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Advanced Journal of Interdisciplinary Studies 8(2024) 1572-1592

Journal homepage: www.ajids.com.et

AJIDS

Volume 8(2), Dec 2024

Determinants of Teff Productivity in Minjarna Shenkora Woreda, North Shewa Zone, Amhara Region, Ethiopia

Getamesay Bekele Meshesha*, Zerihun Demessie Ayele

Department of Economics, College of Finance, Development and Management, Ethiopian Civil Service University, Ethiopia.

*Corresponding author email: getamesaybkk@gmail.com

Abstract

The main objective of this study was to examine the determinants of teff productivity in the Minjarna Shenkora Woreda of the North Shewa Zone in the Amhara Region of Ethiopia. A mixed research approach was employed to gather and analyze data from 288 farming households, utilizing both primary and secondary data sources. For primary data collection, a questionnaire was used. The collected data has been analyzed by using descriptive statistics and an OLS inferential model, with total teff output per hectare serving as the measure of productivity. The findings indicated that the average teff production in the study area was approximately 13.32 quintals per hectare. The results revealed that determinants such as education level, access to credit, use of compost, irrigation, soil fertility, and non-farm income positively and significantly influenced teff productivity. Conversely, the dependency ratio, farm land size, and access to market information were found to be negative and significantly affect teff productivity at the 1% and 5% significance levels. As a result, those mentioned statistically significant variables have impacts on policy making process. Thus, the policy makers should considered these work on Creating more farmers training schools for farmers training, Creating regular soil and water conservation to keep their lands as fertile, Encouraging household income diversification for enabling them for more accessing of inputs, accessing for different off farm activities and create strong institutional support for credit access to increase teff productivity in the study area.

Keywords*: Minjarna Shenkora, Productivity, Teff, Woreda.*

1. Introduction

Advancing agriculture is a key strategy for eliminating extreme poverty, enhancing shared wealth, and guaranteeing food security to nourish an estimated 9.7 billion individuals by 2050 (Viana et al., 2022).It is vital to the economies of developing nations, providing essential income, foreign exchange, and employment opportunities(World Bank, 2023).In many developing countries, it significantly contributes to food and nutrition security and economic growth, accounting for 65% of the workforce and 32% of the gross domestic product specifically in Sub-Saharan Africa (Abebaw&Anteneh, 2023;Tilaye et al., 2023).Boosting agricultural production and productivity has become a key global priority to enhance food supply by maximizing the use of

limited land resources and utilizing better agricultural inputs, especially in developing nations, with a focuson Sub-Saharan Africa (SSA) (Hailu et al., 2022; Zegeye et al., 2022). In these regions, agriculture is viewed as a crucial tool for promoting growth, sustainable development, reducing poverty, and improving food security (Tadele et al., 2021; Negese &Beyene, 2023).

Agriculture is the dominant sector of Ethiopia's economy, having a greater impact on overall economic growth compared to non-agricultural sectors. It contributes around $27.5 billion, which is 34.1% of the GDP, employs about 80% of the workforce, generates 79% of foreign currency earnings, and supplies roughly 70% of the raw materials needed for industries, facilitating investment and market growth (Keba, 2022; Atinkugn &Abibual, 2023;Tekeste et al., 2023). However, various studies indicate that the agricultural sector struggles to produce enough food to support the rapidly increasing population, primarily due to low cereal crop productivity and a widening gap between supply and demand for agricultural products. Contributing determinants include insufficient technology, limited adoption of modern inputs, inadequate extension and credit services, as well as natural disasters like drought and environmental degradation (Shakira, 2018; Aynalem et al., 2020; Asmiro&Girma, 2024). Therefore,

Teff (Eragrostisteff) is the most important staple crop among various cereal crops in Ethiopia, serving both domestic consumption and trade purpose. It is also contributing to household food security. Teff is typically grown at elevations ranging from1 800 to 2,200 meters above sea level and in areas with sufficient rainfall. In comparison to other cereal crops, teff is regarded as a lower-risk cereal crop due to instability to endure challenging weather conditions (Fufa et al., 2011: Adugnaw &Birara , 2023). This grain is mainly used for making Injera, a spongy flatbread, the main national dish in Ethiopia. Teff is also valued for its fine straw, which is used for animal feed as well as mixed with mud for building purposes (Minten, 2016; Nigusu et al., 2022). Besides, this crop is among those that are not fully utilized, yet it has the potential to enhance food security and diversify agriculture. It is nutritious and suited to Ethiopia's growing conditions, but there has been minimal investmentto develop its potential for both domestic and international markets (Habte et al., 2022; Gebrehiwot &Ndinda, 2024).

