**ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY**

**SCHOOL OF BUSUNESS AND ECONOMICS**

**DEPARTMENT OF ECONOMICS**


# DETERMINANTS OF TEFF PRODUCTION AND PRODUCTIVITY OF SMALL HOLDER FARMERS: THE CASE OF ADEA BERGA WOREDA, WEST SHEWA, OROMIA, ETHIOPIA


BY: LEMA URGE



MAY, 2015

ADAMA, ETHIOPIA

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BY: LEMA URGE

ADVISER: S. V. RAO (PhD)

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CERTIFICATE

This is to certify that “Determinants of Teff Production and Productivity of Small Holder Farmers: The Case of Adea Berga Woreda, West Shewa, Oromia, Ethiopia” under taken by Lema Urge for the partial fulfillment of the requirements for the degree of master of science in Development Economics at Adama Science and Technology University. It is an original work and not submitted earlier for any degree either at this University or other University.

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| S.V. Rao (PhD) | ____________________ | _____________________ |
| (Research Advisor) | signature | Date |

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY SCHOOL OF BUSINESS AND ECONOMICS DEPARTMENT OF ECONOMICS

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## ACRONMY

| | |
|---|---|
| ADLI | Agricultural Development Led Industrialization |
| ATA | Agricultural Transformation Agency |
| CSA | Central Statistical Authority |
| DPs | Development Partners |
| DZARC | Debre-Zeite Agricultural Research Center |
| EDRI | Ethiopian development research institute |
| EEA | Ethiopia Economic Association |
| EIAR | Ethiopian Institute of Agriculture Research |
| ESSP | Ethiopia Strategy Support Program |
| FfE | Forum for Environment |
| GDP | Gross Domestic Product |
| GTP | Gross and Transformation Plan |
| ILRI | International Livestock research Institute |
| MAFAP | Monitoring African Food and Agricultural Policies |
| MDG | Millennium Development Goals |
| MoARD | Ministry of Agricultural and Rural Development |
| MoFED | Ministry of Finance and Economic Development |
| NBE | National Bank of Ethiopia |
| PADET | Participatory Agricultural Demonstration Extension of Technology |
| PASDEP | Plan for Accelerated and Sustainable Development to End Poverty |
| SDPRP | sustainable development and poverty reduction plan |
| SSA | Sub-Saharan Africa |
| TE | Technical Efficiency |
| TFP | Total factor productivity |
| WB | World Bank |

## Abstract

Teff is indigenous to Ethiopia in its origin. Unique character of teff in production required to study determinant production and productivity of Teff. This study is conducted in six kebeles of Adea Berga Worada. The study was mainly used the 2014 (2006/7 E.C) production season at rural small household farmers level which was collected by questionnaire. The main objectives of the thesis are to determine Total Factor Productivity (TFP) of farmers, to know determinants of teff production and productivity and to manipulate the efficiency level of the farmer of the district. The researcher used Cobb-Douglas production function and stochastic Frontier production function to analysis TFP and TE of farmers respectively. Production and productivity can be boosted either through increased use of inputs and/or improvement in technology or by improving the efficiency of farmers given fixed level inputs and technology. Even though teff has multidimensional use, the level of production and productivity is very low. Farmers in Adea Berga allocated above 70 percent of their land holdings to teff production. Among others, use of appropriate technologies like fertilizer, improved seed, weeding and/or herbicide application is very good aspect of the farmer of the region. But productivity of the farmer still 9.16 quintal per hectare, which is lowest among cereal crop even if its share is greater than all cereal crops. Average TFP and TE of the farmer is around 7 and 48 percent respectively which show high inefficiency gap to improve teff productivity.

# CHAPTER ONE

# 1. INTRODUCTION

## 1.1 BACKGROUND OF THE STUDY

Like in other developing countries, agriculture in Ethiopia is fundamental for the economy of the country. The role of agriculture has lion-share in development of the country's economy which accounts, in average, 46.3 percent of GDP, 80 percent of employment and 83.9 percent of exports. The country's aspiration for achieving overall economic growth largely depends on the productivity of the agriculture sector which requires appropriate follow up of policy design and implementation (UNDP, 2015, Wikipedia, 2015).

Growth of production and productivity of agricultural sector is known to be poverty-reducing, given the extent of rural poverty and the dependence of smallholders on agricultural income. Increasing agricultural products boosts the income of millions of smallholder farmers accounting for about three-quarters of Sub-Sahara African (SSA) poor population. This indicates agriculture is the backbone of economies of developing countries which requires transformation (C. Schaffnit-Chatterjee, M.L. Lanzeni, 2014).

Due to the importance of the sector, it has been more than two and half decades since the Ethiopian government had formally adopted Agriculture Development Led Industrialization (ADLI) as its development strategy. The main goal of this strategy is to attain fast and broad-based development within the agricultural sector and sector's development to power broad economic growth (Xinshen D., 2010).

In the implementation of the strategy, the government designed and implemented several economic development plans. Notably the Sustainable Development and Poverty Reduction Plan (SDPRP), which covering 2002/03 to 2004/05; a Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) that run from 2005/06 to 2009/10 and Growth and Transformation plan (GTP) which extends from 2010/11 to 2014/15 is also the part of that plan. As a result, there was good improvement in growth in economy for these continuous years. The available data show that the country has registered a 11% real Gross Domestic Product (GDP) growth over the period 2002-2008 as a report of National Bank of Ethiopia in 2009 ( Bekabil et al, 2011).

The pre-1991 command economy largely created disincentive to the farmers to market their output and it remained as constraint for output increases and further productivity improvement is low despite the introduction of new technologies in the mid-1970s. The major outcome of the 1991 market liberalization is that Ethiopian peasants can produce and sell their products at the free market prices. Different programs and plans introduced to improve agricultural sector. One of the major programs in rural development, in general, and agriculture, in particular, is the extension package which supports the promotion of modern agricultural technologies and agricultural growth to improve productivity of farmers (Xinshen, D. 2010).

Smallholder agriculture dominates developing countries where a large proportion of population and the poor reside in rural areas. Similarly, Ethiopia shares this feature. Over 80 percent of the 86.6 million Ethiopians lived in rural areas in 2013 and their main source of income is agriculture. In addition, Smallholder agriculture is the most important sector of Ethiopia's economy. The government through allocation of more than 15 percent of the total budget, along with Development Partners (DPs), had demonstrated a strong commitment to the sector, although a significant portion of this directly targets the relatively large and chronically food-insecure population. Due to the fact that smallholder farmers account over 90% of agriculture in the country, 94% of agricultural output come from peasant farms (MoARD, 2010, Fantu et al, 2014).

The plans and programs discussed above is not exclude teff. It is domesticated in Ethiopia before recorded times and is locally important. Teff is grown only in Ethiopia and Eritrea as food crop. It is the most valuable cereal crop in Ethiopia. It also accounts for the largest share of land coverage among staple crops in the country. Because of its nutritional value and cultural preferences, demand for teff is very high, especially in urban areas. It is one of the major cereal crops which it has been considered as dish pride culturally for most of country's citizen. It is not used only as flat bread in the country but also as animal forage and wood house construction by mixing with mud (Abraham R., 2015).

Teff is one of the most important crops for farm income and food security in Ethiopia. It is the second most important cash crop (after coffee), generating almost 500 million USD income per year for local farmers. In the major agricultural season of 2011/12, teff was grown by 6.3 million farm households in Ethiopia (CSA, 2012).

Teff (Eragrostis tef) is a major staple food crop in Ethiopia. It is cultivated and used for human consumption in Ethiopia for centuries. However, its global use for human consumption restrained partly due to the limited knowledge about its excellent nutrient profile and the processing challenges in making teff-based food products. As a gluten-free cereal crop, recent studies on teff suggest that its consumption can help to prevent and control iron deficiency and diabetes, demonstrating its potential to be a global functional food (ESSP, 2014).

It is grown at middle elevations between 1,800 and 2,200, high productivity region, meters above sea level and in regions that have adequate rainfall. Compared to other cereals, teff is considered a lower risk crop as it can withstand adverse weather conditions (Bekabil et al, 2011). The productivity of teff in Adea Berga was 11.95 quintals per hectare. In the rank of teff productivity of Ethiopian Woreda, Adea Berga is 23rd by average productivity of teff in the region (J. Warner et al, 2015)

Despite the specific species hay teff, it is the most adoptable crop in any weather condition which can be grown in a large part of the country, from lowland to highland areas. It is reported to be drought tolerant and grow on a wide variety of soils which is not surprising considering that there are nearly 4000 varieties identified worldwide (Davison et al, 2011).

Among cereals, teff accounts for the largest share of the cultivated area (28.5percent in 2011), followed by maize (with 20.3 percent). It is second (to maize) in terms of quantity of production. The average annual cultivated area is estimated at 8.5 million hectares. The proportion of area coverage for the main crops is teff 43.9%, wheat 23.1%, barley 17.7%, pulses 14.6% and sesame 0.7 %.( MoARD, 2012). However, because its market price is often two or three times higher than maize, teff accounts for the largest share of the total value of cereal production. It is grown by a total of 6.2 million farmers (FAO, 2013).

As a result the share of teff in total cultivated areas increased by 2 percent, compared to the decline in barely (25 %) and wheat (12 %), and rapid expansion in coarse grains (maize, 11%, and sorghum, 19%). It is the most important cereal, both in terms of production and consumption in Ethiopia. It fetches relatively high price in the market, making it attractive cash crop to farmers. Teff is nutritionally rich with high levels of iron and calcium, as well as highest amount of protein among cereals consumed in Ethiopia (Berhanu G. and D. Hoekstra, 2009, FAO, 2013).

According to Todaro (2003) the productivity of agricultural product is not determined by prevalence of technology unless the social, institutional, cultural and commercial, constraints are improved. For instance, since 1995/96-cropping season when Participatory Agricultural Demonstration Extension of Technology (PADETS) became operational, fertilizer and improved seeds widespread with increasing rates of adoption, despite the removal of all input subsidy since 1997/98. Between 1995 and 1999, the consumption of fertilizer increased from 35,272 to 2,168,756 quintals. In the same period, improved seed application rose from 11,043 to 177,783 quintals. The number of participating farmers leaped from 31,256 to 3,731,217 covering nearly 40% of the farming population. The value of credit, which began at 8.1 million, has reached 150.2 million. Demonstration plots in the fields of farmers covered by the package rose to at 3,807,658.

