Academic year 2020

THE IMPACT OF AGRICULTURAL CREDIT ON THE PRODUCTIVITY OF TEF FARMERS, A CASE FROM THE AMHARA REGION OF ETHIOPIA

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Thesis submitted in partial fulfilment of the requirements
for the joint academic degree of International Master of Science in Rural Development from Ghent University (Belgium), Agrocampus Ouest (France), Humboldt University of Berlin (Germany), Slovak University of Agriculture in Nitra (Slovakia), University of Pisa (Italy) and University of Córdoba (Spain) in collaboration with Can Tho University (Vietnam), China Agricultural University (China), Escuela Superior Politécnica del Litoral (Ecuador), Nanjing Agricultural University (China), University of Agricultural Science Bengaluru (India), University of Pretoria (South-Africa) and University of Arkansas (United States of America)

This thesis was elaborated and defended at Ghent University within the framework of the European Erasmus Mundus Joint Master Degree "International Master of Science in Rural Development " (Course N° 2015 - 1700 / 001 - 001)

Certification

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The impact of COVID-19 pandemic on the execution of the master thesis

The COVID-19 pandemic which seemingly started as a joke had its toll during the conceptualization and write-up of my thesis. The closure of international borders, partial and in some cases total limitation of movements made the execution of this piece of work pushed to a tight corner. As a result, this work made use of secondary data from the world bank database which to a large extent covered the need to collect primary data. Also, discussing and sharing ideas with my promotor and tutor "on-line" through various channels may have limited some other useful forms and benefits of physical interaction. But we did our best to utilize the available means. Physical meetings and discussions I believe would have been optimal considering the magnitude and technicalities involved in writing a good master thesis. An even bigger issue was my mental state. Living alone during the lockdown period coupled with the every minute update of the COVID-19 situation in Belgium, my home country, and the entire world rather scared and kept me in a state of shock that at times I could not eat or have the required calm to study. These notwithstanding, the clock never stopped ticking and at this point in presenting this work, I think it could have been much improved without the COVID-19 pandemic.

ACKNOWLEDGMENT

I am grateful to VLIR-UOS for funding my study through UGent.

Sincere thanks go to my promoter Prof. Marijke D'Haese and my tutor; Chinedu Obi for their guidance and the invaluable insights given to me while carrying out this study.

I would finally like to thank my family members and friends for their support and encouragement throughout my life.

Contents

List of Abbreviations

SSA	Sub-Saharan Africa
GDP	Gross Domestic Product
AGDP	Agricultural Gross Domestic Product
SDG	Sustainable Development Goal
MFI	Microfinance Institution
ADLI	Agricultural Development Led Industrialization
SNNP	Southern Nations, Nationalities, and Peoples
ATA	Agricultural Transformation Agency
USD	United States Dollars
NGO	Non-Governmental Organizations
NBE	National Bank of Ethiopia
LSMS	Living Standard Measurement Study
LSMS-ISA	Living Standard Measurement Study-Integrated Survey on Agriculture
WB	World Bank
IIA	Independent of Irrelevant Alternative
CSA	Central Statistics Agency
MNL	Multinomial Logit Regression
ESR	Endogenous Switching Regression
PSM	Propensity Score Matching
LTL	Long Term Loan
STL	Short Term Loan

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Abstract

The agricultural sector of most Sub-Saharan African (SSA) countries is an important sector that defines the economic policies and is mainly responsible for growth. Ethiopia has a high agricultural potential yet low actual productivity especially for cereals such as tef with high socio-cultural and economic value. The orthodoxy of development stakeholders in Ethiopia holds that the problem of smallholder agriculture is that of inadequate technology adoption. Low productivity as a resultant has led to lower gross incomes and unsustainable livelihood strategies. Access to agricultural credit for technology adoption has proven to have an ability to improve yields and gross income of smallholder farmers. However, the source of credit farmers' access, be it institutional or non-institutional potentially has different impacts on productivity both in magnitude and direction. Various approaches have been used to remedy this situation as governments have been changing strategies over time. From the provision of subsidies around the 1990s with limited recorded success to the recent market-oriented financial system consisting of specialized credit institutions. Data for 2269 tef farmers was extracted from the World Bank Living Standard Measurement Survey (LSMS) wave 3 carried out between 2015 - 2016 was used to analyze and achieve the objectives of this study. A multinomial logit model was run to ascertain the socio-economic and production factors influencing tef farmers' access to various credit sources. Non-institutional credit access was positively and significantly influenced by gender (male) in the Amhara region, education, and commercialization in Ethiopia. Extension access in the Amhara region proved to have a negative and significant influence on non-institutional credit access. On the other hand, institutional credit access was significantly and positively triggered by gender (male) and inorganic fertilizer use in the Amhara region, and extension access inclusive in Ethiopia. Nevertheless, household size indicated a negative and significant influence in institutional credit access for tef farmers in the Amhara region. Also, a Heckman sample selection model employed to correct for selection bias and endogeneity portrayed non-institutional credit as having a positive impact on the gross income acquired by tef farmers with this effect being significant at the country level. Institutional credit proved to have a negative and significant impact on gross income both at the level of the Amhara region and Ethiopia.

Keywords: Agricultural credit, gross income, multinomial logit, Heckman selection, tef, Amhara, Ethiopia

1. Introduction

1.1. Background of study

Agriculture is a key driver of economic development for most agriculture-based economies. In Sub-Saharan African (SSA) countries, the agricultural sector holds an unarguably vital position in economic development and poverty alleviation (Vandercasteelen et al., 2013). The majority of the poor masses have a great dependence on agriculture as the primary source of food, fuel, and income (Apata et al., 2010). However, the SSA region still accounts for most of the world's poor, contributing 27 of the world's 28 poorest countries (World Bank Group, 2018). Although agriculture has the potential of improving the livelihood of many rural households in SSA, the smallholder farmers still experience numerous challenges that hinder their productivity (Ehui and Pender, 2005).

Some of the challenges include the following. Firstly, there is a challenge of high transaction costs largely attributed to poor infrastructure. This constrains farmers' access to markets which could boost their growth (Machethe, 2004; Raimi et al., 2017). Secondly, the problem of inadequate comprehensive farmer support services such as access to extension services, insurance, and credit schemes have also proven to be obstacles to the improvement of production and productivity of smallholder farmers (Machethe, 2004). Thirdly, there is an inadequate technology adoption and implementation. Hence, the use of chemical fertilizers, pesticides, improved seed varieties is low for most rural smallholder farmers in SSA (Adjognon et al., 2017). Fourthly, poor government policies and their implementation in SSA characterized by low investments, weak institutions, price instabilities, and food importation have rather undermined and reduced expected growth of smallholder farmers (Binswanger et al., 2000; Ehui and Pender, 2005; Raimi et al., 2017). Fifthly, certain socioeconomic trends such as urbanization and migration have led to a decrease in rural farm labor availability and declining labor productivity (Ehui and Pender, 2005; Jayne et al., 2010). Finally, the problems caused by climate change have left many poor smallholder farmers in a vulnerable position (Binswanger et al., 2000; Ehui and Pender, 2005). These constraints generally increase farmers' vulnerability to shocks, pest, disease attacks, and preand post-harvest losses, thereby reducing their productivity and resulting in poverty.

To eradicate poverty and increase food security in SSA for the achievement of the Sustainable Development Goals (SDGs) 1 and 2, there is a need to increase the productivity of rural farmers in SSA through well-structured local institutions that provide credit facilities (Osabohien et al., 2018; Osabuohien et al., 2018). It is established that the adoption of improved technology and inputs can curb the menace of low productivity in SSA (Adjognon et al., 2017). However, rural farmers are limited by credit access and it has prevented many from accessing or adopting new technologies (Machethe, 2004). Therefore, the creation and operation of parastatal institutions aimed at channeling credit to smallholder farmers are necessary to boost smallholder agricultural productivity. According to Nwaru (2004), agricultural credit is the present and temporary transfer of purchasing power from a person or an organization who owns it, to a person(s) who wants it, allowing the later the opportunity to command another persons' capital for agricultural purposes but with the confidence in his willingness and ability to repay at a specified future date. Agricultural credit can serve as advances for production, storage, transformation, and sales of farm produce given to farmers (Agbo et al., 2015).

Agricultural credit could stem from two main sources, institutional and non-institutional sources. Institutional sources are those which operate with legal identities, under government stated laws with defined formalities such as banks, Micro-finance Institutions (MFIs), credit cooperatives, NGOs, cooperative banks, and credit unions. While with non-institutional sources, there is the provision of credit without legal formalities such as with traders and commission agents, landlords, moneylenders, credit clubs, friends, and relatives (Steel and Andah, 2003; Hussain and Thapa, 2012; Agbo et al., 2015; Ali Chandio et al., 2017; Yadav, 2017). Credit for agricultural production has been widely considered as the main factor favoring the course of modernization of agriculture and economic development (Nouman and Syed, 2013). It has proven to be instrumental in the adoption of new farm technologies and farm input acquisition such as the use of improved seed varieties, inorganic fertilizers, and better irrigation schemes (Iqbal et al., 2003; Saboor et al., 2009; Matsumoto and Yamano, 2011; Hussain and Thapa, 2012; Abdallah, 2016a; Abdallah, 2016b; Ali Chandio et al., 2016; Narayanan, 2016; Chandio et al., 2017; Rehman et al., 2017).

While credit has been recognized as a way of improving productivity, it's effectiveness in improving productiveness of rural farmers suffers for two reasons; limited accessibility and misuse of credit. Agricultural credit access is found to be affected by socioeconomic factors of the farmer,

farm-specific, and institutional factors (Agbo et al., 2015). Other issues hampering the smooth access to agricultural credit, including but not limited to the untimely delivery of credit which upsets planned activities in the production process. Bureaucratization and high illiteracy rates of rural farmers also constitutes a major hurdle for rural farmers to access credit. Also, stringent collateral requirements are often not met by rural farmers. Moreover, high administrative charges, high transaction costs, high-interest rates, and hidden charges deter rural smallholder farmers from credit. More so, landlessness and small farm size discourage credit access. Furthermore, distance to the formal credit institution makes acquisition and usage of credit rather difficult (Agbo et al., 2015; Aghapour Sabbaghi, 2017; Elahi et al., 2018). Finally, the high probability of failure of farmers to reimburse acquired credit has influenced the functioning of credit institutions, making them adopt measures often not suitable for smallholders (Pishbahar et al., 2015). In the other hand, some rural farmers have misused acquired credit for agricultural purposes for non-agricultural purposes such as festivities (wedding and burial ceremonies), repayment of other informal loans, school fees and medical bills mainly influence by high household dependency ratios (large household size) and low off-farm income (Elahi et al., 2018). Also, Kumar et al., (2017), expressed that non-institutional credit is somewhat a demerit to the farmers as it is considered extortionate as a category for example moneylenders impose higher taxes not accepted by law in an attempt to enrich themselves.

The issue of rural poverty, low farm productivity, limited access, and misuse of credit is very noticeable in Ethiopia which serves as the study area of this research. Primarily an agricultural country, agriculture contributes significantly to the Gross Domestic Product (GDP) (about 44 %) of Ethiopia and employs about 80 % of the population. It is responsible for 90 % of export earnings, supplying the nation with 70 % of her raw materials for secondary industries. It strives to ensure national food security, provides the capital for social investment and industrial development with enormous spillover effects witnessed in non-agricultural sectors (Belete et al., 1991; Spielman et al., 2010; Mcintosh et al., 2013; Durie, 2018). Smallholder peasant agriculture in particular accounts for over 95 % of output generated from cultivated land using traditional methods (Croppenstedt et al., 2003; Mcintosh et al., 2013; Cafer and Rikoon, 2018). Despite this position held by the agricultural sector, the country still has a significant yield gap between the actual yields and potential yields with a primary reason for such gap being low technology adoption (Abate et al., 2016). Although having average cereal yield higher than that of Eastern Africa, the average

cereal yield levels are still lower when compared to other developing countries (Bingxin and Alejandro, 2014; Hailu et al., 2015). The yield gap is also true for tef, which is one of the most prominent food crops produced in the country, especially in the Amhara region. Tef is increasingly demanded internationally by the Ethiopian diaspora, hence an increase in the productivity of tef is needed to meet the growing demand. This has the potential of improving the income of the rural producers and reducing poverty in rural areas of Ethiopia.

