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DETERMINANTS OF AGRICULTURAL PRODUCTIVITY AND RURAL HOUSEHOLD INCOME IN ETHIOPIA

THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES OF WOLKITE UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR AWARD OF THE DEGREE OF MASTER OF SCIENCE IN ECONOMICS (DEVELOPMENT ECONOMICS)

By: BIRHAN GIRMA

WOLKITE ETHIOPIA

JUNE, 2018

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JUNE, 2018

WOLKITE, ETHIOPIA

DECLARATION

I, Birhan Girma Tafess, declare that this Msc. Thesis entitled "The determinants of agricultural productivity and rural household income in Ethiopia" is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references. I also declare that this work has not been submitted before for any other degree at any other institution.

Researcher's Name June, 2018 Signature

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CERTEFICATION

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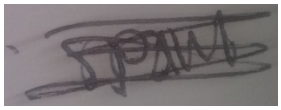
Co- Advisor: Mekdes Shewangizaw (Msc.) Signature  Date: June, 2018.

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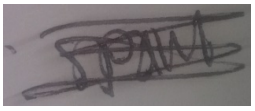
Co- Advisor: Mekdes Shewangizaw(Msc.):Signature  Date:June___, 2018.

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ABREVIATIONS

ADLI	Agricultural Organization Led Industrialization
CSA	Central Statistical Agency of Ethiopia
FAO	Food and Agricultural Organization
FE	Fixed Effect
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
IFAD	International Fund for Agricultural Development
MOFED	Ministry of Finance and Economic Development
NGO	Non Governmental Organization
OLS	Ordinary Least Square
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PSNP	Productive Safety Net Program
PFP	Partial Factor productivity
RE	Random Effects
R&D	Research and Development
SDPRP	Sustainable Development and Poverty Reduction Program

SSA Sub Saharan Africa

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ABSTRACT

Improvements in the agricultural productivity and rural household's income and identifying the factors contribute to its improvement is very critical for enhancing food security and poverty reduction strategy in Ethiopia. The aim of this paper is to investigate the factors contributing to agricultural productivity and rural households' income differential in Ethiopia. The study used panel data of Ethiopian socio- economic survey collected by Central Statistical Agency of Ethiopia in collaboration of World Bank in the three survey periods of 2012, 2014 and 2016 production years. The study was used econometric models derived from Cob- Doglas production function namely: Pooled ordinary least square (within- group), fixed effects (FE) and random effects (RE) models for labor and land productivity and multiple regression models to identify contributing factors for rural household income differential across regions. And the model output indicated that, irrigation use, number of oxen, non- farm income, and education level of household head, cultivated area, age and amounts of fertilizer used were the significant variables that contribute to farm income differential in the study area. Therefore, the policy implication of the study is that, increasing and proper utilization of the aforementioned variable's should have get due attention to speed up the enhancement of agricultural productivity and rural household income.

***Key words**: Labor productivity, Land productivity; Rural Household income, Rural*

Household Panel Data, Fixed effect model.

Chapter One

1. Introduction

1.1 Background of the Study

Globally, agriculture plays a crucial role in most economies especially those of developing countries. It provides the main source of food, income and employment to the rural populations. Improvement in agriculture and its productivity is fundamental to achieving food security; poverty alleviation and overall sustainable economic development (United Nations, 2015). According to the World Bank (2015), over 70 percent of the world's poor live in rural areas, and agriculture is their main source of income and employment.

Nearly 870 million people out of the world's 7.1 billion, (one out of eight) were suffering from chronic undernourishment in 2014- 2015. Almost all the hungry people (852 million) live in developing countries, representing 15 percent of the population of developing counties. There are 16 million people undernourished in developed countries (FAO, 2014). The World Bank (2015) also estimates that about 2.4 billion people lived on less than US $2 a day in, the average poverty line in developing countries.

According to the World Bank (2015), in Africa, agriculture employs 65 percent of the labor force and accounts for 32 percent of gross domestic product. Agriculture is essential for sub- Saharan Africa's growth and for achieving the Millennium Development Goal of alleviating poverty by 2015. A higher and sustained growth requires attention to five core areas of public action: (i) Facilitating agricultural markets and trade; (ii) Improving agricultural productivity; (iii) investing in public infrastructure for agricultural growth (iv) Reducing rural vulnerability and insecurity, and (v) Improving agricultural policy and institutions. In many developing countries agriculture is a significant source of food for citizens and a means of livelihood for the most vulnerable members. Raising agricultural

productivity is an important policy goal for concerned governments and development agencies. Most literatures seem to conclude that investments in agriculture and rural development, both private and public, stimulate economic growth and development. According to IFAD (2013), good agricultural performance was very important in reducing poverty and hunger rates in the more successful countries. Agricultural growth also has a high poverty reduction pay- off than non- agricultural growth or investments. (World Bank, 20014) Agriculture is the main engine of the economic growth for Sub- Saharan African countries. However, feeding the increasing population of Sub- Saharan Africa is becoming a critical challenge for most of the countries in this area (Owusu et al, 2010, p. 108).