In Ethiopia, Teff is cultivated on over 3 million hectares of land, with a production exceeding 5.4 million tons, and more than6.5 million farmers are involved in its cultivation (CSA, 2020).This crop possesses unique beneficial characteristics for both producers and consumers. For example, teff is resilient to harsh environmental conditions and is resistant to various biotic and abiotic stresses. Its seeds are not susceptible to storage pests, are gluten-free (making them safe for diabetics and those with gluten sensitivities), and are high in minerals and protein (Tabe-Ojong, 2017; Kaleab, 2018; Habte et al., 2022). Consequently, Ethiopia has a significant opportunity to enhance food security by increasingteff production and productivity, as well as exporting it. With its numerous advantages, including being gluten-free and

highly nutritious, teff has the potential to become the next super-grain, while Injera could emerge as a global super-food (Fikadu et al., 2019; Awulachew, 2020).

For teff farming, the Amhara region is the second-largest producer of teff in the nation, after the Oromia region. In this area, teff covers over 1 million hectares of farmed land and yields more than 2 million tons. The North Shewa zone is the second largest teff-producing zone inthe Amharaarea, providing over 14% of the yearly teff production to the region (Kebede., 015; Nitsuh, 2019). According to the CSA report from 2019, the Minjarna Shenkora woreda is one of the top teff-producing woreda in the NorthvShewa zone of the Amhara region. It produces about 356,837 quintals of teff each year. However, the average teff output in this area is 2.29 tons per hectare, which is lower than the Oromia region at 2.51 tons per hectare and higher than the national average of about 1.8 tons per hectare. Therefore, there is a need for efforts to boost teff production and productivity at the woreda, zone, region, and national levels to reach 4.34 tons per hectare nationally (Abewa et al., 2020).

Despite the teff productivity remains low due to spatial variability such as climate changes, low rainfall, technical inefficiencies, and other influences, the Ethiopian government is focused on promoting improved teff varieties, fertilizers, and modern agricultural technologies to smallholder farmers (Bachewe et al., 2018; Fikadu et al., 2019). Teff production in the study area faces significant challenges similar to those encountered by other cereal crops as other areas of the country. These challenges include an inefficient production system, climatic issues, a lack of improved seed varieties, insufficient and inadequate inputs such as pesticides, improved varieties, production inputs, effective management practices, soil fertility management, and pest and weds control for other study area (Dagar et al., 2021; Negese, 2023).

When the study comes to see the other research works, over the years, various researchers have conducted studies on teff production and productivity in Ethiopia (Samuel, 2015;Elias et al., 2017; Bachewe et al., 2018; Hyejin, 2018; Kaleab, 2018;.Mekamuet al.,2018; Almaz& Begashaw,2019; Deresse& Tekilu,2019; Fikadu et al., 2019;Nitsuh, 2019; Abewa et al., 2020;Hailu et al., 2022;Nigusu et al., 2022;Abebaw &Anteneh , 2023; Mekonnen., 2023 and Gebrehiwot &Ndinda, 2024) are the main one. From their works , the teff productivity is influenced by demographic factors (Age of households, sex, Marital status), socioeconomic(Education level, households income, off-farm income, and expenditure), environmental factor(climate determinants , fertilizer application, , temperature, moisture) and institutional factors like extension contacts to farm households, cooperative partnership, credit usage, credit access, etc. These are the main determinants of teff production and productivity in those studies.

Besides, many of those studies identified the main determinants of teff productivities in general aspects. Nonetheless, several studies have previously been carried out in this field, investigating the effects of adopting individual agricultural technologies on Teff

productivity. some of them showed that main challenges for improving teff productivities: many of the studies considered very few explanatory variables for their works, few of them studied for few agricultural products without considering environmental issues like soil types, soil fertility and agro ecological type for their production. Besides, none of study conducted in Minjarna ShenkoraWoreda for teff productivity in contexts of its status, major determinants and challenges for its production and productivity.

As a result, this study intended to fill the earlier noted gaps by using different information from different studies, locating further research gaps and problems within the study field. This indicates that it sought to cover a wider study area with a larger sample size, focused on productivity instead of just direct production estimates, included numerous explanatory variables such as the dependency ratio soil fertility and irrigation practices in the framework, and merged descriptive analysis with inferential statistics to explore the issues thoroughly, ultimately leading to better policy suggestions. Thus, to address these problems, the research aimed to respond to two questions about teff productivity in the region. The questions are: what are the main determinants factors affecting teff productivity in the study area? And , what significant obstacles do farmers encounter in boosting their teff productivity in Minjarna ShenkoraWoreda?