Mechanisms have been put in place to enhance tef farmers' access to credit in Ethiopia. As an example, the Agricultural Development Led Industrialization (ADLI) approach created in the mid-1990s is part of a national set of policies in Ethiopia with the view that reduction of poverty, increase productivity and income of Ethiopian smallholder farmers is impossible without improving the yields significantly for major staples such as tef, barley, wheat, maize and sorghum (Samuel, 2006; Elias et al., 2013; Bachewe et al., 2018). Despite this effort to improve access to credit, the productivity of tef farmers remains low (Bingxin and Alejandro, 2014; Hailu et al., 2015). This stresses on the fact that there is a need to improve farmers' access to amongst others agricultural credit to enhance their capacity to use fertilizers, improved seeds and adopt other technologies for improved farm productivity and the adoption of better livelihood strategies (Samuel, 2006). Hence the impact of agricultural credit, its sources should be evaluated for tef farmers in other for practical and adoptable recommendations to be put in place, the *raison d'etre* of this study.

1.2. Problem statement

Literature has been advanced to explain the farmers' access to agricultural credit and its impact on productivity and income. On the impact, the current view amongst researchers is that the problem of smallholder agriculture is mainly technical and resource-related. They identified the low level of agricultural productivity as the most crucial outcome of the problem, hence emphasizing the role of agricultural credit as a major solution that would enhance productivity and increase farmers' income (Samuel, 2006). The adoption of improved agricultural technologies such as the use of high yielding seed varieties, fertilizers, and irrigation schemes by smallholders is looked upon as the main solution pathway of overcoming the problem of low productivity. *Ceteris paribus,* with appropriate application, agricultural technology application should bring about additional income,

accelerate economic growth, create more marketing opportunities, and help numerous farmers move out of poverty (Wossen et al., 2017).

The lack of adequate capital, savings of farmers, imperfect information, and imperfect credit markets lead to inadequate technology adoption, and improper resource allocation may contribute to low per hectare farm productivity (Saboor et al., 2009; Wossen et al., 2017). Anetor et al., (2016) mentioned from a study carried in Nigeria that, the lack of adequate finance and credit facilities stands at the core of the problems plaguing agriculture as other issues are either directly or indirectly linked to it. The production socioeconomic factors of farmers such as sex, age, educational level, household size, farming experience, and off-farm income influence the access to credit (Jabbar et al., 2002; Agbo et al., 2015; Tura et al., 2017). Agbo et al., (2015) stressed that farmers who are highly educated, that have better farming experience and other sources of off-farm income stand a better chance of accessing agricultural credit. However, younger farmer and female farmers, in particular, are disproportionately excluded in credit provision. The exclusion of youths and female in credit access is a practice that is also noticed in Ethiopia. This practice may influence sustainable food production and of course the achievement of the SDGs in the country, considering the opportunities that could be accrued when youths and female are incentivized to undertake agriculture occupation.

Despite that several studies have been conducted to illustrate the challenges of access and impact agricultural credit on the productivity of smallholder farmers, there exists to the best of the authors' knowledge some literature gaps which this study has been set out to address. Firstly, Ali Chandio et al., (2017) classified agricultural credit in two groups, institutional and non-institutional sources but did not explain which source had a more significant impact on the productivity of farmers. In the same light, a study carried out in Pakistan evaluated the impact of agricultural credit from institutionalized sources on the productivity of wheat farmers with a firm recommendation to evaluate the impact for farmers with a non-institutionalized source of credit (Chandio et al., 2018). Secondly, Tura et al., (2017) in a study in Ethiopia evaluated how socioeconomic variables influence the demand and usage of credit without looking at the impact agricultural production factors will have on credit access. This study will take into consideration, evaluate, and contrast both institutional and non-institutional credit on tef crop which balances the loopholes in literature. Finally considering the economic, socio-cultural and the administrative support tef receives, and

the Amhara region being one of the largest tef production basins, it becomes relevant for impact analysis to be done with well recognized and robust data set such as the Living Standard Measurement Study (LSMS) dataset of the World Bank (WB), not yet used for tef impact analysis in the Amhara region of Ethiopia.

1.2. Research objectives and questions

This work is aimed generally to evaluate the impact and access of agricultural credit on the productivity of tef farmers in the Amhara region of Ethiopia.

Specifically, it is intended to

1. Identify and disintegrate the various sources of agricultural credit used by tef farmers in Ethiopia.
2. Identify the production and socioeconomic factors influencing access to the various credit sources.
3. Evaluate which credit source has a more significant impact on tef productivity.
4. Assess which socioeconomic and production factors impact tef productivity.

From the above objectives, the following research questions will be addressed.

1. What are the credit sources used by tef farmers in Ethiopia?
2. What are the different production and socioeconomic characteristics of tef farmers influence their access to different credit sources?
3. Which credit source impacts tef productivity more?
4. What are the production and socioeconomic factors that contribute significantly to the productivity of tef farmers of the Amhara region of Ethiopia?

1.3. The relevance of the study

The study by disintegrating and classifying the available credit facilities will bring out recommendations to boost the tef sector with insights from the evaluation of the impact of credit on the productivity of tef farmers (Saboor et al., 2009). Tef has received relatively less attention in international research probably due to its localized importance in Ethiopia and Eritrea (farmed

by approximately 6.3 million farmers alone in Ethiopia). This study, therefore, adds to the limited knowledge about tef productivity economics (Vandercasteelen et al., 2013).

1.4. Organization of work

This study is further organized as follows.

- Section 2: Literature review, which will elaborate on the sources, access, and uses of agricultural credit. Empirical evidence of the impact of credit on crop production will also be touched. Finally, this section will state the theoretical or conceptual framework on which this study is based.
- Section 3: Methodology, where the light will be shed on the setting that is why Ethiopia was chosen for this study and why the focus is on tef. The data will be described. Variables of interest and the econometric method will also be described.
- Section 4: Results and Discussion, where the findings of the study about the objectives of the study will be stated.
- Section 5: Conclusion and recommendations/policy implications from the study will be stated.
- The last section will contain the reference to the literature used for the write-up and the appendices.

2. Literature review

2.1. The source and access to agricultural credit

Agricultural credit provision is an essential support system that empowers farmers for the better use of capital and resources for improved productivity (Saleem and Ali Jan 2009). It is an integral part of agricultural technology adoption in the rural economy (Rehman et al., 2017). Throughout SSA, credit use has been viewed as minimal as a result of the inadequately developed financial markets and the risks associated with the provision of credit to smallholder farmers resulting in a constraint in farm input use (Croppenstedt et al., 2003). This is evident in Ethiopia where Sheahan and Barrett, (2017) found that only 25 % of farming households have received some form of credit services. Without prior knowledge, farmers often find it challenging to understand and adapt to the procedures and regulations of lending organizations, hence they will need instruction and supervision which is often provided by agricultural extension agents (Saboor et al., 2009).

Agricultural credit could be categorized based on different criteria. On tenure, as short, medium, and long term and according to purpose as productive and unproductive (Agbo et al., 2015; Yadav, 2017). Besides, agricultural credit could stem from two main sources, institutional and non-institutional sources. The former such as nationalized, privatized establishments and commercial banks function under government-stipulated laws and follow-up. The later on the other hand functions without government control like borrowing from relatives, friends, neighbors, and professional moneylenders (Saboor et al., 2009; Bashir et al., 2010; Iqbal et al., 2003; Ali Chandio et al., 2017). A study in Ghana carried out by Sekyi et al., (2019), mentioned the duality of the financial sector to be the formal/institutional sector comprising of commercial banks, insurance companies and mortgage banks which function under government regulations and the informal/non-institutional sector which are often not regulated like friends, relatives, traders, agricultural input dealers and moneylenders (Isoto et al., 2017). In the following section, we differentiate the institutional credit from the non-institutional credit.

2.1.1. Institutional credit

The institutional credit is credit obtained from sources such as banks, microfinance institutions, financial cooperative, credit unions, and national credit providing programs, that operate with legal identities, under government stated laws with defined formalities (Steel and Andah, 2003; Hussain and Thapa, 2012; Agbo et al., 2015; Ali Chandio et al., 2017; Yadav, 2017). Institutional credit has proven to be helpful in the adoption of new farm technologies and farm input acquisition such as the use of improved seed varieties, inorganic fertilizers, and better irrigation schemes (Iqbal et al., 2003; Saboor et al., 2009; Matsumoto and Yamano, 2011; Hussain and Thapa, 2012; Ali Chandio et al., 2016; Narayanan, 2016; Chandio et al., 2017; Rehman et al., 2017). Agricultural diversification and investment in new technologies by rural farmers have been widely made possible by institutional credit (Abdallah, 2016a; Abdallah, 2016b).

Access to institutional credit is constrained by socioeconomic factors, farm-specific, and institutional factors (Agbo et al., 2015). The untimely delivery of credit upsets planned activities in the production process hinders credit access. Bureaucratization and high illiteracy rates of rural farmers also constitutes a major hurdle for rural farmers to access credit. Also, stringent collateral requirements are often not met by rural farmers. Moreover, high administrative charges, high transaction costs, high-interest rates, and hidden charges deter rural smallholder farmers from credit. Besides, landlessness and small farm size discourage credit access. Furthermore, distance to the formal credit institution makes acquisition and usage of credit rather difficult (Agbo et al., 2015; Aghapour Sabbaghi, 2017; Elahi et al., 2018). Finally, the high probability of failure of farmers to reimburse acquired credit has also influenced the functioning of credit institutions, making them adopt measures often not suitable for smallholders (Pishbahar et al., 2015).

The financial or credit cooperative is a very common type of institutional credit source. As with conventional practices in many other areas, financial cooperatives are individually organized in different countries (that is by the farmers themselves or any other group as the case may be) who might be involved in similar farming activities or locality and providing both the demand and supply of loanable funds (Abate et al., 2016). There is the implementation of bilateral lending contracts between the cooperative and the borrower with the borrower and co-signer; who must be a member of the cooperative bearing the liability of repaying the loan (Abate et al., 2016). These

cooperatives in their functioning pool different resources together such as credit, information, and labor amongst members, having the potential to create economies of scale and improve the welfare of members (Wossen et al., 2017). The development of institutional credit also relies on NGOs (local and international) and government credit sponsored programs.

MFIs are another source of institutional credit. In Ethiopia for example, the specialized MFIs came into existence in the 1990 economic reforms and government transformation with a total of 30 MFIs in 2012 serving over 2.3 million clients. Regulated by the National Bank of Ethiopia (NBE), MFIs are share companies owned by individuals, public bodies, NGOs, or by a combination of the three. Compared with financial cooperatives (Table 1) that are confined to particular locations, MFIs rely hugely on external funding and operate in large geographical scopes (Abate et al., 2016).

Table 1: Main differences between financial cooperatives and MFIs in Ethiopia

	Financial cooperatives	**MFI**
Ownership	Owned by members/clients	Owned by investors/NGOs/State
Governance	Governed by a voluntary board of directors and based on the one-man-one-vote principle	Governed by an appointed board of directors and based on one-share-one vote principle
Clientele	Low-income clients and small farmers that share a common bond	Low-income clients and small farmers (mostly women) who be to the same community
Source of fund for lending	Member deposit	External loans, grants, and/or investors
Products and services	Full range of financial services (primarily saving and credit)	Focus on microcredit
Lending approach	Individual lending and saving precedes credit	Primarily follow group lending, and credit precedes saving

Earnings	Net income divided among members (often in the form lower interest on loans and higher interest on savings)	Net income either builds reserve or divided among investors

Source: (Abate et al., 2016)

2.1.2. Non-institutional credit

The non-institutional credit sources are those sources wherein provision of credit is most often without legal formalities such as traders and commission agents, landlords, moneylenders, credit clubs, friends and relatives (Steel and Andah, 2003; Hussain and Thapa, 2012; Agbo et al., 2015; Yadav, 2017). Access to non-institutional credit is to a greater extent, hindered by socioeconomic factors of farmers (Agbo et al., 2015). Rural farmers sort for non-institutional credit for rather immediate utilization in the farming process such for input purchase and farm-related transaction costs (Iqbal et al., 2003; Saboor et al., 2009; Matsumoto and Yamano, 2011; Hussain and Thapa, 2012; Ali Chandio et al., 2016; Narayanan, 2016; Chandio et al., 2017; Rehman et al., 2017).

Due to the relative ease in acquisition, most rural smallholder farmers will readily go in for non-institutional credit but are somewhat disadvantaged because of the extortionist inclinations of the lender who imposes higher taxes not accepted by law in an attempt to enrich himself (Kumar et al., 2017). Poor accountability of received credit is very common with rural smallholders when dealing with non-institutional credit as there is the misuse of acquired credit for immediate household sustenance such as feeding and medical bills mainly influence by high household dependency ratios and low off-farm income (Elahi et al., 2018).