Ethiopia is one of the largest African countries with a population of above 102.374 million people. The country shares boundaries with Eritrea to the north, Kenya to the south, Somalia to the east and Sudan to the west. According to the Central Statistics Agency (World Bank, 20017) of Ethiopia, the majority (83.8%) of Ethiopians reside in the rural areas. Hence, subsistence and rain- fed agriculture is the economic base and means of livelihood of the majority of these people. The contribution of agriculture to GDP in Ethiopia is above the average contribution of Sub- Saharan Africa. The share of the agricultural sector in Sub- Saharan Africa is around 40 per cent. On the other hand, the contribution of the agricultural sector to GDP in Ethiopia is 41 per cent (MOFED, 2012, p. 13).

The government of Ethiopia has tried to improve the performance of agriculture by planning and implementing different strategies. Agricultural Development Led Industrialization (ADLI) is the central pillar of the economic policy of the country. The Sustainable Development and Poverty Reduction Program (SDPRP), a Plan for Accelerated and Sustained Development to End Poverty (PASDEP) and the recent Growth and Transformation Plan (GTP) are some of the development strategies of the government. Agricultural Development- Led Industrialization (ADLI) is a long term strategy in which, at the early stages of development, the agricultural sector is expected to play a leading role in the growth of the economy (MOFED, 2012, p.38). At this stage, agriculture is considered to be the engine of growth to feed large

proportions of the population and thus is a source of input to the emerging industries. In the early stages of economic growth, the major economic activities are related to agriculture which has a strong growth linkage with other sectors (Morris et al, 2014, p. 15).

Supportive policies should be in place to stimulate agricultural production and other income diversification strategies. As clearly stated by Block and Webb (2011, p. 337), constraints such as poor land quality, lack of financial markets and climate variability cannot be improved by farm operators at the household level. Block and Web (2011, p. 337) explained that these are constraints that can be solved by investing resources in income and wealth generating activities. Therefore, these issues were good indicators for assessing the major problems of the rural households. Similarly, there was a need to focus on the determinants of agricultural productivity and rural household income in this study.

1.2 Statement of the Problem

Agriculture is still the key sector in many developing African countries. Its contribution goes to the extent of stimulating other sectors by providing input supply. Ethiopia is one of the countries that allocated at least 10 per cent of its total public expenditure on agriculture which is the NEPAD benchmark for the SSA. Despite the focus of the government on the agricultural sector through Agricultural Development Led Industrialization (ADLI), the rural communities are unable to produce enough to feed themselves. In Ethiopia, many farm households are still unable to feed themselves and are on the list of the Productive Safety Net Program (PSNP).The objective of the program is for farmers to ensure minimum levels of food consumption and to protect the existing assets (Gilligan et al, 2009,). Hence, the aim of this study is to investigate the factors affecting agricultural productivity and rural household income in Ethiopia.

The agricultural sector is the backbone of the Ethiopian economy. It is the leading sector that contributes to the Gross Domestic Product of the country. However, as farming in Ethiopia is uncertain and usually at the mercy of nature, it is

invariably a difficult struggle for the smallholders to make ends meet (CSA, 2009, p. 3).

The government has tried to address the major problems of agricultural production. According to Teshome (2006, p. 17), the focus of the government policy shifted to alternative livelihood activities when it was realized that subsistence farm operators were unable to make a living from agriculture. An assessment of secondary sources in Ethiopia showed a wide gap between expected and actual production of agricultural products. According to the reports of the Bureau of Agriculture and Rural Development of Ethiopia (2014/15), the actual production was just over half of the expected production.

Important resources are being utilized by the Ethiopian government to improve the agricultural productivity and rural household income to alter the state of agriculture in the country. Material resource and human capitals are allocated towards this end. Extension workers, packages or programs, and agricultural inputs are some of the resources that are made available to farmers to change their style of farming and augment productivity (CSA, 2013). Despite of all these efforts of the government, the agricultural productivity and farm household income is still very low in Ethiopia. The major reason behind is mainly the backwardness of the agricultural sector. Using farm technology is enormous for rural households of Ethiopia as land productivity, traditional tools, draft animals and family labor are still the most important factors of production (Beyene, 2004).

Actually here the important question to rise for agricultural policy makers will be, whether the agricultural sector can be made more productive, by achieving more output with the current input level, or achieving the current output with less input usage than is currently observed in Ethiopia. An important step in answering this question is to identify the determinants of productivity enhancement and its components. Significant share (about 98 percent) of Ethiopia's agricultural output comes from small-scale farm households, but subsistence farmers are still operating under traditional practices. This has limited total production that would have been produced in the country if the productivity of the small scale farmers were enhanced either by improving their production capacity or by using modern

technologies or a combination of both.