In terms of its spread in hitherto unknown areas, adoption rates of new varieties and fertilizer, diffusion and increased yield rates resemble green revolution in cereals (Gezahegn et al 2006). Given an irreversible trend of declining size of cultivated land, with the population growth, mismatch with production, one of feasible way to raise production would be to increase land and farmers productivity through agricultural extension. This show that production increase require whether farmers efficiency or land expansion.

As Abraham (2015) stated that government pressure is one of the factors that determine teff production. During and after Derg regime there is non-conducive environment for teff production and productivity. The Dictatorial military regime of Mengistu, there was strong campaign and enforcement of farmers for shifting of tef with other high productive staple crops.

As Haftamu et al, (2009) argument, frequent plowing is not a major factor to increase teff productivity, but it is important to control weeds. Frequency did not affect most of the yield and yield attributes of teff. However, it affected tilling of teff when combined with compaction. Incidentally, this factor alone did not increase the number of tillers per plant. Compaction resulted in low tilling but high ground cover. This means compaction did not favor tillering of teff but it encourages ground cover. Interaction between compaction and N also influenced tillering and ground cover of teff. Optimum returns were found from biomass and grain yields on compacted plots. The overall outcome of compaction is that it affects teff productivity. As their conclusion compaction is determine teff productivity rather than frequent plowing.

The action of the government can determine the production and productivity of the teff. The government policy needs to focus on improving the incentive for teff, which is increasingly considered as a cash crop by many poor farmers. Farmers have continued to grow teff probably because other crops also face the same disincentives. High domestic demand and relatively high prices in the local market have also encouraged teff farmers. The government is concerned about high prices and takes measures to keep teff prices lower for consumers. However, unlike maize and other cereals, teff consumers are largely middle and high income urban dwellers. Results of income elasticity analysis have shown that teff is more of a luxury food item for rural and poor urban people. As teff prices rise, low income families switch to maize, sorghum and other cereals (FAO, 2013).

## 1.2. STATEMENT OF THE PROBLEM

In the case of Africa, there is an overall consensus that there is large potential for improvements in agricultural production. Africa has more than half of the world's uncultivated but agriculturally suitable land and has scarcely used its extensive water resources. The vast agricultural area available improves food insecurity of the continent's population (John, A 2013).

According to EEA agriculture in Ethiopia is marked by declining productivity due to low technological inputs, soil degradation, diminishing farm size and its dependence on unexpected change of nature. Agricultural production has always been subsistence oriented and rain fed, unable to ensure food security (Dendu, 2014).

Like most of African countries, Ethiopia's agricultural system is dominated by smallholder farmers. As a result, 94 percent of other agricultural outputs come from peasant farms. In addition, the fact that small holder farmer accounts 90% of farmers in agriculture in the country which show the importance of small holder farmers in economic growth of the country. To get economic growth increasing productivity of smallholder farmers is must. Developing smallholder agriculture is key, given the predominance of small farms and their efficiency when taking all inputs into account. Smallholder agriculture is the driving force of economic growth and poverty reduction (ATA, 2013, Fantu et al, 2014, C. Schaffnit-Chatterjee, M. Lanzeni, 2014).

Teff is among the most widely grown cereals in Ethiopia. It is a staple diet of the majority of the population and the most widely planted by farmers. Not only serve as food grain for human being but also as animal forage (Davison et al, 2011).

Even though different studies indicate the percentage share of teff production large in both area coverage and number of farmers, corresponding productivity is very low due to poor soil fertility conservation and traditional plowing system. The productivities of teff at national level as low as 1.4 tons per hectare. Moreover, the productivity of smallholder farmers more lower than the above figure, were in some cases with the highest productive farmers achieving 25 qtl/ha and in the field trials of some research center is reaching 40-50 quintals/ha. As a result, the total national production of teff was lower than maize and sorghum (Bekabil et al, 2011, CSA 2012, Minten et al, 2013, Agegnehu, et al, 2014).

However, demand for teff continued to increase because of population pressures, while supply remained short, largely because of drought and government agricultural policies. Not only these, the adoption of new technologies by the small scale farmers which account 95% of the total area under crop cultivation in the country is quite limited. The adoption of new technologies by farmers under varying contextual settings is influenced by number of Socio-economic, institutional, and demographic factors of the farming households. According to Todaro (2003) the prevalence of technology in agriculture may not attain its target goal unless the social, institutional, cultural and commercial, constraints are improved (Wikipedia, 2014).

Although the quantities of fertilizer, selected seed, herbicides and pesticide dramatically increased at national level, the productivity of teff per hectare is the lowest among cereal crops. This indicates that each input is not properly applied on cultivation field. The amount of fertilizer applied per hectare is not at recommended rate (Gezahegn et al, 2006, Minten et al, 2013).

Despite the high importance of teff in the local food sector, investments in research towards the development of teff productivity practices are very low. In addition the potential area of past research are conducted are teff value chain at different market level, productivity trail in research institute, forage for horse owner, analysis of incentives and disincentives for teff in Ethiopia, genetic source of teff highly studied areas of the previous thesis (Bekabil et al, 2011, Getachew et al, 2006, Gemedo et al 2010, Davison, 2011, FAO, 2013).

Not only this, the research have been done are not conducted in area under consideration on determinants of teff production and productivity. The factors that determine teff production and productivity have variation in different geographical and agro-ecological zones, it is mainly depends on soil type, weather condition, elevation, rain availability, socioeconomic activity of smallholder farmer and even the adoption of modern technologies is vary as we far from city center (Teklu, 2009, Bekabil et al, 2011, Davison et al, 2011, C. Schaffnit-Chatterjee, M. L. Lanzeni, 2014).

Therefore, this paper will suggest the determinants of teff production and productivity in case of smallholder farmer in Woreda. It also answers the influence of socioeconomic behavior of smallholder farmers of the district and geographical areas towards teff production.

The survey of the sample may also enable the researcher to identify the socioeconomic activities of farmers of the Woreda which is affect teff production and productivity of district.

On the basis of the above explanation, three essential questions were posed:

- What are the determinants of teff production in specified district?
- What are Total Factor Productivity farmers?
- What is the efficiency of a farmer?
- What are the policy options available to improve teff production and productivity?

## 1.3 OBJECTIVES OF STUDY

### The General Objective

The general objective of this paper is to examine determinants teff production and productivity of smallholder farmers in Adea Berga Woreda, West Shewa Zone, Oromia region, Ethiopia.

- To examine determinants of teff production and productivity smallholder farmers.

### The Specific Objectives

- To identify significant variables determining teff productivity.
- To determine efficiency of farmers.
- To give alternative policy implication.

## 1.4 SIGNIFICANCE OF THE STUDY

The outcome of this paper will come with information for concerned body in formulating and planning the areas requires priority to improve the problems under consideration.

In particular, it helps agricultural sector in their effort to formulate policies and develop intervention mechanisms which help to increase teff productivity among smallholder farmers in study area. Moreover, this study may serve as a reference for further studies and has its own contribution to the previous studies.

## 1.5 SCOPE OF THE STUDY

The study is conducted in Adea Berga district, West Shewa zone, Oromia region, Ethiopia. It is comprise six kebeles of the district namely Ilu Xosigne, Ilu Warabo, Hara Shobore, Dire Madalle, Debisa Agasa and kerkaressa. The study only considered 2006/7 E.C or 2014 production season of the area.

## 1.6 LIMITATION OF THE STUDY

Since the study consider cross sectional data of the agricultural production, it is difficult for the researcher to say this study sufficient to determine agricultural production and productivity of the region. On other way as the sample size increase we might increase the rate of representative of the sample. The financial capacity of the researcher was low to done more detail study on this title. Generally, further study required by using time series data and increasing sample size of the farmer.

### 1.7 ORGANIZATION OF THE PAPER

The research is designed in four consecutive chapters. Chapter one is introduction which covers background of the study, statement of the problem, objectives of the study, and its significance. Information on the previous works and empirical findings are properly included in chapter two. Research methodologies, data type, area of study and model specifications discussed in Chapter three. Chapter four covers analysis and discussion, conclusions and recommendations of thesis.

# CHAPTER TWO

# 2. LETIRATURE

Teff (Eragrostis tef) is indigenous to Ethiopia in its origin. It is a grain crop solely produced in this country for human consumption purpose. Tef grows in most of the agro ecology zones of Ethiopia. Nationally teff ranks first in total crop land and quantity of produce among other cereals. It is sown on average on 22.73 percent of cultivated crop land of the peasant holding in Ethiopia. Teff rises as much as 34.19 percent of cultivated cropland in west Shewa zone which has highest proportion. The grain is an important crop used to make the Ethiopian staple food, Injera. This food is consumed at least once a day in better off households. The straw serves as a feed for livestock. Also the straw is important row material for the purpose of house construction. Market wise, urban dwellers have very high demand to consume teff. These demand made its price level higher than other cereals. As a result, tef price is reasonably stable. Moreover, tef can be stored for long without quality deterioration if a holder expects upward price movement. Farmers in the study area prefer to produce tef for the given market advantages. Farmers have an interest to increase total production of tef. One way of increasing production is through the use of improved technologies and eventually improving productivity per unit area (Mesfin et al, 2013).

## 2.1 DEFINITION

Teff is defined by different scholars and researchers in different ways even if it is related together. One of the first definitions is that the definition that related with scientific name given for that plant which is defined as Teff (Eragrostis tef [Zucc.], Poaceae) is a C4 annual tropical grass. It has a large crown, many tillers and a shallow diverse root system (Roseberg et al, 2005).