2. Materials and Methods

2.1.Description of the Study Area

The study was conducted in Minjarna Shenkora woreda and it is one of the woreda from North Shoa Zone inside the Amhara region of Ethiopia. It is named in part after a historic woreda of Shewa, Menjar, which was the southernmost woreda of Shewa and close to the area of the present day woreda (WIKIPEDEA., 2024). Located at the southern end of the Semien Shewa Zone, It is bordered on the east, south and west by the Oromia Region, on the northwest by Hagere Mariamna Kesem, and on the northeast by Berehet (Kebede. A., 2015).it is located farther to the southern part of North Shewa zone, and about a hundred thirty five km southeast of the Capital city, Addis Ababa. And have a total of approximately 229, 463 Hectare of land. The geographical location of the study area is extended from 8 ^{0} 42’46’’ N to 9 ^{0}7’37’’ N latitude and from 39 ^{0}12’57’’ E to 39 ^{0}46’53’’E Longitude. The altitude of the study woreda ranges from 1400-2400 meter above sea level and it obtains high rainfall between Junes to August. (Terefe et al., 2018).

The most recent population estimate shows that there are 33,331 individuals residing in the study area, which includes 15,446 males and 17,885 females (ZOFED, 2022). This woreda consists of 30 kebeles in total, with 27 being rural and the remaining urban. The primary cereal crops grown in the woreda are teff, wheat, sorghum and maize (Mekonnen,H.,2023).In the study area, 49,220 hectares of farmland were used to grow these crops in the 2019/20 growing season as per the ZOFED, 2022 report. Around 17,106 hectares were dedicated to teff leading to the production of approximately 356,837 quintals of teff. Thus, Minjarna Shenkora woreda recorded a higher teff yield than any other woreda in the North Shewa Zone during that season. Nonetheless, the overall teff productivity in

the woreda is low compared to other woredas. Therefore it is important to examine the main determinants of teff productivity in the woreda.

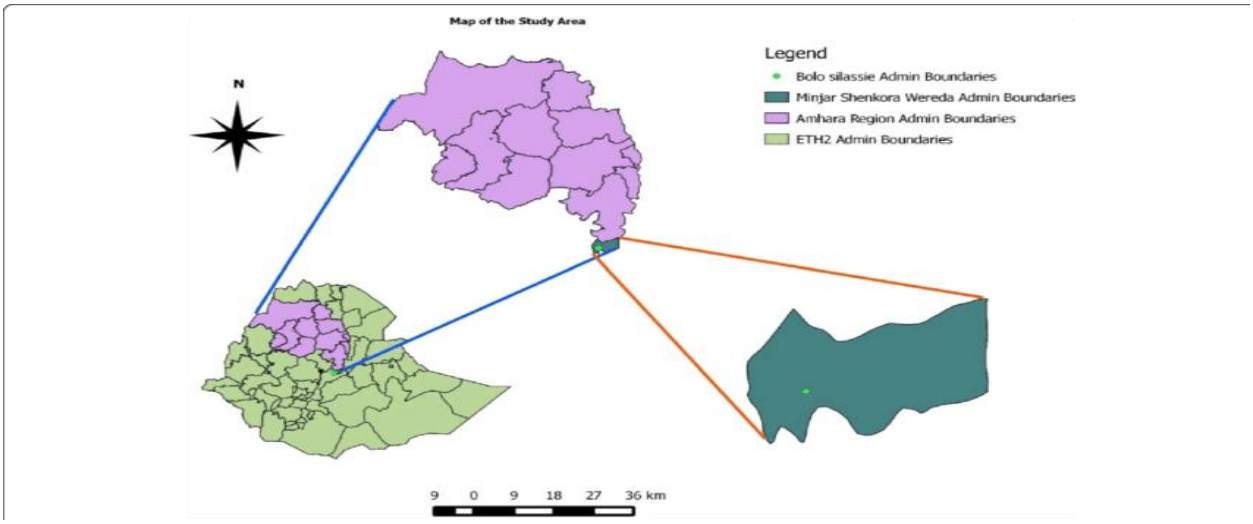

Figure 1.The study area Map

Sources Adopted from Zerihun et al., 2021.

2.2.Research Design and approach

This study employed an explanatory type of research design to elucidate the cause and effects of specific phenomena or comprehend the reasons behind relationships. It is commonly utilized to explore complex problems, uncover reasons behind trends, or understand underlying factors of behavior (Janet &Ruane, 2006). It is anchored by deductive approaches to answer the aforementioned research questions. Deductive research is a scientific approach that is employed to test a theory or hypothesis through observations and empirical evidence data for research. It works for examining the main determinants of teff productivity in Minjarna Shenkora woreda, Amhara Region, Ethiopia.