2.2. The uses of agricultural credit

The literature on the uses and impact of agricultural credit emphasized its importance in the adoption of modern agricultural technology and increased productivity consequently leading to higher income for farmers (Iqbal et al., 2003; Rehman et al., 2017). Diversification of production activities and the undertaking of investment in new technologies such as higher-yielding seeds, irrigation schemes is strongly aided by rural farmers' access to available credit (Abdallah, 2016a;

Abdallah, 2016b). In SSA, access to agricultural credit plays a vital role as a catalyst to input acquisition, utilization, better input mix, and subsequent gains in agricultural productivity (Abdallah, 2016a; Sheahan and Barrett, 2017). Generally, farmers use agricultural credit for purchasing seed, fertilizers, pesticides, irrigation, and tractor (Saboor et al., 2009; Matsumoto and Yamano, 2011; Hussain and Thapa, 2012; Ali Chandio et al., 2016; Narayanan, 2016; Chandio et al., 2017). Smallholder farmers, majority of whom practice subsistence farming, are generally depicted as having lower income, less saving incentives with low capital formation potential. Usage of high-quality seeds, adequate farm fertilization, and better farm equipment is not in their capability due to the non-availability of credit, (Saboor et al., 2009). Saboor et al., (2009) and Osabohien et al., (2020) emphasized that credit access and the timely availability of credit facilitated farmers' purchase of major agro-industrial inputs and increased productivity.

The access and use of credit are strongly correlated with increases in productivity, enhancing the livelihood standards of poor farmers, further helping them have higher possibilities to come out of poverty, Saboor et al., (2009) and Osabohien et al., (2020) with an overall positive impact on agricultural contribution to the GDP in developing countries (Saleem and Ali Jan 2009). Also, a study in Ethiopia on the concept of water collection for irrigation purposes in arid regions; a form of technology to combat water shortage and improve productivity by Wakeyo and Gardebroek, (2017), emphasized the fact that the financial status of farmers will limit their ability to purchase plastic sheets, clay, cement for pond construction, and water-lifting equipment if they face constraints in accessing and obtaining credit. In an extension, Isoto et al., (2017) concluded from a study in SSA that, agricultural credit for rural farming households turn to act as a shock absorber for uninsured health risk, increasing the household productivity of labor and overal agricultural productivity of farmers.

Obilor, (2013) from a study in Nigeria and Saleem and Ali Jan, (2009) in another study in Pakistan looked at the impact of agricultural credit on agricultural productivity considering mainly the output price index and agricultural gross domestic product and found positive relations. Also, studies carried out in Ethiopia by Abate et al., (2016) and Cafer and Rikoon, (2018) indicated that there is an increase in credit and technology adoption amongst farmers in Ethiopia corresponding to increasing production and productivity. Furthermore in Tanzania, research by Matata et al., (2010) brought out the fact that farmers reiterated the importance of agricultural credit by

recommending that, access to agricultural credit should be improved so that their ability to hire workers to be increased to improve their production, productivity, and incomes. Not leaving out the livestock sector, Jabbar et al., (2002) in a study conducted in SSA mainly Nigeria, Ethiopia, Uganda and Kenya said credit have the potential to increase the productivity of the dairy sector as it enables smallholder dairy farmers to invest in productivity-increasing inputs. Overall, while competently aimed towards agriculture, credit policies employed in a more integrated framework can contribute significantly to employment generation, reduction in poverty and long-term sustainable production (Osabohien et al., 2020).

2.3. Empirical evidence of the impact of credit on crop productivity

There are several studies conducted based on different econometric methods and context showing that agricultural credit is beneficial to crop productivity. Some studies have employed the use of regression as an approach in evaluating the impact of credit on various productivity indicators and other credit-related aspects (Carter, 1989; Feder et al., 1990; Saboor et al., 2009; Saleem and Ali Jan 2009; Bashir et al., 2010; Nosiru, 2010; Chisasa and Makina, 2015; Tura et al., 2017; Chandio et al., 2018). Osabohien et al., (2020) rather employed the Propensity Score Matching technique to evaluate the impact on credit access on agricultural productivity.

In Nicaragua, it was shown through the application of multiple regression model that credit impacted production positively and could also favor the move towards structurally balanced growth in Nicaraguan agriculture (Carter, 1989). In China, a rather switching regression model was used to establish the relation between microcredit and agricultural productivity (Feder et al., 1990). In another study carried out in Pakistan by Saboor et al., (2009), multiple regression analysis was employed to segregate farmers into credit and no-credit scenarios to evaluate the impact of microcredit in alleviating poverty with farm income as a dependent variable. Still, in Pakistan, agricultural gross domestic product; a dependent variable was analyzed using a linear regression model on the Cobb-Douglas type with the assumption that agricultural production is a function of agricultural credit disbursed by various institutions for various agricultural activities (Saleem and Ali Jan, 2009). In the same line, Chisasa and Makina (2015), used the ordinary least squares estimates of the Cobb Douglas production function to evaluate the effect of bank credit on agricultural output and found positive and significant results. Besides, in the Ogun State in

Nigeria, multiple regression models amongst other techniques were employed to elaborate on the positively correlated relationship between microcredit and productivity (Nosiru, 2010). Meanwhile in Ethiopia, multiple regression models were carried out by Tura et al., (2017) to determine the major factors influencing the demand for credit by wheat and tef smallholder farmers. Another in Pakistan, Chandio et al., (2018) employed the technique of multiple logarithm linear regression of the Cobb–Douglas production function and instrumental variables (two-stage least square) to segregate the impact short term loans and long term loans from formal sources had on wheat farmers. Furthermore in Nigeria, the propensity score matching technique was used to ascertain the influence access to credit has on the agricultural productivity of farmers, with results indicating thrice as much yield for those who had access to credit than those who did not (Osabohien et al., 2020).

However, contrary to the above positive views by some authors, Abate et al., (2016) mentioned that growth in the volume of credit to smallholders does not in all cases have a direct proportionality to higher rates of technology adoption and outputs as some farmers use their credit for purposes other than agriculture. This means, therefore, that access to credit does not automatically mean increment in productivity. Factors like adequate use of the credit and other resources and management of other factors of production are important. The socioeconomic characteristics of the farmers including age, experience, and education are also important factors influencing the adequate use of credit for agricultural productivity (Agbo et al., 2015; Tura et al., 2017). In other cases, how the credit is sourced, and the conditions may also influence its use.

2.4. Theoretical framework

Some theories have emerged from authors such as the “Progressive Social theory”, “Cultural Liberal Theory”, “Regional theory” and the “Livelihood Portfolio theory”, that are in line to give an elaborate relationship between the dynamics of individuals and the socioeconomic nature of their communities affecting their assets, productivities, income and ultimately poverty status.

A study by Bradshaw, (2007) stated the “Progressive Social Theory” which is an extension from the “Individualistic” theory and the “Cultural liberal Approach” theory wherein individual characteristics are not looked as a source of ultimate poverty but rather the economic, political and social system causing people to have reduced chances, resources, and potential with which to

achieve improved incomes and well-being. Also, the "Regional theory" reiterates the stance that people, their institutions, and cultures in particular geographical locations are void of the objective resources needed to generate well-being and income (Bradshaw, 2007; Shildrick and Rucell, 2015).

The "Livelihood Portfolio theory" based on the economic assumptions that, income maximization is achieved by individuals and households under constraints with the imminent risk of not being able to meet production and other welfare need (De Neubourg, 2009). As a preventive measure, households set aside their financial assets and if not suffice, alternative funding is sort such as credit to fund activities such as agricultural production (De Neubourg, 2009). De Neubourg, (2009) and Osabohien et al., (2020) further places the "livelihood portfolio theory" on the welfare pentagon with its five core institutions that households use to satisfy current and future needs in each society: family, markets, social networks, membership institutions, and public authorities.

3. Methodology

3.1. The Setting

3.1.1 Why Ethiopia?

The study setting is Ethiopia and the crop of interest is tef. The Ethiopian government that existed in the 1990s formulated an economic growth strategy that placed a high priority on improving growth in agricultural yields to attain food security levels and alleviate poverty (Bingxin and Alejandro, 2014). At the center of this strategy is cereal products such as tef, maize, sorghum, and wheat, with the focus being mainly on facilitating the adoption and sustainable usage of technological packages that combine agricultural credit, fertilizers, improved seeds, and better management practice to achieve increment in yields (Bingxin and Alejandro, 2014). Besides, the government of Ethiopia tried to address the issue of low cereal yields by the provision of subsidized credit via state-owned banks with little progress achieved (Abate et al., 2016). With limited recorded progress from the policy of subsidized credit provision, Ethiopia has moved to a more market-oriented financial system with specialized Microfinance Institutions (MFIs) and Financial Cooperatives becoming the primary source of credit for smallholders (Abate et al., 2016). This shift in policy is contextual and mainly for the increase in the production and productivity of smallholder farmers to attend higher income levels and improved livelihoods.

As a cereal, tef; *Eragrostis tef* belongs to the grass family, Poaceae (Gramineae), sub-family Eragrostideae, is endemic to Ethiopia (Teklu and Tefera, 2005; Tulema et al., 2005). There is a significantly high geographic concentration of cereal production in Ethiopia. Almost 80 % of the total area under cereal cultivation is in the Amhara and the Oromia regions to the northwest, west, southwest, and south of the capital Addis Ababa (Bingxin and Alejandro, 2014). Found in most parts of Ethiopia, especially in highlands of altitudes ranging from 1800 – 2100 meters above sea level, tef has Amhara and Oromia regions as main production areas and to a lesser extent, in Tigray and the Southern Nations, Nationalities and Peoples (SNNP) growing under diverse agro-ecological conditions (Vandercasteelen et al., 2013; Bingxin and Alejandro, 2014).

The crop is sown between the months of July-November. This period corresponds to the main *meher* rains (rainy season) in Ethiopia while harvesting is done in February (Vandercasteelen et al., 2013). Tef grain has an average yield of about 1.2 tons per hectare with a potential of 2.5 tons per hectare when improved cultivars with better management practices are employed. The average yields are yet lower when compared to other cereals (Table 3) (Haileselassie et al., 2011; Elias et al., 2013; Hailu et al., 2015).

Traditionally sown in Ethiopia by broadcasting with a seed rate of about 25-50 kg per hectare, has been argued as a contributor to low productivity of tef (Vandercasteelen et al., 2013). This practice causes uneven distribution of seeds, increases competition between plants for growth requirements making weeding difficult at maturity. Row planting and transplanting seedlings have been proposed as new sowing technology and implemented at a seeding rate of between 2.5-3 kg per hectare with increased yields achieved (Vandercasteelen et al., 2013; Tesfaye, 2015) Despite indications that the new technology brings about increase yields, its adoption is low due to constraints faced with the efficiencies of other resources such as land and labor (Vandercasteelen et al., 2014).

To improve their productivity levels, tef farmers of Ethiopia access credit from various sources. These sources include relatives, neighbors, grocery/local merchants, moneylenders, employers, religious institutions, MFIs, banks, and NGOs. These sources could be broadly categorized into institutional (formal) and non-institutional (informal) credit sources (Steel and Andah, 2003; Hussain and Thapa, 2012; Agbo et al., 2015; Ali Chandio et al., 2017; Yadav, 2017). Institutional

and non-institutional sources of agricultural credit impact the productivity of farmers differently (Chandio et al., 2018). Institutional credit sources especially that of long term tenure are often deployed for future capital investment purposes such as land maintenance and irrigation schemes whereas non-institutional credit sources are used for direct purchase of inputs with different impact on overall productivity (Ali Chandio et al., 2017; Chandio et al., 2018).

3.1.2. Why focus on tef?

In the last decade, tef has been at the forefront of the agricultural policy and rural development (Hailu et al., 2015). Ethiopia's Agricultural Transformation Agency (ATA) has supported tef due to its numerous benefits, making it a national priority crop (Cafer and Rikoon, 2018). The ATA has as a vision for the tef value chain to have "an efficient and well-functioning tef value chain that enables a sustainable increase in smallholder tef farmer productivity and profitability while providing high-quality output at an affordable price to tef consumers" (G. Hailu et al., 2015).