On other hand, tef is one of the most popular cereals hugely important crop in terms of production and consumption in Ethiopia. It is a national obsession in Ethiopia. The tiny grain the size of poppy seeds has been consumed in this east African country for centuries. This definition is related with size, categories of grain and benefit of teff for the society (Bekabil et al, 2011).

As International Livestock research Institute define teff as a grass-like fine seeded staple food crop grown in Ethiopia. It is an annual love grass species and which many other names given for it were include; tef, annual love grass, teff grass and summer annual grass (Berhanu G., D. Hoekstra, 2009, Davison et al, 2011). According to Abraham (2015) tef is a fine stemmed, tufted annual grass characterized by a large crown, many shoots and a shallow, diverse root system. Its inflorescence is a loose or compact panicle. The seed sizes are quite small ranging from 1–1.7mm long and 0.6–1mm diameter with l000 seed weight averaging 0.3–0.4 grams and 150 grains of tef has equivalent weight with almost one seed of wheat. With the exception of finger millet, tef has the smallest size among the crop seeds in the world. There definition is here focused on the characteristic of teff and comparison with other cereal grain.

In general, even though different person define slightly in different ways, it is the grass like cereal product which has significant share of cereal products all in terms of area, consumption and production to serve both as alternative food for human being and forage for animals in specific, it also help smallholder farmer as source of income in Ethiopian context.

## 2.2 GENETIC SOURCE OF TEFF

The report of Vavilove indicates, Ethiopia has diverse agro ecological zones. This diversity has endowed the country with diversified fauna and flora. This situation favors the country to be the center and origin for many economically important crops such as Eragrostis tef, Guizotia abyssinica, Enset ventricosum, Coffee Arabica, Catha edulis, Rhamnus prinoides, Hagenia abyssinica, Coleus edulis, Coccinia abyssinica, Brassicacarinata, Triticum durum and Hordeum vulgare (Abenet et al, 2010).

Most of the earlier studies indicate that the historical domestication of teff is related with Ethiopians. Based on morphological, biochemical and bio-systematic data and DNA sequencing, tef has been grown in Ethiopia since before recorded times. It is an endemic tropical cereal crop of Ethiopia and it has been cultivated for thousands of years in Ethiopian high lands. It is a warm season, annual grass that originated in Ethiopia and was imported to the United States more than 25 years ago (Davison et al, 2011, Abraham, 2015).

According to Abraha Arefaine (2013) teff is an indigenous cereal crop in Ethiopia. Ethiopia and Ethiopians is the origin and the first domesticator of this unique crop. It also thought to have been spread to Europe through the Portuguese movement in the $16^{th}$ century. Tef was distributed to several countries in the $19^{th}$ century, and now it is cultivated as a forage grass in Australia, India, Kenya, and South Africa. Not only teff is traditionally harvested for food grain in Ethiopia, but also it is believed to have been first domesticated by pre-Semitic inhabitants in Ethiopia between 4,000 B.C and 1,000 B.C. Teff belongs to family Poaceae and genus Eragrostis (Abenet et al, 2010).

Tef is believed to have originated in Ethiopia and is endemic to the country. However, it has not been considered as an important food crop by the international scientific community or funding agencies for a long period of time.(Bekabil et al, 2011)

At all, we can understand that from the previously conducted researches as the domestication and source of teff is from Ethiopia.

## 2.3 USES OF TEFF

Teff is both cereal and cash crop grain used for various purpose which enforces smallholder farmers to allocate part of their land. In the first, it can be used as animal forage at all and in part (residue) in western countries and Ethiopia respectively. Since the straw of teff is comfortable for animal consumption for most of Ethiopian smallholder farmers use its residue, after threshing, for oxen food specially during tilling period. The second and essential use of teff is serving as a source of income. It is one of the most important crops for farm income in Ethiopia. It is the country's most important cash crop (after coffee), generating almost 500 million USD income per year for local smallholder farmers (Davison et al, 2011, CSA, 2012).

Third and the most important use of teff is that making bread which is called Injera in local language, and porridge. It is likely to remain a favorite crop of the Ethiopian people and it is also gaining popularity as a health food in the western world. The unique quality of teff is high mineral content and being gluten-free. It's also nutritionally very rich in carbohydrate. The last benefit of teff is that the residue is not only use for animal forage but also for construction purpose by mixing with mud and wood (ESSP, 2014, ATA, 2015, Abraham R. 2015).

## 2.4 Ecological Zone of Teff Production

Teff is adaptable for large geographical and ecological area of weather condition. It can grow from sea level up to 3000 meters above sea level and performs well between 1700 and 2400 m. Tef is cultivated in high rainfall areas with long growing periods. It can also grow in low rainfall and drought prone areas characterized by protracted growing seasons and frequent terminal moisture stress. It tolerates reasonable levels of both drought and water logging better than most other cereals. Tef grows on various soil types ranging from very light sandy to very heavy clay soils, and under mildly acidic to slightly alkaline pH conditions. The cultivation of tef in Ethiopia has partly been motivated by its relative merits over other cereals in the use of both the grain and straw (Teklu, 2009, Mesfin et al, 2004, ATA, 2013).

## 2.5 Problem of Teff Production and Productivity

The very low level of yields in SSA is due to various reasons, especially poor irrigation, low fertilizer use, infrastructure constraints, insecure land tenure, Soil depletion, high dependence on rainfall are some the factors affect teff production and productivity. Lack research in many critical areas like, reducing lodging, water-logging, drought resistance, and improved blended fertilizers limits the quantity of production. The adoption rate of improved seed by growers is very limited in the country emanating from shortage of supply, accessibility, suitability of available varieties to all agro-ecological conditions and not affordable price. The employment of ineffective agronomic practices limits production in diversified ways which comprises poor land preparation and inefficient method of sowing. The high losses occurs during post-harvest operations additionally limits the volume of production and aggravates the marketable price. These losses are resulted from poor threshing practices and constraints in use of mechanical harvesters (Schaffnit-Chatterjee, Lanzeni, 2014, Abraham, R. 2015).

Agriculture transformation agency (2015) studies indicate that there are problem related to fail to reduce lodging, avoid water logging, improving drought-resistance species, and improved fertilizer blends.

Land preparation is one of the most labor consuming tasks in Teff production. In most areas, Teff plots are plowed at least four times using old age farm implements before planting, as it is necessary to break up the soil in order to facilitate germination of the very small Teff seeds. Weeding is other labor-intensive and not always effective: weeding is probably the major use a combination of chemicals and hand weeding to control weeds. In the early stage of growth, it may not be possible to distinguish Teff from weeds, increasing the difficulty of weeding (Bekabil et al, 2011, Abraham, R. 2015).

Lodging is the state of permanent displacement of the stems from their upright position. All high yielding factors like variety, fertilizers, population and irrigation affect lodging. Careful management of the factors like selection of resistant genotypes, development of resistance varieties, following raised bed cultivation, proper N fertilizer application, irrigation at right time and quantity, pest and disease management and growth regulator application will reduce lodging and improve yield and quality of the crop (Abraham, R. 2011).

Like lodging, shattering is a source of significant loss of yield in Tef production. Shattering occurs at all stages of Tef production process, starting from as soon as the crop begins to dry out and is a risk until the grain is threshed. Tef shattering can also be exacerbated by the incidence of rain and practices used by farmers in harvesting, gathering, piling and threshing (Bekabil et al, 2011).

### 2.6 Trial of Improving Productivity

Some researches done to improve or get new production which increase productivity of teff at research center. Mixed cropping of teff (Eragrostis tef ) with faba bean (Vicia faba) was compared with sole cropping in the 2002 and 2003 growing seasons at Holetta Research Center, in the central highlands of Ethiopia. The treatments were sole teff (25 kg seed ha−1), sole faba bean (200 kg seed ha−1) and 12.5, 25, 37.5, 50 and 62.5% of the sole seed rate of faba bean mixed with a full teff seed rate. A randomized complete block design replicated four times was used. Treatment effects were significant for seed and biomass yields of each crop species. Increasing the seed rate of faba bean in teff/faba bean mixture increased faba bean seed yield but decreased teff grain yield. Nonetheless, mixed cropping of faba bean with teff increased land use efficiency and gave higher total yields compared to growing either species in sole culture (Getachew et al, 2006).

Three teff row-seeding technologies are introduced Ethiopian Agricultural Transformation Agency introduced three technologies that can well run row plantation for teff. The Agency provides the prototypes and the designs of the technologies to Amhara, Tigray, Oromia and South Ethiopia regional states officials at a forum organized in Addis Ababa by the Agency. The three agricultural technologies are expected to help mechanize smallholder farmers engaged in growing teff (Bekabil et al. 2011).

In the traditional way a farmer has to labor for 76 hours per hectare to plant teff seeds. The innovations provided by the Agency on average can manage it in 10 hours. Of course, the best modern tool introduced by the Agency can finish planting teff in 6 hours per hectare given the nature of the land (ATA, 2013).

### 2.7 Area and Output Share of Teff

Teff is one of the most important crops for farm income and food security in Ethiopia, the second most populous country in Africa. It is Ethiopia’s most important crop by area planted and value of production, and the second most important cash crop (after coffee), generating almost 500 million USD income per year for local farmers. In the major agricultural season of 2011/12, teff was grown by 6.3 million farm households in Ethiopia (CSA 2012). It is the most beneficial crop in Ethiopia in terms of area and in value of production, and is the second most important cash crop after coffee (Minten et al, 2013).

In 2011/12, it was estimated that teff made up 20 percent of all the cultivated area in Ethiopia, covering about 2.7 million hectares and grown by 6.3 million farmers. The second most important crop was maize at 15 percent of all cultivated area. However, given the relatively low yields of teff, the total national production of teff (3.5 million tons) was lower than maize (6.1 million tons) and sorghum (3.9 million tons) (Minten et al, 2013).

As reported by Abenet, G. et al (2010), Teff accounts for about a quarter of the total cereal production in Ethiopia. It is grown over approximately 2.8 million hectares, or 27% of the land area under cereal production. The yearly average main season area covered by teff is about 1.91 million ha making up 29 % of the total cereal area (Getachew et al, 2006).