2.3.Sampling Techniques and Estimation

To choose a sample from among all teff producers, a multi-stage sampling technique was used. The Minjarna Shenkora woreda is made up of 30 kebeles, of which 27 are rural and the remaining are urban. These kebeles are divided into three agro climatic zones. According to MSDARDB's 2021 classification, the study concentrated on the agro-ecological traits of the Dega, Woina-Dega, and Kola zones. Five representative kebeles for teff producers were randomly chosen for this study based on their teff production potential among other kebeles: two from the Dega zone, two from the Woina-Dega zone, and one from the Kola zone. Furthermore, a sample of 288 households was selected by applying of simple random sampling technique from these kebeles to reflect individuals engaged in farming, specifically the cultivation of teff within the woreda.

There are two standard techniques for calculating sample size in quantitative

research: one for known populations and another for the number of unknown populations. We used the following sample size formula to estimate the population size for our study, assuming that it is unknown. The research design, the intended precision level, the expected population variability, and the chosen confidence level are some of the variables that affect the sample size determination. When the population size (N) is unknown or not used for estimation, the formula below or Cochran's formula is a commonly used or dominant formula for determining minimum sample size when the study focused more on the precession level, confidence level, population variability and the heterogeneity of population than its number for calculating the minimum sample size (Dawson, 2009).

Therefore, we can apply the formula provided below.

$$n = \frac{z2 * p * q}{\propto 2}$$

According to the 2021 report from MSDARDB, it was estimated that 75% of farmers were teff producers, contrarily; theremaining25% of farmers had not produced teff for their livelihood activities. Therefore, in our study, we set z= at 95%, with a standardized normal value of 1.96, Degree of variance with P=0.75, q=0.25andα= 0.05---Margin of error.

$n = (1.96^2 * 0.75 * 0.25)/0.05^2$= 288.1=***288hhs.***

Where: n = Minimum sample size

Table 1. Sample Distribution for Teff Producers in the Kebele of Minjarna Shenkora Woreda.

No	***Agro Ecology Zone***	***Name of Selected kebele***	***Total Population in HHs***	Percentage of the total household head.	Number of chosen household heads
1	Dega	Eranbuti	1559	1559/9031 = 17.2	50
		Chercaha	2666	2666/9031 = 29.5	85
2	Woinadega	AreritZuria	1543	1543/9031 = 17.2	50
		Rarite	1370	1370/9031 = 15.2	44
3	Kola	Cheli	1893	1893/9031 = 20.9	59
Total sample sum			***9031hhs***	***100%***	***288hhs***

Source: MSDARDB, 2021.

2.4.Data Types, Sources and Collection Procedure

This study used data from both primary and secondary sources. The study is based on household-level cross-sectional survey data collected from 288Teff farmers in the woreda. The survey was created to gather information regarding the demographic, economic, social, and institutional traits, soil kind and various other difficulties faced by

rural farming families. It was arranged with both closed and open-ended queries. Four data collectors received a short briefing and training for data gathering based on the interview plan. Ongoing oversight was maintained during the entire data gathering phase. The survey was initially prepared in English, and then translated into Amharic to collect primary information from farming households.

The research also carried out a preliminary test to check the dependability and accuracy of the questionnaire prior to collecting actual data. The preliminary test included 10% of the sampled households. Based on the results, the variables in the research area showed strong dependability. This assessment was measured by the Cronbach's alpha method, which yielded a value of 0.79, surpassing the minimum acceptable standard of 0.7. As a result, it was confirmed that the final survey could proceed using the prepared questionnaire. Additional data was gathered from various documents and published materials such as books, journal articles, conference papers, and reports from the Central Statistical Agency and Agriculture and Development Offices in the research area.

2.5.Model Specification and Estimation

The economic idea of production acts as the foundation analysis for a lot of research aimed at assessing production and productivity. To tackle this matter, the production function was created to comprehend and evaluate the connection between the resources utilized in the production process and the output produced (Varian, 1992). To make the best use of resources, farmers and businesses must grasp some basic ideas of production (Onalan and Basegmez, 2018; Gautam, 2024). The Cobb-Douglas production function illustrates the link between physical capital and labor inputs and the resulting output.

It is a practical version of the production function, showing how physical capital and labor inputs relate to the output produced (Dagar et al., 2021; Getamesay et al., 2023). Agricultural economists have utilized Cobb Douglas production functions for the production process thattransforms inputs into output (Tabe-Ojong&Molua, 2017; Orolando, G., 2023). Thus, this research chose the Cobb Douglas production function as a practical form of study model specification as

$$Y = A * L^{\beta_1} * K^{\beta_2} \text{---------- } \textbf{\textit{(1)}}$$

Where, L = real value of labor input, K = real value of capital input, Y= real value added in output or production,β_1=output elasticity w.r.t. to labor, and β_2 = output elasticity w.r.t. to capital (Gautam, 2024).