Tef is of a high demand nationally and internationally in Eritrea and including the Ethiopian diaspora, used in making the major staple called *injera* (D'Andrea, 2008; Haileselassie et al., 2011; Cafer and Rikoon, 2018). An approximated two-thirds of the Ethiopian population uses tef as their daily staple (Vandercasteelen et al., 2013). It is also readily used for "porridge" making, local alcoholic beverage manufacturing; *tella* and *katikala,* it's straw as animal feed and for construction purposes (Teklu and Tefera, 2005; Elias et al., 2013). In other regions, it is grown as a forage crop such as the case of South America, South Africa, Kenya, The United States, and Australia (D'Andrea, 2008).

Grown by more than six million smallholder farmers, its production alone accounts for 21 % of total cereal production using 28 % of Ethiopia's total productive acreage (Cafer and Rikoon, 2018). By land area and value of production, tef remains the most important crop but comes second after coffee for cash crops generating almost 500 million United States Dollars (USD) income per year for local farmers, and the farmers earn more for growing teff than other cereals (Minten et al., 2013; Yihun et al., 2013; Tesfaye, 2015). Also, it is a versatile crop and can be grown in lower moisture and waterlogged soils, increasing its suitability to be used in multiple cropping systems (Teklu and Tefera, 2005). Also, comparing tef with other cereals such as barley, wheat, and maize,

it is seen that the former has lower insect pest and disease problems during growth and seed storage periods further making it a healthy, reliable, and a low-risk crop (Teklu and Tefera, 2005).

Notwithstanding all these advantages associated with tef cultivation, the present agricultural status quo is still characterized by lower average yields of tef compared to other cereals such as barley, wheat, maize, and sorghum, (Table 2) making it difficult for Ethiopia to feeding her entire population, hence its continued dependence on foreign food aid which has triggered a broad socioeconomic debate (Berhanu, 2004; Samuel, 2006). This has made caused tef to receive a great deal of attention mainly through fiscal resources placing the crop at the forefront of the country's rural development agenda, in a bait to increase its production, productivity and raise the income of the majority who are smallholder producers (Engeda and Benson, 2013; Hailu et al., 2015).

Table 2: Comparing average yields from tef and other cereals in Ethiopia

	2004/2005			**2010/2011**		
	Production (000' tons)	**Area (000' hectare)**	**Yield (Quintals ha^{-1})**	**Production (000' tons)**	**Area (000' hectare)**	**Yield (Quintals ha^{-1})**
Tef	2026	2136	948.50	3483	2761	1261.50
Barley	1328	1095	1212.79	1703	1047	1626.55
Wheat	2177	1398	1557.22	2856	1553	1839.02
Maize	2394	1393	1718.59	4986	1963	2539.99
Sorghum	1726	1254	1376.40	3960	1898	2086.41
Millet	333	313	1063.90	635	408	1556.37
Oats	57	45	1266.67	48	31	1548.39
Rice				90	30	3000.00

Source: Hailu et al. (2015)

3.2. Data

The data for this study is from a household survey carried out in Ethiopia and it is of a cross-sectional form. The Living Standard Measurement Study (LSMS), is a household socioeconomic survey wave 3, carried from 2015 to 2016 by the World Bank (WB) Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) team in collaborated with the Central Statistics Agency (CSA) of Ethiopia. The data was collected from field agents through questionnaire administration. The survey consisted of five questionnaires. The household questionnaire provided information on basic demographics, education, health, labor, and time use, saving, farm and non-farm income, assets, credit, and other income sources. The agriculture questionnaire had the post-planting and post-harvest questions which focused on crop farming activities and solicited information on land ownership and use, farm labor, inputs use, GPS land area measurement, capital, crop harvest, and utilization. Besides, the livestock questionnaire collected facts related to animal holdings and cost, production cost, and sales of livestock products (CSA, 2015). For the sake of this study, sufficient data cleaning was done using RStudio software (R 3_6_1), and STATA (SE 13.1). The data include 2269 tef farmers in Ethiopia of which 321 is from the Amhara region. The data include information gotten from the household, post-planting, and post-harvest questionnaires.

3.2.1. Variable description

From the above studies, to evaluate the impact of agricultural credit on the productivity of tef farmers of the Amhara region, the following variables will be taken into consideration.

Dependent variable: Tef productivity (gross income from tef)

Productivity could be measured in two ways. Firstly, either as crop yield or as gross income gotten from the sales of the harvested crop. A dummy was used to record whether farmers sold harvested tef crops for income or not. The assumption is that farmers whose productivity is increased form

the greatest share of those that sell their product. The gross income in Ethiopian Birr of tef sold was also recorded and was considered as a dependent variable for this study.

Independent variables

Table 3: Description of independent variables

Variable	Description
Access to credit	The survey gave an insight into the credit situation of farmers. • Access to credit was recorded as a dummy. Farmers with access to credit had a value of 1 otherwise 0. • The source of credit was recorded. For analysis in this study, this will be considered as a dummy. With two categories, institutional and non-institutional, farmers that did not use any of these categories valued 0, only non-institutional sources 1, and institutional sources 2. • Reasons for farmers not accessing credit were recorded • The perception of credit beneficiaries in the community recorded as a dummy. Male with a value of 1, female 2, and 3 for both.
Gender	The sex of the household head was recorded as a dummy variable. Male household heads had a value of 1 while females a value of 0.
Educational level	The educational level of the household heads was recorded. Those with any form of education were assigned a value of 1 and no education value of 0.
Household size	From the survey, the number of persons residing in every household was recorded
Age	The age of household heads was registered in years.

Land size	The GPS measured area of the cultivated land was gotten from the survey. It was recorded in square meters. For this study, it will be converted to hectares.
Labor	Labor employed by the farmers (men, women, and children) in their production process was recorded and classified into three categories. • Labor provided by household members • Hired labor • Unpaid labor provided by neighbors and friends from other households For this work, the labor will be aggregated and measured as the total number of days worked in the farming season and the amount of money paid for hired labor.
Inputs	Inorganic fertilizer • Firstly, the survey registered as a dummy if the farmers used fertilizers or not. Farmers who used fertilizers were recorded as 1, and those who did not as 0. • Secondly, details and the types used, the total quantity of each used, means of acquisition (purchase or credit), and its monetary value was recorded. The dummy for inorganic fertilizer was used Organic • Manure and compost: recorded as a dummy. Usage valued as 1 while no usage recorded 0. Irrigation

	• The survey established if farmers practiced irrigation. This was recorded as a dummy. Farmers with a positive answer were recorded with a value of 1 otherwise 0. • Various methods of irrigation also recorded. Seeds • The type used, either traditional or improved was recorded as a dummy from the survey. Farmers who used traditional seeds were given a value of 0 and those with improved seeds valued 1. • The sowing technique was also recorded as a dummy. Broadcasting valued at 1 while row planting at 2. • The amount spent on improved seeds registered. • The total amount spent on seeds also recorded.
Access to agricultural extension	From the survey, information about extension service to farmers was documented. • Participation in an extension program or not was recorded as a dummy variable. Participation was valued as 1, no-participation valued 0. • For the farmers recorded as not participating in any extension service, their reasons for not participating were also recorded.

Source: Author's compilation

3.3. Econometric approach

To achieve the objectives of this study, two types of models were employed. A Multinomial Logit Regression (MNL), used to identify how socioeconomic and production factors of tef farmers influences their access to credit. Also, the Heckman selection model was used to evaluate the effect of credit sources and other covariates on income from tef for farmers in the Amhara region and Ethiopia. The following section elaborates on the implemented model and their functional forms.

3.3.1. Multinomial logit regression

The dependent variable in the MNL was credit source. There were two main sources or categories of credit tef farmers were associated with, institutional and non-institutional. A third category, the no credit category had farmers who never accessed credit. This makes credit source polytomous with three levels. The socioeconomic and production regressors used include gender, household size, education, income from tef, inorganic fertilizer use, and extension access.

MNL models have been implemented in some studies. It was used to articulate the probabilities of a farm household head being classified under a particular loan category; full rejection, partially satisfied and if the borrower is fully accommodated by commercial banks in Nigeria taking into consideration socioeconomic and production characteristics of the farming household heads, (Rahji and Fakayode, 2009). Also, a study carried out on smallholder farmers in the North and Eastern highlands of Ethiopia to evaluate which socioeconomic and agricultural production parameters influence the soil and water conservation adoption techniques, with dependent variable categorized into the adoption of no improved/adoption of traditional soil and water conservation, adoption of improved stone bunds method and improved soil bunds method, (Beshir, 2014).

The MNL assumes that the log-odds of each response follows a linear model.

$$\cap ij = \ln \frac{\pi ij}{\pi ij} = \alpha_j + xiBj \qquad (1)$$

Where α_j is a constant and Bj is a vector of the regression coefficients, for j = 1, 2…, j – 1.

The model is analogous to a logistic regression model except for the fact that the probability distribution of the response is multinomial instead of binary with j – 1 equation. This implies the

MNL will have two equations (Eq. (2) and (3)). The baseline or reference level will be the no credit category, and the other two categories will each be contrasted against the baseline category.

$$\ln\left(\frac{P(non-inst.)}{P(no\ credit)}\right) = \alpha_{10} + \alpha_{11} X1(1) + \alpha_{12} X2 + \alpha_{13} X3(1) + \alpha_{14} X4 + \alpha_{15} X5(1) + \alpha_{16} X6(1) \quad (2)$$

$$\ln\left(\frac{P(inst.)}{P(no\ credit)}\right) = \alpha_{20} + \alpha_{21} X1(1) + \alpha_{22} X2 + \alpha_{23} X3(1) + \alpha_{24} X4 + \alpha_{25} X5(1) + \alpha_{26} X6(1) \quad (3)$$

Where:

- j= Dependent variable, = 0 for No credit category, =1 for Non-institutional credit and =2 for Institutional credit
- α_{ij} are the constants and various coefficients of the regressors
- $X1$ = gender of the household head/tef farmer (1 = male)
- $X2$ = household size
- $X3$ = education of household head (1 = educated)
- $X4$ = gross income from tef sales recorded in Ethiopian Birr
- $X5$ = inorganic fertilizer use (1 = yes)
- $X6$ = extension access (1 = yes)

Eq (2) and (3) above give the odd, that is the ratio of the probability of choosing either non-institutional credit or institutional credit sources respectively over the probability of choice of no credit. Exponentiating the resulted coefficients gives an insight into the odds or a marginal change in the predictor variable. The *mlogit* package in the STATA 13.1 software prints out tables indicating the probabilities and the confidence intervals of independent variables. The magnitude of coefficients of variables significantly influencing tef farmers in choosing or accessing the different credit categories could be estimated.

A post-estimation analysis to test for the Independent Irrelevant Estimate (IIA) assumption will be tested using the Hausman-McFadden test as described in Hausman and McFadden, (1984). For the MNL to be valid, the IIA assumption which stipulates that the probabilities of a tef farmer accessing credit or not is not impacted by the choice of credit source, should not be violated (Vijverberg, 2011). This sets the null hypothesis to be Ho: difference in coefficients not systematic.

3.3.2. Maximum likelihood estimates of the Heckman's sample selection model

Evaluating the contribution of agricultural credit sources on the productivity of tef farmers intuitively requires a regression analysis with income from tef as a dependent variable. The independent socioeconomic and agricultural production variables include age, gender, household size, education, credit source (institutional and non-institutional), inorganic fertilizer use, labor (household and hired), land size, credit amount, type of farmer, and farm type. Due to the heterogeneity of the tef farmers, there exist possibilities of self-selection into credit acquisition schemes. This is a problem of selection bias. A naïve and quick way to evaluate this impact would be to run an Ordinary Least Square (OLS) regression. It will produce biased estimates as it does not solve the problem created by the selection bias.