According to the data of the CSA (2012), teff production was expanded by 72 percent between 2004/05 and 2010/11 year. The share of teff in total cultivated areas increased by 2 percent, compared to the decline in barely (25 percent) and wheat (12 percent), and rapid expansion in coarse grains (maize, 11 %, and sorghum, 19 %). Among cereals, teff accounts for the largest share of the cultivated area (28.5 percent in 2011), followed by maize (with 20.3 percent). Teff is second (to maize) in terms of quantity of production. However, because its market price is often two or three times higher than maize, teff accounts for the largest share of the total value of cereal production. Teff is grown by a total of 6.2 million farmers. Since teff farm operations such as land preparation, weeding and harvesting are highly labor-intensive, with limited availability of suitable mechanical technology, there are no large scale teff farmers in the country. Many farmers grow teff as cash crop because of its higher and more stable market price (FAO, 2013).

Generally, we can conclude that teff is the most significant cereal or cash crop in consumption, production and area of cultivation

*Table 2.1 Cereals area and production (Smallholder farms, Meher season), 2004/05-2010/11*

| *Crop* | *2004/2005* | | | | *2010/2011* | | | | *Expansion rate* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Area 000 ha* | *Production 000 tonnes* | *Yield (tones/ha)* | *Share in Total Cereals Area (%)* | *Area 000 ha* | *Production 000 tonnes* | *Yield tonnes/ha* | *Share in Total Cereal Area (%)* | *Area 000 a* | *Production 000 tonnes* | *Yield (tonnes/ha)* | *Share in T. Cereal Area (%)* |
| *Grain* | *9811* | *11907* | *-* | *-* | *11823* | *20349* | *-* | *-* | *20.5* | *70.9* | *-* | *-* |
| *cereals* | *7638* | *10031* | *-* | *-* | *9691* | *17761* | *-* | *-* | *26.9* | *77.1* | *-* | *-* |
| *Teff* | *2136* | *2026* | *0.95* | *28.0* | *2761* | *3483* | *1.26* | *28.5* | *29.3* | *72.0* | *33.0* | *1.9* |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Barley* | *1095* | *1328* | *1.21* | *14.3* | *1047* | *1703* | *1.63* | *10.8* | *-4.5* | *28.3* | *34.2* | *-24.7* |
| *Wheat* | *1398* | *2177* | *1.56* | *18.3* | *1553* | *2856* | *1.84* | *16.0* | *11.1* | *31.2* | *18.1* | *-12.4* |
| *Maize* | *1393* | *2394* | *1.72* | *18.2* | *1963* | *4986* | *2.54* | *20.3* | *40.9* | *108.3* | *47.8* | *11.1* |
| *Sorghum* | *1254* | *1716* | *1.37* | *16.4* | *1898* | *3960* | *2.09* | *19.6* | *51.4* | *130.8* | *52.4* | *19.3* |
| *Finger millet* | *313* | *333* | *1.06* | *4.1* | *408* | *635* | *1.56* | *4.2* | *30.4* | *90.8* | *46.3* | *2.8* |
| *Oats* | *45* | *57* | *1.26* | *0.6* | *31* | *48* | *1.54* | *0.3* | *-31.6* | *-16.1* | *22.7* | *-46.1* |
| *Rice* | *-* | *-* | *-* | *-* | *30* | *90* | *3.03* | *0.3* | *-* | *-* | *-* | *-* |

Source: FAO, 2013

**2.8 Measurement**

Agricultural productivity is typically measured partially in terms of output per unit area of land or per person employed. Some of the highest yields per hectare have been achieved in developed Asia where intensive agriculture – with much labor, capital, and fertilizer has driven total harvest of crop or livestock product per hectare to about 8 times that of the US. In contrast, the highest outputs per worker are in North America where technology allows a farmer to cover more land and produce more per year (Schaffnit-Chatterjee, Lanzeni, 2014).

Output can be improved by using more agro-chemicals, machinery and energy but they cost money. Total factor productivity or TFP takes into account contributions of all conventional inputs and captures how much is obtained out of a given combination of land, labor, capital and materials. A rise in TFP reflects technical or managerial innovations allowing to get more with less. Global agricultural output increased threefold between 1961 and 2009 and only about 60% of this improvement can be attributed to the use of more land, labor, capital or materials. The rest is due to an improvement in TFP more efficient use of those four items (Schaffnit-Chatterjee, Lanzeni, 2014).

Measuring productivity is conceptually better understood when total factor productivity (TFP) is measured empirically. Total factor productivity is the ratio of aggregate outputs to aggregate inputs. Some studies use inter spatial measures of total factor productivity based on Divisia Index as defined by Denny and Fuss where efficiency is estimated for different kinds of land contracts. The TFP approach is found to be suitable for cases where the complexity and diversity of smallholder farming, like in Ethiopia, is large; it also makes comparison possible among different farming systems. The superiority of the method of TFP over the conventional method of measuring land and labor productivity emerges from the fact that the latter is misleading if there is high substitutability between inputs. Within the TFP methods, there are different kinds of measurement techniques that need to be seen from various methodological perspectives (Gezahegn et al, 2006).

While TFP is a more complete measure of productivity, its measurement requires detailed information on all output and input quantities as well as information on prices and unit costs. While obtaining such data is an onerous task for countries with detailed agricultural data like the US, it is sometimes not even possible for countries in SSA and indirect methods are required to derive approximate measures of TFP (Schaffnit-Chatterjee, Lanzeni, 2014).

# CHAPTER THREE

## 3. RESEARCH METHODOLOGY

### 3.1. THE DESCRIPTION OF THE STUDY AREA

The study is carried out in Adea Berga Woreda, West Shewa Zone, Oromia Regional State of Ethiopia. The Woreda has three towns which are administered by municipality. The Woreda administration is centered at Enchini town. The other towns of the include Mugher, and Olonkomi. The district administration is located around 64 km far away from Addis Ababa to west, with an estimated area of 798.35 square kilometers (Road Authority of the District, 2014/15).

According to work plan of 2014/ 2015 of Road Authority of the District a total population for this Woreda 144,180 of whom 71,075 were men and 73,105 were women; 16,771 of its population were urban dwellers and encompasses 3 urban and 34 rural kebeles. Agricultural produces like barley, teff, sorghum, pea, bean and vegetables are produced in this Woreda.

Adea Berga is bordered on the south by the Ejere and Walmara, on the west by Metta Robi, on the north by Degam and Kuyyu, and on the east by Mulo districts. From total area of the district 45,358 hectare were used as arable land; 17,380.08 hectare were used for grazing land; 2068.75 hectare were for construction and 1281.50 were covered by forest. (Office of Rural land issue of district)

The location of the district is north between latitude $9^0$12'N-$9^0$37'N and east on longitude $38^0$36'. The average altitude and temperature of the District is 3180m above sea level and $10^0$c-$15^0$c respectively. (Work Plan of Road Authority of the Woreda, 2014/15)

According to this plan the weather condition coverage of the Woreda is 29%, 34% and 37%, dega, weinna-dega and cola respectively. The major soil type of the districts is black soil which cover 44%; red soil 39% and mixed soil 17% of the total area.

### 3.2. DATA TYPE AND SOURCE

The researcher used primary data which is cross-sectional in nature for the study. The primary data are collected from rural small-farm households. Since some of the farmers did not read and write it's supported by interviewers and informal observation and communication also used.

The data collected by field survey from small-farm households. It focused on data from smallholder farmers on Socio-economic characteristics of households, teff production activities and methods, land features and government and Non-Government Organization (NGO) support.

### 3.3 SAMPLING TECHNIQUE

Since agriculture is practiced in rural data collection focused on rural kebeles. Two stage sampling technique used. First, 6 kebeles selected from 34 rural kebeles of production area. Second, in each kebeles 25 households selected purposely for the study. By this sampling method the data is collected from 146 smallholder farmers from 28,131 total smallholder farmer of the Woreda rural households (Woreda Health office, 2015).

### 3.4 METHOD OF DATA COLLECTION

Formal questionnaires developed and used to collect relevant information from the farmers with the help of trained high school and 10+3 complete enumerators. These enumerators trained how to collect relevant production and productivity of teff. The data collection made in the year 2015. A total of 146 farmers of Adea Berga interviewed. Additional set of information was collected by informal observation, communication and relevant governmental and non-governmental organization to back up questionnaire based statistics.

### 3.5 METHOD OF DATA ANALYSIS

The analysis basically employed both descriptive and Econometric methods. Descriptive statistics (mean, percentage, range, Bar chart etc.) is used to summarize the variables used in the model and describe the study area. Even though descriptive statistics from household's survey give important information, it is difficult to do relevant conclusion without using a necessary econometric estimation.

#### 3.5.1 MODEL SPECIFICATION

1. **Production Function**

The Cobb-Douglas production function is used for determination of the relation between gross production values obtained as a result of teff production and the inputs used (Goksel, 2007)

$Y = AL^{\beta}K^{\alpha}$..........................................................................................equation 1

Where, Y is represents teff gross output

A is represents technology

L is represents labor

K is represents capital

When the $Y = AL^{\beta}K^{\alpha}$ is transformed into log linear form, the parameters can be estimated the linear form in the equation 2 was obtained by running logarithm on both side of the equation 1.

$\ln Y = \ln A + \beta \ln L + \alpha \ln K$....................................................................equation 2

The model used in this study is given as

$\ln Y = \ln A + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + ... + \beta_n \ln X_n + \varepsilon_i$ .................equation 3

This is the revised form of the convectional Cobb-Douglas production function in order to estimate TFP.

Where, Y is represents production level, A represents TFP coefficient, X represents the inputs used and β and α parameters $\varepsilon$ error terms of the model.

