport mechanism to transport larger loads. Many of the streets to the market are unreliable, especially during the rainy season. The results show that 15% of the sample households had infrastructural problem. The study area has other problems associated not only with marketing. Diversified opportunities also need to be exploited to improve marketing and effectiveness. Among the different options that prevailed, the major ones are increased urban consumption, high price, and availability of choice. The continuously growing urbanisation with urban residents' favour to teff *Injera* is an eye-catching situation while the cost of teff is also going high time to time.

***Table 7**. Marketing constraints and opportunities of producers*

Constraints of teff marketing	Frequency	Percent
Price setting	39	22.8
High fertiliser and new teff variety price	31	18.1
Lack of organised market	45	26.3
Shortage of land	30	17.5
Infrastructural challenges	26	15.2
Total	171	100

Table 7, Continued

Constraints of teff marketing	Frequency	Percent
Opportunities of teff marketing		
High price	54	31.6
Increase in urban teff consumption	65	38.0
Availability of productive teff variety	52	30.4
Total	171	100

***Source**: survey result, 2019*

Discussions on important factors affecting intensity of teff marketed

In Table 8, the primary determinant factors of the volume of teff sold resulted from OLS. More than 50% of the hypothesised explanatory variables significantly affect the amount of teff supplied. The test of goodness of fit (F-test) shows how the model is significantly fit to the data used. The coefficient of determination (R^2) has also clarified that the hypothesised independent variables explain 88.67% of the model (volume of teff marketed). The diagnostic test has confirmed the absence of multicollinearity problem among independent variables, as found in the Table 9-11.

***Table 8**. OLS estimates of factors affecting volume of teff marketed*

Variables	Coefficients	Standard error	T-ratio	P-value
Constant	-1.5125	1.0516	-1.44	0.152
Gender of household head	0.4688	0.2125	2.21	0.029**
Age of household head	-0.0130	0.0107	-1.21	0.229
Family size	0.0362	0.0437	0.83	0.408
Education of the household head	-0.0849	0.0689	-1.23	0.219
Number of livestock owned	-0.0587	0.0294	-1.99	0.048**
Experience in teff production	0.0345	0.0113	3.06	0.003***
Teff farm size	0.1116	0.2584	0.43	0.666
Amount of teff produced	0.5569	0.0239	23.25	0.000***
Credit access	0.0218	0.1444	0.15	0.880
Extension service	-0.1269	0.4802	-0.26	0.792
Lagged market price of teff	0.2183	0.0879	2.48	0.014**
On-farm income	0.00003	0.00001	2.08	0.039**
Off-farm income	0.00005	0.00002	2.10	0.038**
Market information	-0.3893	0.3812	-1.02	0.309
Distance to the nearest market	-0.0902	0.0212	-4.26	0.000***

Note**: dependent variable — amount of teff marketed, number observations — 171, F (15, 155)=80.85, (Probability > F value=0.000) R-square=0.8867 and adjusted R-square=0.8757. (*, ** and denote significance levels at less than 10, 5 and 1% respectively)*

***Source**: survey result, 2019*

***Table 9**. Multicollinearity test result for continuous variables*

Variable	Variance Inflation Factor (VIF)	1/VIF
Experience of household head	2.50	0.399887
Age of household head	2.42	0.413218
On-farm income	1.91	0.5202618
Amount of teff produced	1.59	0.628315
Teff farm size	1.55	0.644964
Off-farm income	1.37	0.729623
Number of livestock owned	1.35	0.742319
Lagged market price of teff	1.32	0.758900
Distance to the nearest market	1.18	0.848645
Family size	1.11	0.902822
Education of household	1.06	0.941370
Mean Variance Inflation Factor	1.58	

***Source**: survey result, 2019*

***Table 10**. Contingency coefficients of dummy variables*

Variables	Gender of household head	Credit access	Extension service	Market information
Gender of household head	1			
Credit access	0.0040	1		
Extension service	0.1752	0.1296	1	
Market information	0.0070	0.0331	0.1818	1

***Source**: survey result, 2019*

***Table 11**. Conversion factors used to compute tropical livestock units*

Livestock category	Tropical livestock unit
Oxen/Cow	1
Sheep/Goat	0.13
Horse/Mule	1.1.
Donkey	0.7
Chicken	0.013
Heifer/Bull	0.75
Calf	0.25

***Source**: [31]*

Gender of the household head. Gender plays an indispensable role in the marketing intensity. The gender of the household head affects the amount of teff supply considerably (less than 5%) and positively. The results show that other things being constant, being a male-headed household increases the volume of teff marketed by 0.4688Qt. Male household heads have enhanced labour capacity and mobility (better exposure for improved farm practice demonstrations) over a female household, enabling them better access to innovative agricultural practices and market information. On the other hand, males spend more money than females in different study areas. More volume of teff is supplied to the market by male-headed households to cover these costs. This result is supported by prior studies of A. Getahun [3], T.M. Challa et al. [11], and A. Elias et al. [21].