The equation (1) indicates that production function depends directly on L and K and that part of output that cannot be explained by L and is explained by A, which is often called technical change. The coefficient of laborer in the C-D function measures the percentage increase in Y that would result from a one-percent increase in L, while keeping K constant. Similarly, β represents the percentage increase in y that would arise from a one percent increase in K, while maintaining L as constant (Smirnov and Wang, 2021).

Then, we transform equation (1) or non-linear functional forms of C-D function to

linear function and developed the production function of teffas equation (2) below

$$lnY_{it} = \beta_0 + \beta_1 lnL_{it} + \beta_2 lnK_{it} + \mu_{it} \text{----------(2)}$$

Where, lnY_{it} = the log of total farm output produced per hectare by i^{th}hhs during period t,

- lnL_{it} = the i^{th} household teff labor inputs during period t
- lnK_{it}= the i^{th} household teff capital inputs during period t
- β_0 = Intercept and μ_{it} = is the residual term

The study also moves From Equation (2) moves to equation (3) to gets the formula of productivity. I.e.it is essentially the ratio of the value of outputs to the value of inputs utilized in production. Thus, it can be calculated by dividing total production by the area as follows

$$\ln (Y_{it}/h) = \beta_0 + \beta_i X_{it} + \mu_{it} \text{----------(3)}$$

Where: ln (Yit/h) represents the natural logarithm of teff output per hectare, which is the dependent variable.

· Xit includes all independent variables associated with the ith observation.

· βi denotes the parameter that needs to be estimated.

· β0 is the intercept and μit represents the residual term.

Consequently, the research created the following model as the final version by applying various economic theory assumptions and used multiple linear regression models for the estimation part due to its adaptability, quantitative analysis abilities, capability to pin point important factors, manage confounding variables, evaluate model fit, ease of interpretation, and ability to test essential assumptions (Gujarati, 2009)..Thus, the study employed ordinary least squares (OLS) regression model for its estimation as.

$$\ln (Y_{it}/h) = \beta_0 + \beta_1 Age + \beta_2 Sex + \beta_3 family\ size + \beta_4 DR + \beta_5 Education + \beta_6 land\ size + \beta_7 Credit\ access + \beta_8 Marketinformation + \beta_9 Oxennumber + \beta_{10} Ferilizers + \beta_{11} Compost + \beta_{1Irr}\ use + \beta_{13} Soil\ fertility + \beta_{14} Non\text{-}farmincome\ t + ui \text{----------(5)}$$

Where: Y_{it}----Annual teff production: h ---land size in hectar and ln (Y_{it}/h) ---Teff productivity.

The study considered all variables for its estimation part in details as below

Table 2. Names of Variables, Their Types, Descriptions, and Anticipated Signs.

No	**Names of variables**	***Their Type***	***Description***	**Anticipated *sign***
1	Age of farm hhs	Continues	Age of the farm hhs Head	-
2	Sex	Dummy	Sex of Household Head: 1 indicates the household head is male, while 0 indicates female.	+
3	Family size in a hh	Continues	Number of family size in a farm household	+
4	Dependency Ratio	Continues	It pertains to the ratio of the economically inactive population (those under 14 and over 65 years old) to the active workforce (ages 15 to 65) in a household.	-
5	Education level	Dummy	1 if the education level of hhs maximum to grade 8 level and 0 otherwise.	+
6	Farm land size	Continues	Farm land size for teff production in hectare	+
7	Access to Credit	Dummy	1 indicates that the household has had access to credit, while 0 signifies that it has not.	+/-
8	Access to market Information	Dummy	1 if the HH has access to market information and 0 otherwise.	+
9	Oxen	Continues	Number of Oxen for Teff production	+
10	Fertilizer use:	Continues	Total amounts of fertilizer uses in Kg	+
11	Compost Use	Dummy	1 indicates that the farmer utilizes compost, while 0 signifies that they do not.	+
12	Irrigation: use	Dummy	1 if the HH has irrigable cultivated land and 0 otherwise.	+
13	Soil fertility	Dummy	1 indicates that the land has fertile soil, while 0 means it does not.	+
14	Non-farm Income	Continues	Overall revenue generated from non-farm income	+

Source: Own Computation, 2023.