**2. Total Factor Productivity**

Total Factor Productivity (TFP) is the portion of output not explained by the amount of inputs used in production. As such, its level is determined by how efficiently and intensely the inputs are utilized in production. (Diego Comin, 2006)

The economic theory of production has provided the analytical framework for most empirical research on productivity measurement. The cornerstone of the theory is the production function, which postulates a well-defined relationship between output and factor inputs. Productivity can be achieved from two sources; first, through technological change of using improved practices of production such as plough, fertilizer, pesticide, improved seed, etc. which pushes the production frontier upward; and second, if the farmer has got further skills in using the existing techniques of production, productivity will increase. Measuring productivity is conceptually better understood when total factor productivity (TFP) is measured empirically. Total factor productivity is the ratio of aggregate outputs to aggregate inputs. The superiority of the method of TFP over the conventional method of measuring land and labor productivity emerges from the fact that the latter is misleading if there is high substitutability between inputs. Within the TFP methods, there are different kinds of measurement techniques that need to be seen from various methodological perspectives. (Gezahegn et al, 2006).

The convectional Cobb-Douglas production function is used for estimation of TFP, equation 4 can be used.

$TFP = A = Y/L^{\beta}K^{\alpha}$ .............................................................................equation 4

Dependent variables checked for the existence of data problems mainly multi-collinearity and heteroscedasticity problems. The model specification test used Ramsey Reset test.

I. The existence of multi-collinearity found solution by omitting one or more variables from the model

II. The significance of the variables and the existence of heteroscedasticity.

To test the variable significance jointly and solely F - test employed to check the joint significance of the independent variables, if the null hypothesis $H_o$ is reject against alternative hypothesis $H_a$ is accepted. T-test and z-test also employed to test the significance of each variable at 5% level of statistical significance.

III. Model specification test

**3. Technical Efficiency**

To estimate the efficiency of the farmer, the researcher used the frontier model (Gezahegn et al, 2009).

$Y_i = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + ... + \beta_nX_n + \varepsilon_i$

Where, $Y_i$ output of the farm i= 1, 2… n

Xi is inputs used

$\beta_i$ parameters

$\varepsilon_i$ error term, $\varepsilon_i = U_i - V_i$

Here I used Cobb-Douglas stochastic frontier. The functional form stochastic frontier is determined by testing

The symmetric random error $V_i$ accounts for random variations in output because of factors, such as, measurement error, exogenous shocks; etc. which is not under the control of the farmer and it is assumed to be independently and identically distributed as N (0, σ2vi). Moreover, the asymmetric non-negative random error, Ui measures technical inefficiency and is assumed to be independently and identically distributed (at zero from below) of the N ($\mu$, $\sigma^2_{ui}$) distribution.

The variance parameter of the model is parameterized as:

$\sigma_e^2 = \sigma^2_u + \sigma^2_v$ and $\gamma = \sigma^2_u / \sigma^2_u + \sigma^2_v$; $0 < \gamma < 1$:

$\bar{y} = y_i - u_i = f(x_i; \beta) - v_i$, after finding the estimates of $u_i$ and $v_i$;

Where, $\bar{y}$: is the observed output of the $i^{th}$ farm household adjusted for the stochastic random noise captured by $u_i$; this equation is used to derive the technically efficient input vector and to derive algebraically.

# CHAPTER FOUR

# 4. DATA ANALYSIS AND DISCUSSION

Chapter four consists of both descriptive and econometric results of the study. Specific to Econometric part, Cobb-Douglas production results were discussed. Total Factor Productivity and efficiency of famers and its determinants also analyzed.

## 4.1 Descriptive Statistics

The data is collected from rural farmer household heads. It is collected from146 rural small household head which the quota is given for the six kebeles randomly selected from 34 rural kebeles. Most of the data is obtained from male headed family household when we manipulate in percentage form, it accounts 86.30 percent out of 146 succeeded respondent household.

As the following table (4.1) indicate that the average production of teff among different dummies. The average produced teff by households used fertilizer is 920.68kg/ha while the households average output produce by non-fertilizer user was 705.61kg/ha. This implies that there was relative significant difference between fertilizer user and non-user. The difference is also there between other dummies even if the magnitude is different. The productive difference between land owned households and non-owned households; herbicide user and non-user; improved seed user and non-user and sex of household head were also explained in next table.

**Table 4.1** Average output by different dummies

| Input | Dummy | | | Output | |
|---|---|---|---|---|---|
| | Group | Percentage share | Number Farmers | Quantity kg/ha | percentage increase |
| Fertilizer | Not user | 2.05 | 3 | 705.6117 | _ |
| | User | 97.95 | 143 | 920.6848 | 30.48 |
| Land | Not owner | 20.69 | 30 | 845.477 | |
| | owner | 79.31 | 115 | 934.3517 | 10.51 |
| Herbicide | Not user | 2.74 | 4 | 766.6667 | _ |
| | User | 97.24 | 142 | 920.4795 | 20.06 |
| Improved seed | Not user | 50 | 73 | 905.5818 | _ |
| | User | 50 | 73 | 926.9491 | 2.36 |
| Sex | Female | 13.70 | 20 | 897.3797 | _ |

| | | | | | |
|---|---|---|---|---|---|
| | Male | 86.30 | 126 | 919.2632 | 2.44 |

Source: author's computation from questionnaire

The percentage change of the output increase is also described in the above table (4.1) between user and non-user and sex dummy. The percentage increase of teff among fertilizer non-user to user is very when we compare with other dummies.

### 4.1.1 INPUT USE

Input use is important determinants of level of output though not a sufficient condition in its own. Farmers use different types of inputs for the farming practices. However, the level and intensity of use differ among them. In this study the most commonly used inputs are fertilizer, herbicide, seed and labor for teff production.

**SEED**

Use of improved seed is a common practice in the study area. The improved variety of teff is used by about 50 percent of sample farmers. However, access to improved teff seed is limited in the study area. These are probably due to the limited technologies in the research area and, in fact, lack of institute that takes the responsibility to multiply released teff varieties to the level of its demand in study area. So far the involvement of private sectors in improved seed production is not recorded in the study areas. The Ethiopian seed enterprise and Ethiopian agricultural research organization produce and multiply limited amount of improved teff seed. This seed eventually distributed to small holder farmers with the help of regional and district bureau of agriculture. But in the area under consideration nothing supplied.

In the study area the improved variety is locally called Aborse. Farmers very much interested in the improved varieties of teff or the main reason that it gives better yield than local varieties. Use of improved teff varieties is varying from place to place. For example in Ilu Xosigne kebele no one use improved teff in contrast in Dire Madalle and Haro Shobore from sample farmers 88 and 78.26 percent used improved varieties of teff.

Table 4.2 Farmers use improved varieties of teff

| Kebeles / improved seed | Debisa Agasa | | Dire Madalle | | Haro Shobore | | Ilu Xosigne | | Ilu Warabo | | Kerkaressa | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No | % | No | % | No | % | No | % | No | % | No | % | No | % |
| Users | 13 | 54.1 | 22 | 88 | 18 | 78.26 | 0 | 0 | 12 | 54.55 | 8 | 33.33 | 73 | 50 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 7 | | | | | | | | | | | | |
| Not Users | 11 | 45.83 | 3 | 12 | 5 | 21.74 | 25 | 100 | 10 | 45.45 | 16 | 66.67 | 73 | 50 |

Source: author's computation from questionnaire No = is number of farmer, % percentage

The sowing manner of the teff is also not in improved way of planting. From the total sample 146 95.89 percent used traditional form sowing which is broadcasting method. In the broadcasting method of sow the rate of fertilizer utilization is low because the probability of seed and fertilizer meet each other is low.

There were a lot of reasons that the farmer enforced to use traditional form sowing. The major reasons are land feature the plot, lack of supply and low financial capacity of farmer at the seasons. The report of the sample famer shown that land feature of region is rocky, hillside and non-conducive land for line sowing. As a result, the adoption rate of line sowing not broadly seen.

**FERTILIZER USE**

Fertilizer used by about 97.95 percent of sample farmers in study area to increase teff productivity. As a report of farmers imply, fertilizer is the most widely used technology or input in teff production. As table (4.3) indicates, from 143 of a farmer 62.94 percent of farmers applied only inorganic fertilizer, 34.96 percent both inorganic and organic fertilizer and 2.09 percent only organic fertilizer on their teff plot of land. Even though organic fertilizer users are approach to 36 percent of the sample, the magnitude and intensity of the application is very low. But the cost of preparation is very small when we compare with inorganic fertilizer. On other hand, Even though organic fertilizer was used by 2.09 percent of the sample farmers, the average output of the sample is approached to double when we compare with inorganic fertilizer.

Table 4.3 Type of fertilizer used with Average output

| Fertilizer type | Number of farmers | Average Output kg/ha |
|---|---|---|
| Organic | 3 | 1638.945 |
| Inorganic | 90 | 907.1756 |
| Organic and inorganic | 50 | 901.9057 |

Source: Author's computation from survey data

As table (4.4) indicates that the coverage of fertilizer is approach to 100 percent in all kebeles considered. However, the required application rate is still low and method of application is not appropriate.

There was different reason why the farmers were not use fertilizer. Fertilizer non-users were unable to apply it due to expensive price, lack of cash to purchase inorganic fertilizer and afraid of natural disasters.

Table (4.4) shows the distribution of fertilizer users and non-user in each kebele and the number of farmers used fertilizer to produce teff. Fertilizer is the most popular input of the district. Its distributions also high in the region which indicate above 95 percent of the farmers in each kebeles were used fertilizer for teff production.

Table 4.4 Farmer's percentage used fertilizer

| Kebele / Fertilizer | Debisa Agasa | | Dire Madalle | | Haro Shobore | | Ilu Xosigne | | Ilu Warabo | | Kerkaressa | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No | % | No | % | No | % | No | % | No | % | No | % | No | % |
| Users | 23 | 95.83 | 25 | 100 | 23 | 100 | 25 | 100 | 24 | 96 | 23 | 96 | 143 | 97.95 |
| Not Users | 1 | 4.17 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 1 | 4.17 | 3 | 2.05 |

Source: author's computation from questionnaire, No = is number of farmer, % percentage

**HERBICIDE USE**

The importance of application of herbicide is well known in the study areas. This time most commonly used herbicide is U-46 which is recommend for broad leaf weeds. The application of herbicide is not attractive even though it's effective in saving labor time that will be used for other activities, because it didn't kill non-broad leaf weeds. About 97 percent of farmers in study area, reported that, used herbicide in 2006/7 E.C production season on teff production. In Ilu Warabo and Kerkaressa 92 and 91.67 percent of farmers used herbicide on teff while the other are 100 percent of sample farmers applied herbicide. They uses it to reduce the number labor consumption on weeding.