The number of livestock owned. This variable was expected to negatively affect the volume of teff marketed, which is in line with the actual result. The number of animals owned negatively affects the amount of teff supplied to the market at less than 5% significance. Ceteris paribus, a unit increase in tropical livestock reduces the amount of teff marketed by 0.0587Qt. It implies that farmers with more livestock keep their land for grazing/fodder or need to produce crops generating more straw for feed than teff like finger millet and wheat. On the other hand, though mixed farming is practiced in the study area, farmers sell livestock beyond their need for farming practices. E.G. Tura et al. [6] and W. Gobie [22] had found the same result on determinants of intensity of marketed surplus of teff and pepper, respectively, increase in the number of livestock had negative relation to market supply.

Experience in teff production. Experiences of HH head in producing and selling teff is found to affect the market supply of teff positively and significantly. As hypothesised, the experience of household heads in producing and selling affected the intensity of teff marketed thoroughly and intensely at less than 1%. Keeping other variables constant, a year increase in farmers' experience of teff production increases the volume of teff supplied to the market by 0.0345Qt. It can be since when farmers produce and sell teff for many years, the probability of establishing market contacts and building up 'credit worthiness' will be high. Hence, farmers are going to supply more quantity to the market. Farmers with more vast experience are supposed to have better competence in assessing the characteristics and potential benefits of teff than farmers with shorter experience. Besides, farmers with more extended experience were expected to be more knowledgeable and skillful. Studies by T.K. Amentae et al. [23] were exploring value chain and post-harvest losses of teff.

Amount of teff produced. As shown in Table 8, the amount of teff paid affects the quantity of teff supplied to the market positively at less than 1% significance. It affirms that increasing teff production by one quintal will enable farmers to increase the volume of teff marketed by 0.5569Qt, citrus paribus. The better the level of production the farmers have, the increased amount of teff they are ready to supply to the market (that is, high teff yield is important for a large amount of marketing). The result is similar to studies of A.A. Fikadu et al. [24], S. Hassen et al. [25], and Z.O. Mohammed [26].

Lagged market price of teff: As expected before, the lagged market price regression coefficient has a

positive and significant relation to the volume of teff marketed at less than 5% significance level. It indicates that keeping other variables constant, a one-birr increase in teff price before a production season causes a 0.2183Qt rise in the amount of teff marketed by farmers this year. It showed a positive and significant relationship since the costs of 2018 can stimulate farmers to produce more teff, which was supplied more in 2019. This study aligns with [6] and [27].

On-farm income. The result shows that income from farming activities other than teff farming affects the volume of teff marketed positively at less than 5% significance level. It means that a one-birr increase in the income from farming activities brings farmers' volume of teff supplied to the market to increase by 0.00003Qt, citrus-paribus. Revenues from other crops or livestock could help farmers buy teff production inputs and enable them to produce more teff and supply more to the market. It means that farmers were active in providing other crops (mustard, niger seed, and linseed), livestock and livestock products (sheep, goat, cow, oxen, chicken, and egg, e.tc.) to the market to get money to purchase production inputs and other household costs. E.G. Tura et al. [6] and A. Elias et al. [21] also found a similar result.

Off-farm income. Off-farm income earned by farmers affects the volume of teff marketed positively and significantly at less than 5% precision level. A one-birr increase in off-farm revenue, citrus paribus, is associated with a 0.00005Qt rise in the quantity of teff sold in the market. It implies that farmers may engage in off-farm activities such as daily labour, petty trading, handicraft, etc., which helps them to earn additional income. This extra income increases farmers' financial capacity in investing in teff production and thereby supply to the market. This result is supported by E.G. Tura et al. [6] and R.M. Berem [28].

Distance to the nearest market. The closest product market has a strong and highly negative effect on participation and the amount of product marketed. As depicted in Table 8, it adversely affects the volume of teff supplied to the nearest market at less than 1% significance. This means that each kilometre to the closest product market lowers the quantity of teff to be supplied by 0.0902Qt, ceteris paribus. It is directly related to means of transportation (human portage and animal backs) used in the study area as it is challenging to load large quantities by humans. It can also result from high transportation costs due to the distant dwelling of the household from the nearest market centre. The results of this study are similar to the findings of E.G. Tura et al. [6], T.K. Amentae [29], and M. Sharma [30].