The Maximum likelihood Heckman sample selection model proposed by Heckman (1979) solves the issue of selection bias and related endogeneity. It is founded on two latent dependent variable models, Eq. (4) and (5) (Heckman, 1979; Puhani, 2000; Bierens, 2007).

$$Y_1^* = \beta' X + U_1 \quad (4)$$

$$Y_2^* = \beta' Z + U_2 \quad (5)$$

Where:

- X and Z are vectors of the regressors which contain similar elements including the intercepts
- U_1 and U_2 are conditional errors of X and Z jointly bivariate and normally distributed with zero mean vector and variance matrix summation

The regressors included in X are

- $X1$= non-institutional credit (1 = access)
- $X2$= institutional credit (2 = access)
- $X3$= age of household head
- $X4$= gender (male) of tef farming household
- $X5$= inorganic fertilizer use (1 = yes)
- $X6$= household labor (days)
- $X7$= hired labor (Ethiopian Birr)
- $X8$= land size (ha)
- $X9$= credit amount (Ethiopian Birr)
- $X10$= farm type, which served as selection regressor in the selection equation (2 = livestock and 3 = both)

The main model of interest, that is that to evaluate the impact of the regressors on the gross income from tef is Y_1^*, but that is only observable if $Y_2^* > 0$, hence the observed dependent variable Y becomes (6)

$$Y = Y_1^* if\ Y_2^* > 0, \qquad Y = \text{missing value}\ if\ Y_2^* \leq 0 \tag{6}$$

Eq. (5) is a probit-type selection equation that describes the type of farmer, that is whether a commercial farmer who will engage in sales of tef for gross income or not. In principle Y_1^* and Y_2^* and unobserved while Y is observed. In specifying the regressors in Eq. (5), the main selection regressor, farm type which is essential in determining is a farmer will engage in sales or not is included in the equation which is absent in Eq. (4). This makes the error terms to be correlated, hence having a bivariate normal distribution, Eq. (7).

$$\begin{bmatrix} u_1 \\ u_2 \end{bmatrix} \sim BN\left[\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_1^2 & \delta_{12} \\ \delta_{12} & \delta_2^2 \end{bmatrix}\right] \tag{7}$$

Maximizing the likelihood of a tef farmer to have income, the conditional expectation of Y_1^* becomes (8)

$$E(Y_1^*|x_i, Y_2^{*\cdot} > 0) = x_{1i}\beta_1 + \frac{\sigma 12}{\sigma_2}\frac{\emptyset\left(-(x_{2i}\beta 2/\sigma 2)\right)}{1-\emptyset\left(-(x_{2i}\beta 2/\sigma 2)\right)} \quad (8)$$

This method is simple, flexible, useful as it provides good values for likelihood estimations, practical for exploratory empirical work, and has become a standard way to obtain final estimates for model types of Eq. (4), (Heckman, 1979; Puhani, 2000). The fact that unobserved factors that affect who gets a gross income from tef sales are correlated with the unobserved factors affecting the gross income itself, there is the endogeneity bias which is the "*select ( )*" option in the hackman command addresses. The "*select ( )"* allows for the estimation of the parameters with an endogenous treatment drawn from an endogenously selected sample.

4. Results and Discussion

4.1. Descriptive analysis of tef farmers

4.1.1. Socioeconomic characteristics of respondents

The variables taken into consideration to get an insight into the socioeconomic characteristics of tef farming households in Ethiopia as a whole and Amhara region, in particular, include the gender, age, educational level of the household head, the household size, and income from tef. The descriptives of these variables are given in the following sections (Table 4).

The gender of the household is indicated as a dummy variable. A majority of the households in our sample were headed by men. These household heads were also practically involved in tef farming and were considered as tef farmers for this study. The survey captured farmers from a wide range (between 22 and 97 years old). The mean age of tef farmers in the Amhara region was not statistically different from that of entire Ethiopia. Considering a household as a person or group of persons who live together in the same dwelling or unit and share the same meal with compromises on spending and basic decisions, the size varied from 1 to 30 persons.

The characterization of the educational level of household heads of tef farming families ranged from no education level to the highest level of education considered in this case as the completion of at least a one-year course at the bachelor level. For the ease of analysis and understanding, these levels were separated into two broad groups; education and no education. The former subdivided into formal and informal. The later includes tef farmers who never had any form of education. The formal education group was subdivided into primary (Grade 1-8), secondary (Grade 9-10), and preparatory levels (Grade 11-12) for university. The informal sector composed of tef farmers who had some form of education in organizations especially the Orthodox church wherein the objective was to improve the reading, writing, and arithmetic skills of local farmers. Here there is no officially structured curriculum as what is taught is tailored to the needs of the local farmers. The level of education amongst interviewed farmers was very low as a greater proportion had no form of education, others attained primary and very small proportion in the secondary and higher education levels. This scenario further deteriorates in the Amhara region with a higher population of no education farmers and lower numbers attaining primary, secondary, and higher education compared to the entire country.

About half of the tef farmers in the survey sold their harvest for money. This constituted the proportion of tef farmers who obtained a gross income from the farming activity

Table 4: Socioeconomic characteristics of tef farming households *(n) = 2269*

		Amhara (n = 321)		Ethiopia (n =2269)	
Variable		**Frequency**	**Percentage**	**Frequency**	**Percentage**
Gender	Male	276	85.98	1878	82.77
	Female	45	14.02	391	17.23
Sales	Yes	146	45.48	958	42.22
	No	175	54.52	1311	57.78
Educational level	No education	223	69.47	1274	56.15
	Informal education	30	9.35	272	11.99
	Primary education	66	20.56	667	29.40
	Secondary education	2	0.62	39	1.72
	Preparatory education			14	0.62
	University +			3	0.13
Variable		**Mean**	**Standard deviation**	**Mean**	**Standard deviation**
Household size		7	3.29	7	3.44
Age (Years)		48.37	14.83	48.8	14.52

4.1.2. Respondents' access to credit

These sets of credit variables have been studied to understand the credit situation of tef farmers in the Amhara region and Ethiopia as a whole. The descriptive analyses are explained in the following section (Table 5). Credit access by farmers could be looked upon as the farmers who had any sort of credit/loan irrespective of the source to aid in their farming activity. Only a third of tef farmers in the Amhara region and Ethiopia had one form of credit or another.

The sources of credit were broadly categorized as institutional and non-institutional. In the Amhara region, the former constituted about three-quarters of the credit sources and included religious institutions, MFIs, banks, and NGOs. The later, about one-quarter of the sources, on the other hand, included credit from relatives, neighbors, grocery/local merchants, moneylenders, and employers. Both sources saw an almost equal distribution in the entire country. These indicated implied an increase in the utilization of institutional credit compared to non-institutional credit sources in the Amhara region for tef production.

Farmers expressed varying reasons for accessing credit. Amongst other reasons in the Amhara region, almost all of the farmers accessed credit for agricultural purposes such as purchase/lease of land, purchase agricultural inputs for food and non-food crops as compared to three-quarters in the entire country. Also, a very small number of farmers with secondary activities rather than used their credit for agricultural purposes used it as business startup capital, expanding existing businesses, and the purchase of non-farm inputs when contrasted with Ethiopia. Matched with credit directed to non-agricultural activities, a greater number of farmers choose not to disclose their use of credit.

The very large proportion of tef farmers who had no credit advanced reasons for this constraint. They included but not limited to the non-availability of credit services, unable to pay the loans, inadequate service provided, ignorance, the credit does not yield expected results, and others.

Further inquiries to know the perception of the tef farmers with regards to credit access indicated that more than half of the tef farmers had the perception that credit could be easily accessed by any gender. A slightly smaller number mentioned men accessing credit more than women.

Table 5: Credit accessed characteristics of tef farmers *(n) = 2269*

			Amhara (n = 321)		Ethiopia (n =2269)	
Variable			**Frequency**	**Percentage**	**Frequency**	**Percentage**
Credit access	Yes		102	31.78	653	28.78
	No		219	68.22	1616	71.22
Credit source (653 farmers)	Non-institutional	Relative	17	16.98	305	46.71
		Neighbor	5	4.85	40	6.13
		Grocery/local merchant	0	0.00	13	1.99
		Moneylender	3	2.83	10	1.53
		Employer	0	0.00	0	0.00
	Institutional	Religious institution	12	11.89	26	3.98
		Microfinance Institutions	54	52.45	206	31.55
		Bank	0	0.00	18	2.76
		Non-governmental Organizations	11	11.01	35	5.36
Reason for credit (653 received credit)	Purchase/lease of land		14	14.02	59	9.04
	Purchase of agricultural inputs for food crops		68	66.97	316	48.39
	Purchase inputs for other crops		9	9.03	91	13.94
	Business start-up capital		2	1.25	30	4.59
	Expanding business		2	1.25	22	3.37
	Purchase non-farm inputs		1	0.31	23	3.52
	Others		7	7.17	112	17.15

Reason for no credit (1616 farmers)	Non-availability of the service	2	0.91	75	4.69
	Unable to pay the loan	97	44.09	839	51.91
	Inadequate service provided	34	15.45	219	13.53
	Ignorance	9	4.09	83	5.12
	Does not yield any results	22	10.00	101	6.24
	Others	55	25.45	299	18.51
Likelihood to access credit	Male	107	33.33	831	36.63
	Female	20	6.35	67	2.93
	Both	194	60.32	1371	60.44

4.1.3. Production characteristics

These are the production factors that characterized tef farmers in the Amhara region and Ethiopia in general. This study considered the following; land size, labor, irrigation, farm fertilization, extension access, seed quantity, seed type, and sowing technique practiced by tef farmers. The following paragraphs and Table 6 will elaborate on these factors.

The land area of pure tef stance was recorded using a GPS with a range from 0.01 hectare (ha) to a 5.04 ha. The mean land size was slightly greater than that of entire Ethiopia. Labor used for tef farming purposes was recorded in the farming season according to two time periods, the post-planting and post-harvest period. The former period involved activities such as land preparation, planting, ridging, weeding, and fertilizer application. Whereas the later period had operations such as harvesting, crop trashing, transportation, and storage. During both periods, labor was sort from the household, hired, and unpaid labor from neighbors. The post-planting period employed solely household labor. The proportion of household labor in the post-harvest period reduced because of the use of hired labor. Intuitively, this move by the farmers is aimed at reducing post-harvest losses.

Irrigation is very vital for crop production especially in drought-prone areas such as the Amhara region. Almost all the tef farmers investigated in this study did not practice any form of irrigation in their tef fields. The very few farmers who affirmed to practice irrigation mentioned three types;

river diversion, pressure treadle pump, and motorized pump. All farmers in the Amhara region who practiced irrigation made use of the river diversion method, whereas slightly above half practiced it in Ethiopia. Closely followed in the proportion of practice were motorized pump schemes and pressure treadle pump least practiced.

Farm fertilization being the addition of extra substances into the fields to improve the fertilization properties of the natural soil by tef farmers could be divided into the use of inorganic fertilizer, manure from animals, and compost use. Inorganic fertilizer recorded the greatest percentage of use in the entire country and the Amhara region compared to the use of manure and compost.

Another essential service in any farming activity is extension service as it is vital for technology adoption, counseling, and often positively correlated to improved productivity. About half of the tef farmers had access to extension services. Those without access had varied reasons hindering their access.

Further, the type of seed planted, the quantity, and the sowing method greatly influence output. Two seed types were mentioned. The traditional seeds, which were the local varieties and improved or hybrid seeds thought to bring about improvement in yields. A very great proportion of tef farmers made use of the traditional seeds. The sowing technique also has an impact on the output or yields tef farmers obtain post-harvest. This is because it has an impact on the competition for available nutrients, space, and sunlight. The broadcasting technique was highly practiced compared to the row planting technique.

Table 6: Descriptive of tef production characteristics (*n) = 2269*

Variable			Amhara (n = 321)		Ethiopia (n = 2269)	
			Mean	**Standard deviation**	**Mean**	**Standard deviation**
Land size (ha)			0.31	0.28	0.26	0.27
Labor	Post Planting	days	25.26	25.62	23.26	21.64
		hours	162	201.86	159	170.98
	Post-Harvest	hired (Birr)	148.8	322.89	116.5	624.83
		unpaid (days)	0.77	1.23	1.11	2.14
		household days	15.57	25.09	12.11	15.34
		hours	84.44	108.65	77.31	98.32
Variable			**Frequency**	**Percentage**	**Frequency**	**Percentage**
Irrigation	Practice	Yes	3	0.93	11	0.48
		No	318	99.07	1940	99.52
	Methods (11 farmers)	River diversion	3	100.00	7	63.64
		Pressure treadle pump	0	0.00	1	9.09
		Motorized pump	0	0.00	3	27.27
Inorganic fertilizer use		Yes	198	61.68	1578	69.55
		No	123	38.32	691	30.45
Manure use		Yes	50	15.66	213	9.38
		No	271	84.34	2056	90.62
Compost use		Yes	16	5.05	46	2.03
		No	305	94.95	2223	97.97
Extension	Access	Yes	194	60.44	1315	57.96
		No	127	39.56	954	42.04

	Reason for no access (954 farmers)	Ignorance	34	26.77	186	19.50
		Lack of money	31	24.41	391	41.19
		Skeptical of the outcome	13	10.24	174	18.24
		Non-availability of the program	8	6.30	43	4.51
		Lack of adequate crop field	14	11.02	53	5.56
		Extension officer did not show up	4	3.15	36	3.77
		Others	23	18.11	69	7.23
Seed	Type	Traditional	314	97.82	2211	97.44
		Improved	7	2.18	58	2.56
	Sowing technique	Broadcasting	305	95.06	2178	95.99
		Row planting	16	4.98	91	4.01

4.2. Econometric analysis results

4.2.1. Factors influencing access to institutional and non-institutional credit

Table 7 presents the multinomial logit regression output, depicting how the socioeconomic and production characteristics of tef farmers of the Amhara region and Ethiopia influence their category or type of credit they access for their tef cultivation. Three categories of types of credit were taken into consideration: no credit, non-institutional, and institutional credit. The no credit category was taken as the baseline or reference category for the analysis. During the analytic phase of this study, the variables were checked for multicollinearity and the variance inflation factor (VIF) indicated there was no multicollinearity. The post-estimation Hausman-McFadden test for the IIA in the Amhara region gave a chi2(6) value of 0.50, with probability 0.9978. This very high probability which is insignificant suggests that we can not reject the null hypothesis and hence

there is no evidence that IIA assumption has been violated. Looking at the Hausman-McFadden test for the sample of entire Ethiopia, the value of the chi2(6) is negative because the model fitted on the data fails to meet the asymptotic assumptions of the test. A probability can not be calculated from this. However, the negativity is not an unusual outcome of the Hausman-McFadden test as the sample with credit is relatively small. In this case, it can also be concluded that there is not sufficient evidence to reject the null hypothesis. The following paragraphs will discuss the results based on the significance and the sign of the parameters.