**Table 4.5 Farmers uses of herbicide**

| Herbicide / Kebele | Debisa Agasa | Dire Madalle | Haro Shobore | Ilu Xosigne | Ilu Warabo | Kerkaressa | Total |
|---|---|---|---|---|---|---|---|

| | No | % | No | % | No | % | No | % | No | % | No | % | No | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Users | 24 | 100 | 25 | 100 | 23 | 100 | 25 | 100 | 23 | 92 | 22 | 91.67 | 142 | 97.26 |
| Not Users | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 8 | 2 | 8.33 | 4 | 2.74 |

Source: author's computation from questionnaire, No = is number of farmer, % percentage

Herbicide non users reported that they didn't used herbicide for the main reason that they had enough family labor, expensive to purchase herbicide and lack of cash to purchase. Like fertilizer the distribution of herbicide use in the region was reached above 90 percent of farmers. From six kebeles of a sample Kerkaressa experienced the lowest level of herbicide distribution which is 8.33 percent of the farmers.

### 4.1.2 LAND FEATURE

There are different soil type and land gradient in the sampled kebeles of the district. The reports of the farmer indicate that there are five type of soil in the region. Of the soil type around 40 percent is occupied by mixed soil. As table (4.6) red soil is the most productive soil type in sampled area even if its variation high from the mean relative to other soil type. But the average fertilizer used per hectare is low next to sand soil which confirms the productivity of red soil.

Table 4.6 soil categories with fertilizer and yield per hectare.

| Soil type | Farmers | | Fertilizer application | | Output | |
|---|---|---|---|---|---|---|
| | No of farmer | % age share | Mean kg/ha | SD | Mean kg/ha | SD |
| Red soil | 29 | 19.86 | 70.41 | 26.74 | 1011.53 | 685.64 |
| Black soil | 29 | 19.86 | 72.52 | 23.99 | 906.08 | 508.56 |
| Sand soil | 9 | 6.16 | 65.78 | 17.23 | 762.18 | 184.63 |
| Clay soil | 21 | 14.38 | 73.71 | 24.33 | 912.99 | 402.08 |
| Mixed soil | 58 | 39.73 | 73.70 | 22.54 | 916.6 | 462.19 |

Source: author's computation from questionnaire, SD is standard deviation

It describes that the average application of fertilizer and average yield in kilogram per hectare. The data is grouped by soil type and explain number of farmer that produce their output on different soil type and average fertilizer used and output obtained on these soil types in kilogram per hectare of land.

This cultivated plot of land have no the same slope gradient. It is ranged from flat to high sloped land. The plot of land grouped under different slope land by management and attitude of respondents themselves. As table 4.7 shows the average output per hectare for each slope of land.

Table 4.7 share of land slope

| Slope | Quantity | | Fertilizer | | Output | |
|---|---|---|---|---|---|---|
| | No farmer | %age share | Mean kg/ha | SE | Mean kg/ha | SE |
| Flat | 54 | 36.99 | 76.44 | 3.02 | 831.62 | 46.99 |
| sloped | 59 | 40.41 | 73.46 | 2.96 | 913.42 | 58.58 |
| More sloped | 33 | 22.60 | 69.66 | 3.96 | 1059.86 | 105.91 |

Source: author computation from questionnaire, SE standard error of mean

The productivity of land is different as land gradient change. As table (4.7) indicate the more sloped land is more productive than flatter. But the standard errors are reverse of their productiveness. That mean the standard error of their productivity is increased from flatter to more sloped land. The productivity of more sloped land is emanating from recent cultivation of land. This indicate that expansion to new plot of land enabled them to get fertile soil than the already had.

There was different land tenure in the area. As farmers report, around 25 percent of farmer got a plot land devoted for teff production by rent. While the other were government grant, heredity, family grant and the other. These created awareness to us, as the diversity of land tenure is very in the district.

### 4.1.3 Uses Teff

Teff is a crop only grown in few countries (mainly in Ethiopia) and its yield response to fertilizer is relatively limited given that the technology to develop high-yield variety of teff is more difficult than to develop other cereal crop varieties broadly grown in the world. On the other hand, teff is more favorable than other cereal in Woreda diet and has higher income elasticity in demand. The reports of the farmer indicate 97.95 percent of respondents used teff for food purposes. But, in addition, they also used residue and surplus for animal forage and sale as a source of income respectively as we understood from table (4.8)

**Table 4.8** uses of teff

| Uses of teff | Number of respondents | Total hectare utilized | Sum of output in kg |
|---|---|---|---|
| Food only | 2 | 2.25 | 2694.613 |
| Sale only | 3 | 1.75 | 3433.67 |
| Food and sale | 54 | 63 | 47658.27 |
| Food, sale and forage | 87 | 148.5 | 79988.2 |

Source: author's computation

The share of land of teff devoted for commercial only was very low. It accounts less than 1 percent of total hectare utilized. Here the categories include food use of teff had higher share of plot of land. This implies that teff is the popular in food consumption of the farmers of the area.

### 4.1.4 Productivity of Teff

Although teff occupied 72.30 percent of total land size owned by respondents, the average output per hectare, of teff is equivalent to 9.16 quintals. This implies that farmers are much less productive. Indeed, yield of teff is only 9.16 quintals per hectare, the lowest level of yield among all major cereal crops.

This is not implying that required amount of fertilizer is not used per hectare of teff production but appropriate use and distribution. On other hand the use of natural fertilizer is very low. When we compare with inorganic fertilizer, organic fertilizer is very low both in rate of distribution and magnitude used for production.

Table 4.9 Technology use and productivity of farmers

| Technologies | User Farmers | | | | Non-user Farmers | | | |
|---|---|---|---|---|---|---|---|---|
| | No farmer | Mean kg/ha | Range | SD | No farmer | Mean kg/ha | Range | SD |
| Improved seed | 73 | 953.32 | 1610.32 | 484.57 | 73 | 894.54 | 1408.53 | 48.55 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Fertilizer | 143 | 921.26 | 1531.50 | 415.085 | 3 | 705.61 | 0 | 0 |
| Herbicide | 142 | 921.76 | 1531.66 | 409.18 | 4 | 766.67 | 466.67 | 329.99 |

Source: author's computation from questionnaire

The table (4.9) shows as the productivity of technology user farmers and non-user. The productivity difference between improved seed users and non-users was insignificant relative to herbicide and fertilizer while its average output is greater than those users. The adoption of improved seed was also lower than the other technology. From 146 respondents only fifty percent was the adopter of improved seed while 97.95 and 97.18 percent of the farmers was the user of fertilizer and herbicide respectively. And their output variation from mean is lower than improved seed users for extension farmers.

The average output of farmers for improved seed, fertilizer and herbicide user farmers are 953.32, 921.26 and 921.76 respectively. In other way, the average output of farmers that not use improved seed, fertilizer and herbicide are 894.54, 705.61 and 766.67 respectively.

Note table (4.9) considers the individual application of technology. Improved seed user and non-user farmer may use or may not use other technologies i.e. fertilizer and herbicide. It's also the same for fertilizer and herbicide user and non-user.

Although productivity of user farmer is greater than non-user, its variation from mean is greater than non-user farmer. The standard deviation of fertilizer and improved seed non-user is lower than the user.

## 4.2 ECONOMETRICS ANALYSIS

Even though descriptive analysis is important for data analysis, it is not sufficient to determine and know the factor determine production and productivity of teff. It also not indicates the level of significance of the factor of production. The model of Cobb-Douglas production function used in my study as follows:

$$\mathbf{Lnoutput = \beta_0 + \beta_1 lnlabor + \beta_2 lnfertilizer + \beta_3 lnrent + \beta_4 lnoxendayha + \beta_5 lnseed + \beta_6 lnpriceofteff + \beta_7 lntillagefrequ + \beta_8 lnAgehhh + \beta_9 lnfamilysize + U_i}$$

**Where, Lnoutput** is natural logarithm of output per hectare, **lnlabor** is natural logarithm of labor in day per hectare used, **lnfertilizer** is natural logarithm of fertilizer in kilograms per hectare used, **lnrent** is natural logarithm of paid rent in birr per hectare, **lnoxendayha** is natural logarithm of oxen day effort per hectare, **lnseed** is natural logarithm of seed used in kilogram per hectare, **lnpriceofteff** is natural logarithm of price of teff in 2006 per kilogram, **lntillagefrequ** is natural logarithm of tillage frequency per hectare, **lnAgehhh** is natural logarithm of age of household head, **lnfamilysize** is natural logarithm of family size of the household, $\mathbf{U_i}$ is error term the model. As table (4.10) states that the marginal Product of labor is derivative of output with respect to labor which is equal to dy/dl=doutput/dlabor which is 6.45. It implies that one day increase in labor tend to increase output by 6.45 kilograms other thing keeps constant. This indicates that the relationship between labor and output is positive. Labor and marginal product of labor is inversely related to the increase in labor. Therefore, the marginal product of labor went on diminishing with the increase in labor input all input else equal. It is also true for the other variables.

Table 4.10 estimation result of Cobb-Douglas production function

| Variable (independent variable lnoutput) | Coefficient | Standard Error | t-stat | p-value |
|---|---|---|---|---|
| Constant | 3.259099 | 1.395096 | 2.34 | 0.021 |
| Lnlabor | .2519435 | .0789916 | 3.19* | 0.002 |
| Lnfertilizer | -.3101108 | .1231388 | -2.52** | 0.013 |
| Lnrent | .1148654 | .109526 | 1.05 | 0.296 |
| Lnoxendayha | -.1551878 | .2630241 | -0.59 | 0.556 |
| Lnpriceofteff | .6437118 | .2530586 | 2.54** | 0.012 |
| Lntillagefrequ | -.0720351 | .3076362 | -0.23 | 0.815 |
| lnAgehhh | .3439983 | .1183172 | 2.91* | 0.004 |
| Lnfamilysize | -.2490117 | .0875251 | -2.85* | 0.005 |

Source: estimation result of data, * and ** is 1% and 5% level of statistical significance

The estimate of returns to scale is estimated from this model by taking the summation of the regression coefficients of inputs or summation of elasticity of output with each input. As table (4.10) implies that this model experienced decreasing return to scale because, the summation of coefficients of the variables is less than a unity. This means when total input double output is respond less than double.