3. Result and Discussion

3.1. Model Specification and Estimation

Descriptive analysis

The study used descriptive stats and inferential analysis in its discussion part. Continuous and two-category variables were used for the descriptive stats. The average and standard deviation were found for the continuous variables. For the two-category or dichotomous variables, a frequency table was made to show their counts and percentages. Table 3 shows that the ages of household heads involved in teff production ranged from 24 to 78 years, with an average age of 41.12 years. Additionally, the average family size in the study area was 4.5, with a minimum of 2 and a maximum of 10 family members. In case of the Dependency ratio,

the result was 1.68 with range of 0.3 to 7 individual who were living in sampled farm households.

Table 3. Descriptive analysis for continues variables.

No	Name for Variable	Sample size	Mean	Std. Deviation	Minimum	Maximum
1	Output	288	13.3213	14.35265	.25	56
2	Age	288	41.12153	10.67492	24	78
3	Family size	288	4.5	1.807842	2	10
4	Dependency ratio	288	1.686806	.9798846	.3	7
5	Land size	288	.9348958	.4604262	.25	3
6	Number of Oxen	288	2.190972	1.13312	1	6
7	Fertilizer	288	412.4479	205.7166	100	1250
8	Non-farm income	288	2810.128	4135.634	0	19600

Source: Own Computation from field survey data, 2023

In study involving 288 households, the average farm landholding size for the sampled farmers was 0.93 hectares per household, with the smallest holding being 0.25 hectares and thelargestat3hectares. The survey also indicated that, on average, each family used 2.2 oxen for teff farming, with a range of 1 to 6 oxen per household. Additionally, chemical fertilizers, specifically Urea and DAP were another key input for teff production and they apply412.44 kg per hectare on average. They used these from a minimum of 100 kgs to a maximum of 1250 kgs per hectare in the study area. In case of non-farm income generation for teff producer farmers generates 2810.128 birr per household. The study used total teff output per hectare used as measures for teff productivity. The result showed that about 13.32 quintals of teff per hectare produced in the study and it ranges from .25 to 56 quintals.

In addition, Table 4 shows that among 288 respondents, 186(64.58%) were from male headed farm households, while 102(35.42%) were female headed. The data reveals that male participation in production is significantly greater than that of females. Concerning education levels, 246(85.48%) of the farming households in the study have completed at most 8 years of schooling compared to others. This indicates that a large number of farming households have an education level that allows them to read or is restricted to primary school. Regarding access to credit from financial institutions, 170 (59.03%) of the sampled farming households have got financing for their teff production. This access alleviates financial constraints for teff farmers and enables them to buy essential inputs like improved seeds and fertilizers. On other hands, the results show that 211 (73.26%) of the farming households lack access to accurate and timely marketing information for their agricultural activities, which hinders their ability to make informed decisions about production and sales. In addition, in case of uses of Compost and Irrigation uses, 78(27.08%) and 90(31.25%) of farm households was used compost for their land and irrigation uses for teff production, respectively. Finally from the survey results

that 249 (86.46%) of respondents have said soil fertility presents in their farm lands.

Table 4. Descriptive analysis for categorical variables.

No	Variable name	Category	Frequency	Percent
1	Sex	Female	102	35.42%
		Male	186	64.58%
		Total	**288**	**100.00%**
2	Education level	No	246	85.42%
		Yes	42	14.58%
		Total	**288**	**100.00%**
3	Access to Credit	No	118	40.97%
		Yes	170	59.03%
		Total	**288**	**100.00%**
4	Access to market information	No	211	73.26%
		Yes	77	26.74%
		Total	**288**	**100.00%**
5	Compost use	No	210	72.92%
		Yes	78	27.08%
		Total	**288**	**100.00%**
6	Irrigation use	No	198	68.75%
		Yes	90	31.25%
		Total	**288**	**100.00%**
7	Soil fertility	No	39	13.54%
		Yes	249	86.46%
		Total	**288**	**100.00%**

Source: Own Computation From Field Survey Data, 2023.

3.2. Determinants of Teff Productivity

The study applied different post estimation diagnostic tests techniques for its selected model and performed by using STATA 14.0 software package before using the results of OLS regression model. The variance inflating factor (VIF) method was used to check the presence of multi-collinearity among continuous variables. The results showed that all continuous variable VIF values were below 10, with a VIF of 2.14, indicating that there is no multi-collinearity issue in the model. It also assessed the multi-collinearity problems among discrete explanatory variables, contingency coefficients were calculated, yielding a result of less than 0.80, which also suggests no multi-collinearity problem in used model. Additionally, the Breusch-Pagan test was performed to assess heteroscedasticity, showing that the variance in εi term is not constant. The outcome of the Breusch-Pagan test Chi2 (1) = 31.44 with probChi2= 0.000.This indicated a heteroscedasticity issue in the model, which was addressed by using robust methods. The study also utilized the Ramsey test for checking omitted variables, with the results showing F (3,269) and prob 0.5556, indicating it is

statistically not significant, and therefore we don't reject its null hypothesis that the selected model has no omitted variables in its regressions. In addition, the model's fitness was evaluated through its R-squared or coefficients of determination, which showed that the dependent variables of the model were, explained 73.6% by all its independent variables.