Gender has a positive and significant effect on the credit source of tef farmers in the Amhara region. Being a male tef farmer in the Amhara region increases significantly the probability of accessing non-institutional as well as institutional credit. However, it was observed that gender (male) is a better explanatory variable for non-institutional credit access than institutional credit. This is because the magnitude of the influence on non-institutional credit access is higher than that for institutional credit. On the other hand, the influence gender (male) of tef farms in entire Ethiopia on credit access from both categories is positive. This is however significant only for institutional sources. The positive impact males have in accessing various credit sources has sociocultural roots especially for non-institutional credit sources as most rural people will trust, and regard the male as more a robust sex capable of repayment. Also, in obtaining loans from institutional sources, the stringent requirements of collateral, paperwork, and distance to travel to credit facilities are most often fulfilled by rural men. This is as they control most assets such as land which could be used as collateral, can endure higher transaction cost to obtaining credit, and the female often looked as the caretaker of the home who does not need to handle outdoor activities. This result agrees with the findings of Abdallah, (2016a) who stated that the probability to access credit is higher for male farmers compared to the female in the African context as males control most assets that could be used as collateral for credit. Besides, considering firm ownership and access to credit, Asiedu et al., (2013); Hansen and Rand, (2014) found out that female-owned firms or enterprises in SSA are particularly constrained when it comes to access to credit compared to their male counterparts. Similarly, a study in the Euro-area on assessing the effect of gender on small firms access to credit reveals that female-owned and managed firms experience difficulty in accessing credit from institutional sources such as banks relative to the male (Stefani and Vacca, 2015).

Household size has an impact on tef farmers' decision on the type of credit to access. In the Amhara region, household size has a positive but insignificant impact on non-institutional credit. A reverse significant trend was observed for institutional credit. At the country level, household size indicated a negative impact on access to both institutional and non-institutional credit sources. This was significant only for access to non-institutional credit sources. This implies that an increase in household size hampers access to credit compared to the base level which is no credit. A higher household size implies varied sources of income for the family and adequate labor for farm activities. This reduces the need for a tef farming household to access credit sources for farm processes such as for hiring labor and purchasing inputs because the cumulative off-farm income from the family might be adequate. Although insignificant for non-institutional credit access in Amhara, these results are in line with the findings of Agbo et al., (2015); Chandio et al., (2017) who mentioned a positively significant effect of increasing household size on the ability of the household to access non-institutional credit. These however contradict the findings from the Amhara region when institutional credit is taken into consideration.

A negative and insignificant impact is seen in the Amhara region for access to institutional and non-institutional credit for educated tef farmers. The negativity is of higher magnitude for institutional credit sources. Accessing non-institutional credit at the level of Ethiopia is significant and positively influenced by been educated. Institutional credit and its relation to education follow the same nature and direction as non-institutional but with insignificant impact in Ethiopia. An educated farmer is more aware of the existence of institutional credit and understands the importance of an injection of funds into his farming activity to make it more profitable. With the existing lengthy procedures in accessing institutional credit and higher transaction costs, an educated farmer might preferably access non-institutional credit. Being educated has an insignificant and negative impact on non-institutional credit in the Amhara region is in line with Sekyi et al., (2019) who found out that less-educated farmers will preferably access non-institutional credit compared to the educated counterparts who can better conceptualize credit information and financial markets and are less likely to opt for non-institutional credit sources. Also, Jeiyol et al., (2013); Agbo et al., (2015) stated that one unit increase in education leads to an increase in awareness and adoption of new farm technology which will increase the probability of accessing institutional credit, which is true for the farmers of Ethiopia in this study with access to institutional credit. This also agrees with Elahi et al., (2018) in a study in Pakistan, where it was

found out that educated farmers are more likely to access institutional services such as institutional credit.

In the Amhara region, gross income from tef sales had a positive but insignificant impact on tef farmers' access to both institutional and non-institutional credit sources. The impact however is greater in magnitude for non-institutional credit. Also, in Ethiopia, a similar but significant trend was observed for access to non-institutional credit. This positive effect implies that, the probability of a tef farmer accessing non-institutional credit increase with increase gross income. This serves as some sort of assurance from the non-institutional credit providers that, the farmer will sell after harvest as usual to reimburse the credit. These findings are consistent with Saqib et al., (2016) and Chandio et al., (2017), who found out that the estimated coefficient of income has a positive and significant effect on credit access.

Although insignificant in accessing non-institutional credit, inorganic fertilizer had a positive effect and significantly motivates farmers to access institutional credit in the Amhara region. This positive and significant influence was also seen for tef farmers at the country level with access to institutional credit. The magnitude is however higher in the Amhara region. The use of inorganic fertilizer in farms could be associated with farmers who mean “business” in their farming activity. Their objective often to improve yields, will propel them to safeguard their investments by obtaining credit from institutional sources where they could further benefit from other packages such as insurance, training in business plan draw-up, financial advice and expert follow up of their activities. According to Jeiyol et al., (2013) the increased use and cost of factors of production such as inorganic fertilizers will require more income to acquire this input which could be gotten from the credit, hence increase credit use.

Extension access significantly stimulates tef farmers' decision on the category of credit to access. The probability to access institutional and non-institutional credit compared to having no access decreases with extension in the Amhara region. This decrease is significant with access to non-institutional credit. In Ethiopia, a negative and significant impact was also observed for non-institutional credit while the probability significantly increases when institutional credit sources are involved. This means that tef farmers with extension access will access credit but will drift more towards institutional credit sources at the country level. This could be explained by the fact

that most extension workers who are state agents or from other non-governmental agencies will have their influence or counsel on the tef farmers tailored towards institutional credit sources because of the perceived trust and reliability of institutional sources. These findings match that of Chauke and Pfumayaramba, (2013); Luan and Bauer, (2016) where extension contact had a positive and significant effect on credit access. Similarly, Tadesse, (2014) found a positive but insignificant relationship between extension and credit access.

Table 7: Results of the multinomial logit estimation on credit source and characteristics of tef farmers

Variables	**Credit source**			
	Amhara		**Ethiopia**	
	Non-institutional	Institutional	Non-institutional	Institutional
Gender (male)	1.903*	0.858*	0.211	1.180***
	(1.052)	(0.492)	(0.156)	(0.217)
Household size	0.033	-0.139**	-0.053***	-0.029
	(0.072)	(0.069)	(0.019)	(0.019)
Education (yes)	-0.153	-0.497	0.503***	0.026
	(0.509)	(0.398)	(0.117)	(0.124)
Gross income	0.000	0.000	0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Inorganic	0.482	1.084**	-0.093	0.403***
fertilizer use (yes)	(0.540)	(0.461)	(0.130)	(0.151)
Extension access	-1.210**	-0.466	-0.248**	0.340**
(yes)	(0.534)	(0.392)	(0.122)	(0.137)
Constant	-3.699***	-1.509**	-1.338***	-2.784***
	(1.272)	(0.762)	(0.209)	(0.271)
Observations	321	321	2,269	2,269
Significant levels *** p<0.01, ** p<0.05, * p<0.1				
Standard errors in parentheses				
	Amhara		**Ethiopia**	

Log likelihood	-192.060	-1896.537
LR chi2(12)	30.26	146.07
Prob > chi2	0.003	0.000
Pseudo R2	0.073	0.037
Hausman-McFadden test		
chi2(6)	0.50	-0.15
prob>chi2	0.9978	n/a

Source: Ethiopia LSMS Wave 3 data analysis, 2020

4.2.2. Effect of credit sources on the tef productivity

The Maximum likelihood Heckman sample selection model was implemented to evaluate the impact the credit sources; institutional and non-institutional will have on the tef productivity taking gross income gotten from the sales of tef as the dependent measure. This analysis engulfed two levels. Firstly, the Heckman model checked if the tef farmers sold their product or not and the second level used the predictions from the first level to analyze the impact on the gross income. Also, other parameters' impact on the gross income gotten from the sale of tef were ascertained. Table 8 presents the expected change in income when a unit change is made in the various regressors. Running an OLS gave results indicating that some variables are significant but with biased estimates. Resolving the issues associated with sample selection bias, the output from the Heckman sample selection model is more consistent. The following paragraphs will further elaborate on these impacts.

Non-institutional credit revealed a positive but insignificant impact on farmers' ability to sell tef post-harvest in the Amhara region. At the country level, a similar but significant influence was noticed. On gross income, non-institutional credit had a positive impact on the ability of tef farmers to obtain income from the sales of their produce. In the Amhara region, the impact is not significant whereas it is significant with a higher magnitude in Ethiopia. This implies that accessing non-institutional credit enhances tef farmers' production and productivity which serves as a motivation to sell tef for non-institutional loan reimbursement. Some of the products gotten as a result of improved production could be used to repay the credit in "kind" of the equivalent credit value which could be considered as gross income. This is in line with the findings of Ogundeji et al., (2018); Abdallah et al., (2019).

Institutional credit showed a positive but insignificant impact on farmers' ability to sell tef post-harvest in the Amhara region. In Ethiopia, a similar but significant influence was noticed. However, this impact is lower in magnitude compared to that displayed by non-institutional credit. Institutional credit has a rather negative and significant impact on the gross income gotten from the sale of tef. The negativity is greater in magnitude in Ethiopia compared to the Amhara region. This indicates compared to no credit, accessing institutional sources reduces the gross income obtained from the sales of tef. This is because of the higher interest rates, higher transaction costs,

and at times, untimely availability of the credit provided by institutional sources. Contrary to this finding, institutional credit sources such as government-sponsored farm credit systems and banks have shown to have a positive and significant impact on farmers income (Nadolnyak et al., 2017)

Age negatively and significantly affected the ability of tef farmers to sell their products both in the Amhara region and at the country level. The magnitude of the impact was however higher in the Amhara region. This implied that the older the farmer, the less likely it is for the farmer to sell his products. Also, age indicated a positive but insignificant impact on the income gotten from the sales of tef post-harvest in both the Amhara region and Ethiopia. Being a male tef farmer had an insignificant and negative impact on the farmers' urge to sell tef in the Amhara region. The impact however indicated positive in Ethiopia. Besides, gender (male) negatively impacted the gross income obtained from the sales of tef both in the Amhara region and in Ethiopia. Tef farming household size in the Amhara region impedes the ability to sell and consequently gross income from tef sales. This impact is significant on the gross income. This is because an increase in household size increases the food needs of the household and reduces the quantity and potential to sell the harvest. In Ethiopia however, a rather positive but insignificant impact is observed on gross income for household size.

The more educated a tef farmer is, the lower the impact on the ability to commercialize tef post-harvest in the Amhara region and Ethiopia. The impact is significant only in the Amhara region. Being educated or not also has an impact on the monetary value of sold tef. In the Amhara region has a negative but significant impact on gross income from tef sales. This is because educated farmers are not solely dependent on money gotten from tef sales for their livelihoods. They could be involved in other income-generating activities. This result is contradicted at the country level by the fact, being educated has a positive and significant effect on tef sales. This is plausible where educated tef farmers understand better how to access credit and market dynamics to maximize their gross income from tef. This is consistent with Abdallah et al., (2019) who in his view mentioned that literacy increases farm income.