From eight independent variables used in this model, five variables were significant at 5 percent level of statistical significance. As we can understand from table (4.10) family size, age of household head and labor were significant at1percent statistical significance level while price of teff and fertilizer used is significant 5 percent of statistical significance level.

**4.2.1 Total Factor Productivity**

Total Factor Productivity (TFP) is the efficiency of non inputs source of productivity. It is show the efficiency of the farmer that emanates from internal ability of the farmer. TFP is the ratio of output and inputs. Total Factor productivity was computed by the ratio teff output to labor and capital. Labor comprise weeding, cutting and oxen day per hectare while capital included fertilizer and seed utilized in kilogram per hectare.

Table (4.11) states mean of TFP of the farmers among technology user and non-user. It also shows minimum, maximum and standard deviation of the TFP for both users and non-users.

Table 4.11 Estimate of total factor productivity for technology user and non-user

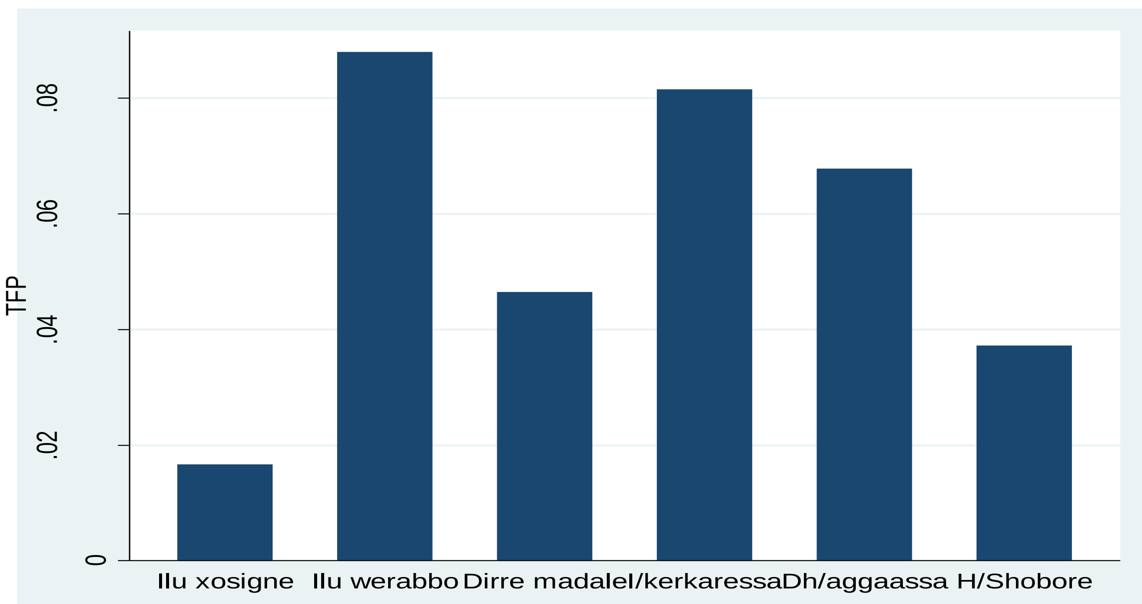
| Technology | Total Factor Productivity | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Users | | | | Non-users | | | |
| | Mean | minimum | maximum | SD | Mean | Minimum | Maximum | SD |
| Fertilizer | .069 | .004 | 0.30 | 0.057 | .068 | 0.029 | 0.11 | 0.04 |
| Improved seed | .062 | .022 | 0.30 | 0.046 | .076 | .004 | .30 | .066 |
| Herbicide | .069 | .004 | 0.30 | 0.057 | .046 | .026 | .065 | .022 |

Source: author's computation estimation result; SD standard deviation

The TFP of technology user farmers are greater than that of non-user in case of fertilizer and herbicide while the reverse is true for improved seed as a report of table 4.11. But, the SD of TFP for fertilizer and herbicide user is higher than non-user.

As figure (4.1) report that, TFP is differ among farmers and between kebeles. For instance TFP is 0.1064 in Ilu Warabo kebele while 0.0284 is in Ilu Xosigne. Total Factor Productivity difference shows the efficiency of farmers in teff production since TFP is indicates productivity increase as a result of non-input and technology change.

Figure 4.1 Total Factor difference among kebele.




**Source: own computation**

As we could understand from the figure there is high inefficiency gap between kebeles and by itself. It requires great effort to improve inefficiency level of the farmer of the region in teff production. TFP of the region also not much differ from kebeles' Total Factor Productivity. The average total factor productivity of the respondents is 0.06 which show the efficiency farmers of the district.

#### 4.2.1.1 Determinants of Total Factor Productivity

There are a lot of determinant of Total Factor Productivity of teff production and productivity in the area. Table (4.12) implies that determinants total factor productivity in linear regression model. Coefficient of the variable shows the direction of relation of variable with TFP of a farmer.

$$\mathbf{TFP_i = \alpha_0 + \alpha_1 labor + \alpha_2 oxenperha + \alpha_3 sexhhh + \alpha_4 Agehhh + \alpha_5 schoolingageofhhh + \alpha_6 maritalstatushhh + \alpha_7 family\ size + \alpha_8 numberchildinschool + \alpha_9 numberchildabove10age + \alpha_{10} fertilizerkgha + \alpha_{11} rentha + \alpha_{12} seedkgha + \alpha_{13} experience + \alpha_{14} priceperkilo + \alpha_{15} hectareutilized + u_i}$$

Where, labor is labor of adult day, oxenperha is oxen day per hectare, Agehhh is age of household head, schoolingageofhhh is schooling year of household head, family size is number of family member, numberchildinschool is number of children in school, numberchildabove10age is number family member above age ten, fertilizerkgha is fertilizer applied in kilogram per hectare, seedkgha is seed consumption in kilogram per hectare, experience is the year that the work in agriculture, priceperkilo is price of last year teff per kilogram, hectareutilized is plot size, and $u_i$ is error term.

Table 4.12 Determinants of Total Factor Productivity

| Variable | Coefficient | Standard error | t-stat |
|---|---|---|---|
| Labor | -.0000921 | .0000255 | -3.61* |
| Oxen | -.0000926 | .0026948 | -0.03 |
| Age | .0000517 | .0005452 | 0.09 |
| Schooling | -.0022241 | .0022108 | -1.01 |
| Family size | -.0027256 | .0027754 | -0.98 |
| No child in school | .0018471 | .0033597 | 0.55 |
| No child above age10 | -.0006072 | .0029771 | -0.20 |
| Fertilizer | .0007088 | .0002091 | -3.39* |
| Seedkgha | -.0016692 | .0014703 | -1.14 |
| Experience | .0009233 | .0004864 | 1.90*** |
| Price per kilo | .0027373 | .0032553 | 0.84 |

| | | | |
|---|---|---|---|
| Plot size | .0031384 | .0047809 | 0.66 |
| Constant | .1415717 | .0663894 | 2.13 |

Source: estimation results *, **, *** 1, 5 and 10 percent significance value

From 12 variables only fertilizer and labor are significant at 1 percent of statistical significance while experience is significant at 10 percent statistical level of significance all the other variables are insignificant. In table above plot size, fertilizer, price per kilo, experience, age of household head and number of child in school have positive relationship with total factor productivity when the other are negative.

### 4.2.2 Technical Efficiency

The other set of estimation followed from TFP estimation is the technical efficiency measurement. Efficiency can be measured with various kinds of measurement and sophistication (Gezahegn, 2006). However, the kind of model employed for a particular measurement often depends very much on the desired objectives of the study. In our case here we employed the stochastic frontier model type for its best fit in our data set on the basis of test conducted. For estimation of the technical efficiency, we specified the model as follows:

**lnoutputinkgha = f (familysize, fertilizerkgha, rentha, seed, labor, hectareutilized, oxenday, schooling, numberchildabove10age) + $e_i$, $e_i = U_i - V_i$**

Where: hectareutilized, is the plot size; oxenday is the number of oxen days spent; labor is quantity of labor in hour; fertilizerkgha is quantity of fertilizer applied in kilogram per hectare; and seedkgha is quantity of seed used in kg per hectare; familysize is number of family member; rentha is rent per hectare, Schoolingagehhh is schooling year of household head; numbercchildaboveage10age is number of child above ten age; $e_{i} = U_i - V_i$ error term and $U_i$ factor out of control of the farmers (measures technical efficiency), $V_i$ factor come with decision of farmers (measurement error, external shock etc.). One stage approach, which includes all inefficiency explanatory variables and conventional input variables simultaneously, was employed in this study.

The estimation result of the stochastic frontier model is depicts that the WALD test and the log-likelihood statistics both favor of Cobb-Douglas stochastic frontier at 5% level of statistical significance for estimations (Table 4.13).