CONCLUSIONS

This study was aimed to investigate teff production, marketing supply, and main factors affecting the volume of teff marketed in Dera woreda, one of the potential teff producing areas in North West Ethiopia. The study established that teff is one of the major cereal crops produced for consumption. The type of teff grown in the study area is locally mixed teff (*Seregegna*) followed by red teff.

The study results show that most producer farmers get market information but their data is often skewed to traders. It calls for introducing a system that provides timely and accurate information. It can be possible by introducing an automatic daily or weekly market price board and creating awareness in the automatic weekly market price board. The study showed that the kebele with a high volume of teff produced is the one in which a low volume of teff is supplied to the market and vice versa since the producers have better access to the market as the distance from producers is closed. The implication is that road networks and transport infrastructure need to be developed in the area. Furthermore, it calls for new market centres near the farmers.

The OLS estimate of the MLR model indicated the gender of the household head, the experience of the household head, amount of teff produced, lagged market teff price, on-farm income other than teff farm and off-farm income positively influenced the volume of teff sold. In contrast, livestock ownership and distance to the market affect negatively and significantly. Furthermore, lack of organised market and price is the most frequently mentioned constraint by farmers in the teff marketing system. Therewith, adulteration, supply and demand fluctuation, and insufficient working capital are the traders' problems in the teff marketing system. However, the rising urbanisation and infrastructural developments are good opportunities for farmers and traders. Farmers who use improved seeds produce more. It implies introducing a vital extension service on improved crop variety and other inputs.

It suggests the need for improving farmers' knowledge and performance by addressing essential training, incentives, and advice to use new crop varieties and inputs that increase productivity, thereby maximising the quantity of teff supplied to the market. The amount of off-farm income earned by the household head is directly related to the amount marketed. Thus, engaging in off-farm activities rather than teff farming has a vital role in generating cash to cover production expenses. However, the more livestock ownership, the lower the volume of teff marketed. It implies that farmers with large amounts of TLU can specialise in livestock farming rather than teff though mixed farming in the livelihood of the study area.

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Взаємозв'язок виробництва та маркетингу теф на прикладі району Дера, Північно-Західна Ефіопія

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Анотація. Незважаючи на те, що деякі виробничі та маркетингові обмеження ледве визначені, район Дера є потенційним виробником тефу в зоні Південного Гондару Ефіопії. У дослідженні проаналізовано виробництво теф, зосереджено увагу на факторах, які впливають на обсяг проданого тефу, на основі даних, зібраних з опитувань домогосподарств, інтерв'ю респондентів та обговорень у фокус-групах. Для аналізу даних використовувалися як описовий, так і економетричний аналізи. Результати показують, що теф, вирощений на досліджуваній території, є змішаним, який практикується в 34,5 % домогосподарств, за ним слідує червоний теф (32,16 %) із загальновживаними сховищами, такими як Гота, Готера та Сак. З точки зору маркетингу, результати показують, що 57,7 % тефу, виробленого в посівний сезон 2019 року, постачалося на ринок через сільських роздрібних торговців, оптових торговців і безпосередньо від виробників до споживачів. Результат оцінок за методом найменших квадратів моделі множинної лінійної регресії вказує на стать і досвід голови домогосподарства, кількість виробленого тефу, відставання ринкової ціни на теф, внутрішньогосподарський дохід, крім оплати за межами ферми тефу, позитивно впливає на обсяги реалізації тефу. Навпаки, володіння худобою та віддаленість від ринку мають негативний і значний вплив. У статті також розглядаються основні обмеження та можливості, з якими стикаються фермери. Відсутність організованого ринку та встановлення цін є найбільш поширеним обмеженням для фермерів у системі маркетингу. Водночас шахрайство, коливання попиту та пропозиції, а також недостатній оборотний капітал є значними обмеженнями для трейдерів. Однак зростання урбанізації, постійне підвищення цін та державні інвестиції в розвиток інфраструктури є великими можливостями як для фермерів, так і для торговців. Отже, щоб досягти кращих результатів на ринку тефу, необхідно впровадити окращені можливості переговорів, точну інформацію про ринок і розвиток інфраструктури. Це дослідження диктує велику кількість подальших досліджень, пов'язаних з впливом урбанізації на споживання перероблених продуктів теф

Ключові слова: зберігання, ціна, дохід, звичайний найменший квадрат, інтенсивність