The influence of inorganic fertilizer use on the ability of tef farmers in the Amhara region to sell their output is negative and insignificant. However, the impact is positive and significant in Ethiopia. Although inorganic fertilizer application is expected to increase yields and consequently

the gross income got from the sale of tef, it is seen that its use in the Amhara region rather had a negative and significant impact on gross income. The existence of schemes where vendors of inorganic fertilizers will prefer to be paid with tef crop after harvest if the input is acquired on credit could explain this trend. This reduces the potential gross income that could have been obtained if the crop was sold. Contrarily, the impact of inorganic fertilizer use on gross income is positive and significant in Ethiopia. This is because increased yield associated with adequate inorganic fertilizer application will lead to more tef harvested and sold. Hailu et al., (2014) from a study in the northern part of Ethiopia brought out a highly positive and significant relationship between inorganic fertilizer adopters and farm income compared to non-adopters which is in line with the findings of this study at the country level.

Labor used for tef farming could be supplied from the household or hired. The former significantly influenced tef farmers' ability to sell tef both at the Amhara regional level and at the country level with a higher degree in the Amhara region, while the laters impact was insignificant. On gross income, household labor indicated a positive but insignificant influence in the Amhara region. In Ethiopia, the impact was negative and significant. This is because a unit increase in labor from the household implies an increase in the household dependency ratio, making the household rather more subsistence inclined. This translates into reduced potentials to sell for income. The later has a positive but insignificant impact on the sale of tef. A similar trend of results was found by Abdallah et al., (2019) wherein, labor employed by farmers in the transitional zone of Ghana had a positive and significant effect on farm income, and those in the savannah zone, a negative and significant effect.

The total farm surface area influences the decision to sell tef. This influence is positive and significant in the Amhara region while it is negative and insignificant in Ethiopia. The positive relationship in the Amhara region means an increase in land size increases the motivation of a tef farmer to sell his products. Land size in the Amhara region also indicated a positive but insignificant contribution to gross income gotten from the sale of tef. This impact is however greater in magnitude compared to that witnessed in Ethiopia which is significant. This is because a unit increase in land size will possibly lead to increase yields *ceteris paribus.* The increased yields boost the potentials to sell. This result is consistent with Hailu et al., (2014); Abdallah et al., (2019) who stated that land size has a positive and significant impact on farm income.

The amount of credit invested in the farming business positively influences income from tef sales. The impact is significant in both the Amhara region and Ethiopia, with a greater magnitude per unit change in the amount of credit observed in the Amhara region. This is because, an increase of credit amount increases disposable finances for the purchase of inputs, adopt better technologies of cultivating tef and transport tef post-harvest to markets where they are sold for income. However, this is contrary to the view Narayanan, (2016) which thinks irrespective of the positive impact of credit amount on input use and technology adoption, there is often reduced technical efficiency of farmers which often results in reduced productivity indicator.

From the above results, non-institutional credit performs better than institutional credit. This is perhaps as a result of the fact that non-institutional credit when accessed by tef farmers with sufficiently large social capital, the loan carries a lower interest rate, reduced transaction costs, and collateral than institutional credit, including the possibility of zero interest and collateral (Karaivanov and Kessler, 2018). This contributes to making non-institutional credit a priori more attractive to borrowers. Also, because most tef farmers are smallholder farmers, they will require relatively smaller amounts of credit for their farming activities. This is consistent with Karaivanov and Kessler, (2018) who mentioned that formal or institutional credit is often chosen by farmers who take higher risk, as large scale farmers whereas informal or non-institutional credit are preferred by farmers with smaller projects.

Table 8: Maximum likelihood Heckman sample selection model output

Variables	OLS		Heckman sample selection model			
	Income from tef		Amhara		Ethiopia	
	Amhara	Ethiopia	Farm sale (dummy)	Gross income	Farm sale (dummy)	Gross income
Non-institutional credit	119.2	477.7***	0.452	65.23	0.561***	285.6**
	(183.4)	(85.92)	(0.326)	(277.4)	(0.072)	(124.7)
Institutional credit	-50.29	-118.5**	0.340	-370.5*	0.247***	-542.7***
	(130.5)	(53.37)	(0.325)	(216.2)	(0.082)	(80.38)
Age	-3.531	-4.001***	-0.017***	9.094	-0.006***	0.641
	(3.353)	(1.345)	(0.006)	(6.549)	(0.002)	(2.743)
Gender (male)	-43.13	2.293	-0.023	-98.72	0.051	-83.19
	(146.5)	(61.86)	(0.252)	(176.8)	(0.073)	(109.8)
Household size	-34.97*	3.711	-0.042	-78.72**	-0.007	16.42
	(20.31)	(5.864)	(0.039)	(36.69)	(0.008)	(11.67)
Education (yes)	-435.5***	86.81*	-0.648***	-732.6***	-0.030	195.6**
	(84.27)	(50.65)	(0.211)	(198.9)	(0.056)	(94.30)
Inorganic fertilizer use (yes)	-235.6*	310.5***	-0.230	-392.5*	0.151**	518.3***
	(126.1)	(49.44)	(0.216)	(235.2)	(0.060)	(94.07)
Household labor	16.84***	2.901	0.030***	2.847	0.008***	-4.514**
	(4.159)	(1.910)	(0.007)	(1.782)	(0.002)	(2.251)

Hired labor	0.182	0.059	0.000	0.210	14.572	0.061
	(0.226)	(0.044)	(0.000)	(0.314)	(8.727)	(0.081)
Land size	716.9***	350.1**	0.806*	636.5	-0.108	856.6**
	(261.0)	(138.2)	(0.414)	(412.1)	(0.109)	(376.8)
Credit amount	0.020***	0.008	1.497	0.018***	-9.017	0.015***
	(0.002)	(0.007)	(6.933)	(0.002)	(9.032)	(0.005)
Farm type (livestock)	-2.354**	-417.9	2.721		5.538***	
	(1.037)	(380.4)	(2.221)		(0.480)	
Farm type (both)	98.31	-216.7*	0.273		-0.301*	
	(470.7)	(121.0)	(0.910)		(0.176)	
Constant	649.1	522.0***	-0.029	1,789***	0.078	808.9***
	(485.8)	(149.4)	(0.916)	(363.5)	(0.211)	(231.6)
Athrho (3)			-0.201		-0.063	
			(0.195)		(0.039)	
Insigma (4)			6.744***		7.260***	
			(0.082)		(0.047)	

Significant levels *** p<0.01, ** p<0.05, * p<0.1

Robust standard errors in parentheses

	Amhara		**Ethiopia**
Observations	321		2,269
R-squared	0.292	0.059	

Source: Ethiopia LSMS Wave 3 data analysis, 2020

5. Conclusion

Agriculture is a vital sector in the economy of most SSA countries including Ethiopia. From the grass root levels, it forms the backbone and foundation of policies to foster socioeconomic development. Livelihood strategies of the rural masses greatly depend on the sustainability of this sector as it strives to ensure food security, raw material supply, jobs, and income provision. Tef in Ethiopia is one such important cereal to the smallholder farmers in the agricultural sector. With the enormous land and economic value associated with its cultivation, smallholder farmers still face a great challenge of lower yields as the average actual yield of 1.2 tons per hectare is said to be below potential yields and even average yields of other cereal crops such as maize, wheat, barley, sorghum, and millet.

Schools of thought have advanced the reasons of such deficit in productivity as the reduced capacity of smallholder tef farmers to adopt and sustainably implement technologies in agricultural production such as usage of better varieties of seeds, fertilizer usage, irrigation kits and other advanced methods of production which have proven to bring about increased yields. Agricultural technology is available for adoption both nationally and internationally, but the financial capacity and knowledge of agricultural credit facilities of these poor smallholder producers are very low to aid in the adoption of such technologies.

Changing government policies over time has led to the creation and functioning of parastatal institutions to aid in funneling credit to smallholder farmers to improve their status. There has been a huge allocation of financial resources from subsidization to the present liberalized market-oriented system. To have an in-depth understanding of how various credit sources influence the productivity of tef farmers. With the notion that an increase in productivity can cause a tef farmer to shift from subsistence to market-oriented farming, hence two variables were used to assess productivity: the type of farmer, that is if the farming household will sell tef post-harvest or not, and the gross income gotten from such sales. Dat corresponding to 2269 tef farmers in Ethiopia, with 321 belonging to the Amhara region was extracted from the LSMS-ISA wave 3, 2015-2916 dataset.

In Ethiopia, there exist institutional credit sources such as religious institutions, MFIs, banks, and NGOs on one hand and non-institutional sources like relatives, neighbors, local merchants, and

moneylenders helping to increase farmers' access to credit. These and other sources elsewhere are reported by numerous authors to have a high probability of improving the productivity of smallholder farmers such as tef producers. A greater proportion of tef farmers access neither of these credit sources. Amongst the third that accessed, it was realized that in the Amhara region, institutional credit sources were more sorted compared to non-institutional credit sources. However, considering the entire country, non-institutional credit sources were accessed by more than half of tef farmers taken into consideration for this study. That notwithstanding, tef farmers face constraints accessing these credit sources such as non-availability or inadequate provision of credit services, some farmers are unable to repay the loans, with most farmer, ignorance, and the notion that these credit did not yield expected outcomes.

Due to heterogeneity existing amongst tef farmers, it was realized from this study using an MNL that in the Amhara region, gender (male) had a positive and significant probability effect on accessing non-institutional credit by tef farmers. Also, extension access had a negative and significant relationship on non-institutional credit. On the other hand, in Ethiopia being educated and commercial-oriented significantly increased the chances of accessing non-institutional credit. Institutional credit access in Amhara was rather improved significantly by being male and employing the use of inorganic fertilizer in the tef farms. This scenario was witnessed in Ethiopia with the inclusion of extension access having a positive and significant influence on accessing institutional credit. The household size in Amhara rather showed a negative and significant impact on tef farmers' accessibility to institutional credit.

Lower productivity of cereal especially tef farmers has proven to be an issue. Credit access is a highly regarded remedy. In the Amhara region as well as Ethiopia as a whole, the impact the various credit sources have on the productivity of tef farmers was evaluated using the maximum likelihood Heckman sample selection model. Gross income considered a proxy of farm income which is the measure of farm productivity that was considered. This model helped resolved the selection bias issues and the endogeneity related issues of the sample to have more consistent estimates of the impact. In the Amhara region, non-institutional credit indicated a positive but insignificant impact on gross income while institutional credit had a negative but significant effect. This trend was consistent at the country level but with the difference that, both credit sources were significant with higher magnitudes of the impact.

Besides, other socioeconomic, institutional, and production factors of tef farmers were found to affect the gross income of tef farmers. The credit amount had a positive impact on the gross income of tef farmers in the Amhara region while the household size, education, and inorganic fertilizer use had a negative effect. In Ethiopia being educated, using inorganic fertilizer, having a larger land size with an increased credit amount, a tef farmer is expected to significantly increase the gross income. However, an increase in household labor proved to significantly reduced gross income.

Looking at the revealed impact the various credit sources have on the gross income of tef farmers in the Amhara region and entire Ethiopia, non-institutional credit has shown a positive impact compared to institutional credit. Although this effect is not significant at the Amhara regional level, it is significant at the 5 % level at the country level. The associated advantages of non-institutional credit such as the possibility of zero interest rate, zero collateral, little or no documentation, and lower transaction costs account for smallholder tef farmers' motivation to access non-institutional credit. Hence it can be concluded that non-institutional credit will be more relevant in the context of tef farmers both in the Amhara region and Ethiopia as a whole.

6. Recommendations

The study has outlined the factors important in determining the type of credit accessed by tef farmers in the Amhara region and Ethiopia, and the impact these credit sources have on the gross income of tef farmers. To improve the productivity of tef farmers in the Amhara region and Ethiopia generally, we recommend the following

Tef farmers should organize themselves into producer groups. Such groups will create trust and promote the acquisition of non-institutional credit amongst members, information sharing, solutions to tef cultivation problems faced by individuals, group labor, planning of farm activities, and proper record keeping. Often, smallholder farmers turn to shy away from using relevant imports such as inorganic fertilizer due to high cost and associated transaction costs. This study has shown at the country level that, it has the potential of improving gross income. The coming together of tef farmers in producer groups could remedy this situation as farmers could engage in bulk purchases at discounted prices with single transportation. These advantages associated with producer groups will encourage increase productivity of the tef farmers and reduce poverty.