After checking all diagnostic tests are mentioned in the above paragraph and estimated the main determinants of teff productivity by the OLS model, Table 5 indicates that the key determinants significantly influencing teff productivity in the study area include the dependency ratio, education level, farm land size, access to credit, access to market information, compost use, irrigation practices, soil fertility, and non-farm income. However, Age, Age square, Sex, Family size, Oxen number and Fertilizer use are not statistically significant or have no impacts for teff Productivity. Thus,

Dependence ratio: The Dependence ratio coefficient is negative and statistically significant at the 5% probability level. This indicates that a 1% increase in the farm household dependency ratio, while keeping all other variables constant, results in a 10.5% decrease in teff productivity. This decline may occur because an increase in family size, particularly among dependents, leads to greater use of land for family food consumption, resulting in overuse and fragmentation of the land, which ultimately reduces teff productivity. This finding aligns with the research conducted by Kaleab. , 2018; Nitsuh. , 2019; Asmiro&Girma., 2024.

Educationlevel:The coefficient for household education level is both positive and statistically significant at the 1% level. This means that families led by individuals with higher education are more inclined to yield larger quantities of teff than those with less education. In particular, if the education levels of farming family increases from primary to secondary or higher education while other factors remain unchanged; their teff productivity is likely to increase by around 3.7%on average. This indicates that education boosts teff productivity more efficiently than in families with lower educational back grounds. It has similar results with the works of Mekamu et al., 2018; Awulachew., 2020; Gebrehiwot &Ndinda., 2024.

Farm Land size: The coefficient for land size is negative and statistically significant at the 1% probability level**. If** the size of the farmland increases by one hectare, while keeping other variables constant, the productivity of teff decreases by 112%.This means, as the farm land size increases, productivities per unit of land often decreases. The explanation for this reverse relation is that when farming families have smaller or scattered land for their living activities, they tend to use more of their effort and time to maintain that piece of land through soil and water preservation. This results in higher teff yields in these situations. On the other hand, if farmers possess larger farm land, they are less inclined to put in effort or time for its upkeep. Consequently, this shift leads to focusing producing other cash crops instead of teff since those require more labor and attention compared to other cereal crops. It is not aligns with the works of Aynalem et

al., 2020; Zegeye, et al, 2022 ; Mekonnen., 2023).

Table 5. OLS Regression Estimation of Crop productivity.

Linear regression output			No of observation = 288 F(15, 272) = 89.83 Prob> F = 0.0000 R-squared = 0.7360 Root MSE = .67542
Lnoutput/ht	***Coefficient.***	***Robust Std. Error***	***t-value***	***P value>|t|***
Age	01506	.0231189	0.65	0.515
Age square	-.0001212	.0002412	-0.50	0.616
Sex	-.070777	.0833166	- 0.85	0.396
Family size	-.0077291	. .0261935	-0.30	0.768
Dependency ratio	-.1054822	.0446576	-2.36	0.019 **
Education level	.0374526 .	0115447	3.24	0.001***
Land size	-1.125008	.1635821	-6.88	0.000 ***
Access to Credit	.2287302	. .0798867	2.86	0.005***
Access to Market Information	-.2287402	. .1020704	-2.24	0.026 **
Oxen number	.0420685	.0342264	1.23	0.220
Fertilizer use	.0003019	.0003765	0.80	0.423
Compost use	2.050133	. .0693111	29.58	0.000***
Irrigation use	.2375473	.0808603	2.94	0.004***
Soil fertility	.2623489	.1250565	2.10	0.037**
Non-farm Income	.0000168	.0000103	1.64	0.101*
_cons	2.032192	. .5259973	3.86	0.000

NB: ***, **and * indicates their significant level at the 1%, 5% and 10% probability level
Source: Own Computation from Field Survey Data, 2023.

Access to Credit Access: Access to credit for farming households from microfinance institutions (MIFs) and other financial service providers has a positive impact on their teff productivity at the 1% significance level**.** There is a notable and positive correlation between accesses to credit andteff productivity. Specifically, if farm households have greater access to credit, while keeping other determinants constant, their teff productivity can increase by 23%. This indicates that the source of financing is a crucial factor influencing teff productivity in the area studied. With increased credit access, households can buy more fertilizers and improved seeds for their farming activities, which in turn boost their teff yields. This finding aligns with the research conducted by Samuel, 2015; Elias et al., 2017; Nigusu et al., 2022.