Table 4.13 Estimated Technical Efficiency (normal/half-normal model)

| Variables | Coefficient | Std. Err. | Z-stat | p-value |
|---|---|---|---|---|
| Familysize | -.0667899 | .0233773 | -2.86* | 0.004 |
| Fertilizerkgha | -.0048673 | .0017877 | -2.72* | 0.006 |

| | | | | |
|---|---|---|---|---|
| Rentha | -.0000375 | .0001138 | -0.33 | 0.742 |
| Seedkgha | -.0004652 | .0034633 | -0.13 | 0.893 |
| Labor | .00767 | .0019777 | 3.88* | 0.000 |
| Hectareutilized | -.298353 | .0466846 | -6.39* | 0.000 |
| Oxenperha | -.0231685 | .0225468 | -1.03 | 0.304 |
| Schoolingagehhh | -.0126249 | .017196 | -0.73 | 0.463 |
| No child above 10 age | .0671123 | .0236482 | 2.84* | 0.005 |
| Constant | 8.181753 | .4447272 | 18.40 | 0.000 |
| lnsig2v | -1.840851 | .6164733 | -2.99* | 0.003 |
| lnsig2u | -1.933384 | 1.886566 | -1.02 | 0.305 |
| sigma_v | .3983494 | .1227859 | | |
| sigma_u | .3803392 | .358767 | | |
| sigma2 | .3033402 | .1814759 | | |
| Lambda | .9547878 | .4776323 | | |
| Likelihood-ratio test of sigma u=0: chibar2(01) = 0.15 Prob >=chibar2 = 0.350 | | | | |

Source: estimation result data, * show 1% statistical significance level, No of Observation = 111

From table (4.13) fertilizer, labor, hectare utilized, number of child above ten age and family size are significant at 1percent statistical significance level.

Next, we test here whether $\gamma = 0$ or $\gamma = 1$, the technical efficiency effects are not simply random error. the researcher needs to test the null hypothesis that there is no inefficiency component. The test result of this estimation, which is based on the z-statistics, shows the half-normal estimations reject null hypothesis at 1% and 5% level of statistical significance. In this estimation the researcher uses the sample size of 111 participating in teff production. In table (4.12) estimation the technical efficiency is negatively related with family size, quantity of seed per hectare, area of hectare utilized and number of oxen per day per hectare while the other is positively related with technical efficiency.

$\sigma_e^2 = \sigma^2_u + \sigma^2_v$ and $\gamma = \sigma^2_u / \sigma^2_u + \sigma^2_v$; $0 < \gamma < 1$:

$\gamma = \sigma^2_u / \sigma^2_u + \sigma^2_v = 0.48$

The technical efficiency component of the farmer is 48 percent of input used for teff production which shows us the availability of high gap to improve inefficiency components of the farmer in the region.

# CHAPTER FIVE

# 5. CONCLUSION AND RECOMMENDATION

## 5.1 Conclusion

Cobb-Douglas production function was used to analysis total factor productivity of farmers while stochastic frontier production function was used to analyze efficiency of teff production in Woreda. TFP of a farmer that used herbicide, improved seed and fertilizer separately is 6.9, 6.2 and 6.9 percent respectively. While for that herbicide, improved seed and fertilizer non-used farmers is 4.6, 7.6 and 6.8 percent respectively. TFP of technology user and non-user of teff producer not show significant difference. This implies that the input use efficiency of the farmer is very low. In other way, for both technology user and non-user, TFP is extremely low which shows us again low efficiency of farmer in input use.

The hypothesis test on existence of inefficiency component in the error term shown that Stochastic Frontier Production function is appropriate production function or there is significant technical inefficiency variation among plots. Accordingly, the $\gamma$ value of 0.48 for teff production function can be then interpreted as, 48 % of the variation in output among farmers is explained by technical inefficiency. The Likelihood-ratio test was done to examine the null hypothesis; determinant variables in the inefficiency effect model are simultaneously equal to zero. Result of the test confirmed that the null hypothesis was rejected, meaning there exists at least one explanatory variable that explains the variation in the technical inefficiency among farmers.

Result of the frontier production function indicates that labor was found to be binding in the production of teff, meaning that an increase in labor will enhance production keeping everything constant. Generally, all significant input variables were found to affect output negatively except labor and number of family member above ten ages, this shows labor intensive character of teff. Moreover, the model output depicted that technical efficiency for *Teff* production was found to be 47.7 percent. The technical efficiency value of 47.7 percent for teff could be interpreted as there is potential to reduce the technical inefficiency by around 52 percent. The inefficiency effect analysis for teff production shown that family size, fertilizer, labor, area of hectare utilized and number of family member above 10 ages are the major determinants. Labor and number of family member above 10 ages were found to affect technical inefficiency in teff production positively.

Important conclusions drawn from this study is that, there exists a considerable room to improve low productivity and reduce the level of technical inefficiency of teff in the district.

## 5.2 Recommendation

Since Total Factor Productivity and Technical efficiency of the farmer of the district simultaneously shown low efficiency in input use, farmers require a lot of support to increase the productivity of teff. The government and non-government organization should give training assistance for the rural household, on how to use input to increase teff production and productivity.

In addition to technical support, the concerning body should create awareness to the farmer how to preserve their land fertility and also the replacement activities of inorganic fertilizer by organic fertilizer should be done due to its more productive and cheap in cost of obtain or preparation. This should carefully do by repeatedly training rural household to change their perception toward organic fertilizer. The agriculture sector excludes women which is the half portion of our society. From total sample size less than 14% is female headed household which their contribution may increase productivity teff. Therefore, encouraging female participation in agricultural production is required.

Furthermore the availability of modern inputs, for example improved seed, is not satisfied, so the government should insure it and give certain subsidy in its provision.

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# APPENDIX

# QUESTIONNAIRE

I strongly request both respondents and interviewers as you answer the question freely and present carefully to contribute for the foundation of reality respectively. Your collaboration is valuable for the researcher and reality.

Purpose of this questionnaire is to fulfill the masters of degree in developmental economics from Adama Science and Technology University.

The objective of the study is to discover determinants of teff production and productivity of smallholder farmers in Adea Berga Woreda.

The questionnaire comprises four pages without current page.

## QUESTIONNAIRE

**I. Personal information of the respondent**

1. Sex of household head
   Male ☐ female ☐

2. Age of household head ☐

3. Marital status: unmarried ☐ married ☐ widowed ☐ divorced ☐

4. Year of schooling of household head ☐

5. Family size ☐

6. How many children would you have? ______________________________________________
7. How many of your family members above 10 years? ____________________________________
8. How many of them in school ____________________________________________________

**II. Teff cropping information**

9. Have you producing teff? Yes ☐ No ☐
10. What type of teff would you grew? Red ☐ White ☐
11.
12. How many oxen would you grown last year? ______________________________

**III. INPUTS, SOIL FEATURES AND ACTIVITIES INFORMATION**

13. What form of sowing are you employ?

Line sowing ☐
Dispersion sowing ☐

14. If not line sowing, why not prefer?
_____________________________________________________________________________
_____________________________________________________________________________
__________________________________________________________________________

15. Would you use fertilizer?
    Yes ☐ No ☐

16. If you say yes question number 15, what type of fertilizer you applying?

Organic fertilizer ☐ Inorganic fertilizer ☐ both ☐

17. If you say compost in question 16, how many quintals you use per oxen? _______________
18. If you say inorganic in question 16, which type of fertilizer are you uses?
    DAP ☐ Urea ☐ Mixed ☐

19. If you say inorganic fertilizer in question 16, how many kilo are you use per timed?
_____________

20. If you say mixed in question 18, how? ________________________________
21. If you say No question number 15, why not use fertilizer?_____________________________
_____________________________________________________________________________
_____________________________________________________________________________
_____________________________________________________________________________

22. Would you use herbicide?

Yes ☐ No ☐

23. If you say no in question 22, why not use?

___________________________________________

___________________________________________

24. Are you use selected seed?

Yes ☐ No ☐

25. Many kilo of teff use per oxen? ____________________

26. If you say no in question 24, why not use?____________________

___________________________________________

27. What is your land slope?

Hill ☐

Medium slope ☐

Flat ☐

28. Which type of soil you grow on?

Red soil ☐

Black soil ☐

Sand soil ☐

Gray soil ☐

Mixed soil ☐

29. Would you preserve your land fertility?

Yes ☐ No ☐

30. If you say yes, what type of conservation method are you utilize?

Tracing method ☐

Mixed cropping ☐

Covering residue ☐

Other specify ☐

31. What type of plough are you employing?

Oxen ☐ Tractor ☐ Hoe ☐ other, specify ____________________

32. How many times are you tilling? ____________________

33. How many times are you weeding?

1time ☐ 2time ☐ 3time and ☐ above

34. Which types of cutting method are you use?

Sickle ☐ Other machine ☐ specify____________________

35. At what drying level of teff stick are you collect?

☐

Wet

Less wet ☐

Dry ☐

V ☐
Very dry

36. What type of cultivation mechanism are you utilizing?
Irrigation ☐

Rain dependent ☐

37. How many times are you producing in year? ________________________

38. Are you use pesticide to protect from insect damage?

Yes ☐ NO ☐

39. If you say No in question 38 why not use it?
______________________________________________________________________________
______________________________________________________________________________

40. Which of the following are you use to thresh teff?

Animal ☐

Other method ☐ specify______________________________________

41. What type of problem do you have during threshing of teff?
______________________________________________________________________________
______________________________________________________________________________
__

42. What amount of yield would be grasped from your cultivation?
_________________________

43. Would you have a plot of land? Yes ☐ No ☐

44. If you say yes question 43, how many oxen of land would you have?
_______________________________

45. How you get farmland? rent ☐ government grant ☐ family grant ☐

46. If it is rent, what is its price per hectare per year? ___________________________________

47. For what purposes would you grow?
Animal forage ☐
Home food ☐
Sale ☐
All ☐

48. If you say sale and all in question 45, what is the price of your teff per kilo? _______________

49. Was there appropriate rain for the production of teff? ☐ Yes ☐ No

50. What the farmer should be done to improve productivity?
______________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
___

51. What should be the role government in teff production and productivity improvement?______
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

52. What should the role of NGO's ___________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_____________________________________________________________________________

## DECLARATION

I, Lema Urge, declare that **"Determinants of Teff Production and Productivity of Small Holder Farmers: The Case of Adea Berga Woreda, West Shewa, Oromia, Ethiopia"** is my own work. I have under taken research work independently with the guidance of research adviser. This study has not been submitted for any degree or diploma, in this or any other institution.

Declared by: Lema urge

Signature: ______________________

Date: ____________________

Place: Adama, Ethiopia

Advisor: S.V. RAO (PhD)

Date: ____________________