Statistics from the study indicated a majority of tef farmers were uneducated. This high rate of illiteracy could be reduced by using local stakeholders such as quarter heads, an association of household heads and local chiefs, who are trusted by the farmers to create awareness amongst the tef farmers on the importance of education such as the informal education provided the Orthodox church. Producer groups could also be a front where some sort of learning could be organized for tef farmers to reduce the cost of individual tutoring. A 45 minutes time slot could be introduced and used during producer group meetings for this purpose. It was indicated from the analysis that education at the country level will positively impact the gross income of tef farmers. More educated farmers will imply more disposable income for tef farmers and better livelihoods.

7. References

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8. Appendices

Appendix I: Credit-related studies, variables used and observed outcomes

Journal name	Title of article /year published	Crop type(s)	Sample size	Theory	Main method(s)	Variables	Results
South African Journal of economic and Management Sciences	Household access to agricultural credit and agricultural production in Nigeria: A propensity score matching model, 2020	All	4210 house-holds	De Neubourg (2009) livelihood portfolio theory	Propensity Score Matching Technique (PSM)	**Outcome variable**: • Agricultural production (Farm harvest, dummy variable) **Control variable**: • Access to credit • Education • Household head • Capital • Labor • Land • Health • Information	• Households' access to credit had a positive impact on agricultural production; this indicates that a unit increase in the effectiveness of access to credit facilities will lead to more than a unit increase (thrice) in agricultural production

African Journal of Economic and Management Studies	The impact of informal credit on rural agricultural productivity in the savannah ecological zone of Ghana, 2019	All	2,437 rural farm households	The Threshold Theory of Decision Making as propounded by Smith and Blundell (1986)	Endogenous Switching Regression (ESR) Model	**Outcome variable**: • Informal credit access (dummy) • Productivity Output per hectare **Control variable**: • Gender • Age • Education • Household size • Farm size • Farm_MEC • Asset index • Income • Multicrop • Non_farm_Biz • Northern • Upper East • Upper West • Group membership	• Access to informal credit significantly stimulates agricultural productivity

						• Non_AgricLand • House	
Agricultural Finance Review	Effects of agricultural credit on wheat productivity of small farms in Sindh, Pakistan: Are short-term loans better? , 2018	Wheat	180		Multiple Logarithm Linear Regression (MLLR) of the Cobb–Douglas Production Function and Instrumental Variables (two-stage least squares) approach	**Outcome variable** • Yield of wheat **Control variables** Per acre costs of major agricultural inputs such as • Seed • Land preparation, • Fertilizers • Plant protection • Irrigation • Labor • Amount of credit	• The study confirmed agricultural credit has a positive and greatly significant effect on wheat productivity. • Short-term Loans (STL) have a greater effect than Long-term Loans (LTL) in the yearly harvest since they are used for immediate quality input purchases. (working capital) • LTL bring greater returns in productivity than STL as they are used for long term investments like irrigation and land improvement. (investment in fixed assets)
International Journal of Innovative	Effect of Access to Credit on Agricultural	Cassava	166		Descriptive Statistics Logit Model	**Outcome variable:** • Access to credit (Dummy)	• Logit model showed that access to credit was

Research in Social Sciences & Strategic Management Techniques	Productivity: Evidence from Cassava Farmers in the Afigya-Kwabre District of Ghana, 2017				and Propensity Score Matching	**Control Variables** • Sex • Age • Marital status • Household size • Level of education, • Farm size • Farming experience • Hired labor • FBO membership • Extension assess • Distance to credit center	significantly influenced by most of the control variables • Credit has a positive and significant effect on cassava productivity

American Research Journal of Business and management	Determinants of Demand for Credit among Wheat and Teff Smallholder Farmers in Central of Ethiopia (Arsi and South West Shewa), 2017	Tef Wheat	150	Theory of Demand and Supply/ Consumer behavior	Multiple Regression Model	**Outcome variable:** • Amount of credit demanded **Control Variables** • Farming experience • Educational level • Income level and Farm size • Dependency ratio • Interest rate (cost of borrowing) • Payback period • Distance from lender • Sources of credit • Access to extension service • Amount of credit demanded • Sex of HHH • Total livestock unit	• Affected positively by education status, dependency ratio, low-interest rate, farm size and long payment period, for tef, and access to training besides for wheat farmer • The sources of the loan if it is business partner affected the amount of credit demanded negatively for tef while sex and sources of the loan if it is a business partner for wheat farmers
The Journal of Finance and Data Science	Is credit the devil in agriculture? The role of credit in	All			Phillips-Perron (P-P) unit	**Outcome variable** • (AGDP)	• Total food production, loan disbursed by ZTBL and the total loan disbursed by various institutions had a positive and

	Pakistan's agricultural sector, 2017				Root test, Johansen Co-integration test	**Control variable** • Total food production • Cropped area • Loan disbursed by ZTBL • Cooperative loan • Total loan disbursed	significant influence on the AGDP, whereas cropped area and cooperatives loan had a negative but insignificant influence on the AGDP
Agricultural Economics (United Kingdom)	The productivity of agricultural credit in India, 2016	Multi-group of crops	Macrol evel	"Liquidity Effect" Theory (Binswanger and Khandkher, 1995)	Regression	**Outcome variable:** • Agricultural Gross Domestic Product **Control variables** • Credit flow • Relevant inputs (including N, P, K fertilizers, pesticides, tractors, and pump sets) • Prices • Agricultural credit	• An increase in credit leads to increase input use but not the GDP of agriculture does not. • Agricultural credit thus enhances inputs, whose impact on agricultural productivity is challenged by low technical efficiency and productivity
Journal of Applied	Bank credit and agricultural	ALL			OLS estimates of	**Outcome variable**	• Bank credit and capital accumulation both have a

Business Research	output in South Africa: A Cobb Douglas Empirical Analysis, 2015				the Cobb-Douglas production function.	• Agricultural GDP (Output) **Control variable** • Credit • Agricultural Capital Formation, • Agricultural Labor Force • Rainfall	positive and significant impact on agricultural output in South Africa.
Acta Oeconomica	Productivity and credit constraints: A firm-level propensity score evidence for agricultural farms in central and east European countries, 2012	ALL	37409	Blancard et al. (2006) Farm Profit Maximisation Model	Propensity Score Matching Model	**Outcome variable** • Output **Control variable** • Total factor productivity • Investment • Land • Variable inputs • Labor	• Farm access to credit increases the total factor productivity up to 1.9% per 1000 euro of additional credit, indicating that improved access to credit results in adjusting the relative input intensities on farms

World Journal of Agricultural Sciences	Microcredit and Agricultural Productivity in Ogun State, Nigeria, 2010	Plantain	90		Descriptive Statistics, Multiple Regression Analysis	**Outcome variable** • Plantain (bunches) **Control variable** • Age • Education • Family size • Farmland size • Farming experience • Land • Labor • Capital • Access to credit facilities	• Access to microcredit could have a prospect in improving the productivity of farmers and contributing to uplifting the livelihoods of disadvantaged rural farming communities
Pakistan Journal of Agricultural Sciences	Impact of agricultural credit on the productivity of wheat crop: evidence from	Wheat	120		Multiple Regression Analysis using the Cobb Douglas Production	**Outcome variable:** • Wheat yield **Control variables** • Seed cost • Fertilizer cost • Irrigation cost	• Agricultural credit plays an important role in accelerating the revolution of agriculture and raising the participation of farmers in the production process.

	Lahore, Punjab, Pakistan, 2010				Function (CDPF)	• Plant protection cost • Land preparation cost • Loan is taken	
European Journal of Business and Management	The Impact of Agricultural Credit on Agricultural Productivity in Dera Ismail Khan (District) Khyber Pakhtunkhwa Pakistan, 2009	Major crops			Linear Regression Model on The Cobb-Douglass Type	**Outcome variable:** • Agricultural Gross Domestic Product **Control variables** • Credit for seeds etc • Credit for tub wells • Credit for implementation of tractors • Credit for other agricultural purposes • Total credit disbursed	• Credit disbursed for seed along with fertilizers and pesticides, irrigation and tractors were found strongly correlated to the agricultural gross domestic product with • In the end, it was concluded that the availability of credit increased agricultural production
Pakistan Journal of Life and Social Sciences	Impact of Micro Credit in Alleviating Poverty: An Insight from Rural	Wheat Gram Rabbi-fodder			Proportionate Analysis, Multiple Regression Analysis	**Outcome variable** • Farm income **Control Variables** • Yield per acre	• Average farm income of farmers who avail credit was more due to higher input level, better technical know-how, a

	Rawalpindi, Pakistan, 2009	Ground-nut Kharif-fodder Buffalo Cows				• Landholding • Number of milk animals	higher level of farm mechanization
World Development	Supply and demand for livestock credit in Sub-Saharan Africa: Lessons for designing new credit schemes	Livestock: Dairy Cattle	4592		Logistic Regression	**Outcome variable** • Borrower and liquidity constraint (dummy) **Control Variable** • Site • Sex • Gender • Education • Training • Prevalence of outstanding loan • Age • Farm size	• Some variables such as sex, education, training prevalence of outstanding loans, and the number of improved animals present on-farm greatly impacted both borrowing and liquidity status of households with different intensities in the various countries.

						• Herd Size • Number of improved cattle	
American Journal of Agricultural Economics	The Relationship between Credit and Productivity in Chinese Agriculture: A Microeconomic Model of Disequilibrium, 1990		253		Switching Regression Model Probit Model	**Outcome variable** • Access to credit **Control variable** • Land • Capital • Number of adults • Number of descendants • Education • Farm experience • Savings in financial institutions • Total initial liquid assets • Total outstanding debts	• Credit has a positive relationship to productivity
Journal of Development Economics	The impact of credit on peasant	Corn Bean	582		Multiple Regression Model	**Outcome variable** • Output (average yield per hectare)	• Credit impacted production positively and could also favor the move towards structurally

	productivity and differentiation in Nicaragua, 1989					**Control variable** • Intermediate inputs • Total labor days • Hired labor • Traction • Non-fixed inputs • Net revenue • Cultivated area • Mean farm size	balanced growth in Nicaraguan agriculture

Appendix II: Extracted variables, format, and levels

Variable	Format	Value/Levels				
HHH_Gender	Dummy	• 1=M		• 2=F		
HHH_Age	Numeric	Years				
Credit Acquisition	Dummy	• 1=Yes		• 2=No		
HH_Credit Source	Nominal	• 1=Relative • 2=Neighbor	• 3=Local Merchant • 4= Money Lender	• 5=Employer • 6=Religious Ins.	• 7=MFI • 8=Bank	• 9=NGO • 10=Other
Reason for credit	Nominal	• 1=Purchase house/Lease land for Business/Farming • 2=Purchase Agric. Inputs for food crops • 3=Purchase inputs for other crops		• 4= Up-capital • 5= Expanding business	• 6= Purchase of non-farm inputs • 7= Others (Specify)	
HH_Credit Amount	Numeric	Birr				
Main credit beneficiaries	Dummy	• 1= Male	• 2= Female	• 3= Both		
Cropping Method	Dummy	1=Pure Stands				

Land Size	Numeric	Hectare (ha)			
Extension Access	Dummy	• 1=Yes	• 2=No		
Irrigation	Dummy	• 1=Yes	• 2=No		
Irrigation Method	Nominal	• 1= River Diversion • 2= Pressure Treadle Pump		• 3= Notarized pump • 4= Hand pull	• 5= Other (Specify)
Inorganic Fertilizer	Dummy	• 1=Yes	• 2= No		
Manure	Dummy	• 1=Yes	• 2= No		
Compost	Dummy	• 1=Yes	• 2= No		
PPLabor	Numeric	Total hours (hr) during Post planting period			
HH Size	Numeric				
Farm type	Dummy	• 1= Crop	• 2= Livestock	• 3= Both	• 4= None
HHH_Edu. Level	Likert				
PH Hired Labor	Numeric	Cost in Ethiopian Birr			
PHhLabor	Numeric	Total hours (hr) employed during the Post-harvest period			

PH Unpaid Labor	Numeric	Number of days of labor supplied by neighbors	
Seed type	Dummy	• 1= Traditional	• 2= Improved
Seed Quantity	Numeric	Total Kilograms sowed	
Sowing Technique	Dummy	• 1= Broadcasting	• 2= Row Planting
Crop Output	Numeric	Kg of teff harvested	
Sale of crop	Dummy	• 1= Yes	• 2= No
Gross income	Numeric	Sales in Ethiopian Birr	