Access to market information: The coefficient for access to market information is negative and statistically significant at the 5% probability level. This indicates that if farmers have more access to market information, while other determinants

remain unchanged, teff productivity also increases.It means that Farmers who know more about input and output prices and other activities are more effective than those who know less. This is because having market information helps them make the right decisions at the right time for their teff production. However, in this study, the confident of the variable turns negative, and productivity falls by 22%.Thismight be because the area studied was not suitable for marketing access variables, or it could be that categorizing the variables as dummy variables and could be by other factors resulted in an opposite relationship. Therefore, the result of this finding is not consistent with the work results of Bachewe et al., 2018; Hailu et al, 2022; Keba, 2022.

Compost Use: The coefficient for the compost usage variable is positive and statistically significant at the 1% level. This indicates that if a teff farming household utilizes compost in their teff production, while holding other determinants constant, their teff productivity will rise by 205%.This implies that, composts from animal dung/manure is very important inputs for teff production activities and keeps the land as a fertile in the study area. It isalign with works ofDeresse&Tekilu,2019; Abewa et al., 2020 ; Adugnaw &Birara , 2023.

Irrigation use:Thefinding indicates that the variable for irrigation use is both positive and statistically significant at the 1% probability level. This suggests that when a farmer employs irrigation for teff cultivation, while holding other determinants constant, the productivity of teff rise by 24%. This implies that farm household's that utilize irrigation are more likely to experience increases in teff productivity compared to those who do not use irrigation. This implies that, using irrigation leads to produce more for different seasons per year than not uses of irrigation for teff production. The result is consistence with Almaz &Begashaw, 2019; Negese , 2023; Tekeste, et al., 2023.

Soil Fertility: The coefficient for soil fertility is both positive and statistically significant at the 10% probability level. This indicates that if farm households possess more fertile land, while holding other determinants constant, the likelihood of increased teff productivity rises by 26%. This may be attributed to the fact that when farm households maintain their land's fertility, it leads to higher productivity of teff in the area studied. This finding aligns with the research work conducted by Samuel, 2015; Hyejin., 2018; Fikadu et al.,2019.

Non-Farm Income: The coefficient for non-farm income is both positive and statistically significant at the 5% probability level. This indicates that, assuming while holding other determinants constant, an increase in non-farm income for farm households is associated with a 0.1% rise in teff productivity. This effect may arise because households with higher non-farm income are more likely to invest in various inputs such as fertilizers, improved seeds, and pesticides for their teff production, leading to greater productivity compared to those without such income. This finding aligns with the studies conducted by Dagar et al., 2021; Negese, 2023).

4. Conclusion and Recommendation

Teff is the most significant cereal crop for food consumption and income generation in Ethiopia. This research was carried out in the Minjarna Shenkora woreda of the Amhara Region, located in the North Shewa Zone, examined the determinants of teff productivity. A multistage sampling method was employed to determine the minimum sample size. Initially, the researcher purposefully selected the Minjarna Shenkora woreda. Next, the study area was divided into three agro-ecological zones, from which five kebeles were selected from the total available. Ultimately, 288 farm households were selected for the study. The findings from descriptive statistics and the OLS model regression revealed that most of the hypothesized variables significantly affect teff productivity in the area.

The analysis showed that from the 15 determinants factors included in the OLS regression model, nine were recognized as important factors affecting teff production in the area studied. In particular, Education/Grade level, access to Credit, use of compost, Irrigation use, Soil fertility, and Non-farm Income were identified to have a positive and significant influence on teff production. In contrast, the Dependency ratio, Land size, and access to market Information were found to negatively and significantly influence teff production in the area. Therefore, the results indicate that many of the factors are important in determining teff productivity in the study area. Consequently, they can help to generate or suggesting various policies to enhance teff production in the Minjarna Shenkora woreda of the AmharaRegion in North Shewa, Ethiopia.

Due to the important results, the following specific areas for action have been pointed out to local administrators as Increasing access for farmers to training programs that promote further education; Motivating farmers to produce and use more compost for their fields; Establishing regular soil and water conservation practices to maintain soil fertility; Providing better access to market information sharing through various plat forms such as television, radio, mobile, and others; Strengthening institutional support to facilitate greater access to credit at the farm household level and Promoting income diversification to allow better access to inputs and the use of various technologies for improvements in teff production and productivity in the study area.

Acknowledgements: We would like to thank the editor and anonymous reviewers for their supportive comments and suggestions.

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