Even though a positive incremental trend of rural household's agricultural production in the last decades in the country, seasonality of farming activity results in unemployment and underemployment for a significant proportion of the rural labor force during most part of the production year. Actually the 2014 national labor force survey indicates that level of unemployment in rural area is only 3% but this figure doesn't include the underemployment rate, CSA, (2014). But practically the rural farm activity in Ethiopia is not worked the full year rather the crop season. This compiled with other economic and natural factors aggravates the problem of the rural household income in the country.

Most of previous studies are failed to consider which agricultural productivity (land or labor) is the most determinants of the agricultural farm productivity and rural household income at national level. Some of them are focused on district or zonal administrative level and fewof them are on regional level. Off these, all are focused on the total factor productivity which is not appropriate enough to measure the wealth and living standards of the household; others are focusing on the income diversification. Therefore, this study tries to fill this gap and considering the partial factor productivity measurement to indentify through which agricultural productivity indicators, the rural household agricultural productivity and rural household income adversely changes in Ethiopia.

To my knowledge, there is no previous research conducted on the determinants of agricultural productivity and rural household income in Ethiopia even though there are related topics with a different focus and research interests. And most of the studies in these topics are not done at national level rather they cover only regional or woreda level. However, those studies did not address the wide range in determinants of agricultural productivity and rural household income. It is, therefore, logical to assess the determinants of agricultural productivity and rural household income in the study area.

1.3 Objectives of the Study

1.3.1 General Objective

The main objective of this study was to examine the determinants of Agricultural Productivity and rural household income in Ethiopia.

1.3.2 Specific Objectives

This research paper addresses the following specific objectives, and generates policy implications and makes appropriate recommendations

1. To examine socio- economic factors which determine the variation in agricultural productivity and rural household income across- regions
2. To examine the determinant factors of agricultural farm land and labor productivity
3. To examine the most potent productivity to enhance the rural household income.

1.4 Research Questions

This research seeks to identify the factors affecting agricultural productivity and rural household income. Specifically, the study addresses the following main questions

1. What are the socio- economic factors that affect agricultural productivity and rural household income?
2. What are the factors that affect agricultural productivity of land and labor?
3. Which factors of production are the most potent for the change rural Household income?

1.5 Scope and Limitations of the Study

1.5.1 Scope of the Study

The main focus of this study is to investigate the factors affecting agricultural productivity and rural household income in Ethiopia. The research area selected for the study is Ethiopia which is one of East African countries this means the study is undertaken at national level.

1.5.2 Limitations of the Study

As this study is undertaken at national level, there is no limitation in scope. But, because of budget and time constraints, the study will be limited to only the secondary source of data. Related to this, Lack of organized and adequate data is assumed to be one of the limiting factors in this study. This emanates from the poor record handling and lack of willingness of some of the offices to provide the relevant datas. This was a challenge for addressing research objectives which depended on the secondary data.

1.6 Significance of the Study

In the developmental endeavors of different regimes in modern Ethiopia, the agricultural sector has attracted the attention of policy makers. It is the key sector in the current government's development strategy because Agricultural Development Led Industrialization (ADLI) is the national economic policy of the country. Thus, the topic of these study and its findings have national importance. It is also one of the critical topics in the areas of development studies as a discipline.

Specifically, the importance of this study is to find out the real challenges for farmers in the areas of agricultural production. It is assumed to suggest ways of removing the challenges of farm operators at national level. Furthermore, this study will also assumed to serves as the basis for future related research works.

1.7 Structure of the Thesis

The study consists of six chapters as indicated below:

Chapter 1: presents the introductory part which includes sections such as background, problem statement, objectives, research questions, limitations and scope of the study.

Chapter 2: presents the related literature reviewon factors affecting agricultural productivity, and rural household income.

Chapter 3: outlines the research design and methodology section. This section

includes the data type and sources, data processing and analysis and issues of validity and reliability. It also outlines the regression model used in the study.
Chapter 4: concentrates on the presentation and discussion of the results on agricultural productivity and rural household income determinants.
Chapter 5: presents the summary, conclusion and recommendations of the study.

Chapter Two

2. Literature Review

2.1 Theoretical Literature Review

2.1.1 Agricultural Productivity Measurements Theories

Agricultural productivity refers as the output produced by a given level of input(s) in the agricultural sector of a given economy (Fulginiti and Perrin 1998). More specifically, it can be defined as "the ratio of the value of total farm outputs to the value of total inputs used in farm production" (Clayide and Heady 1982). However, agricultural productivity can be measured by partial productivity or total factor productivity measures depending on the number of inputs under consideration

Total factor productivity is also defined as the ratio of an index of agricultural

outputs to an index of agricultural inputs. The agricultural output index is a value-weighted sum of the whole components of agricultural production, whereas, the agricultural input index is the value-weighted sum of the whole conventional agricultural inputs such as fertilizer, land, labor, machineries and livestock.
However, it is difficult to aggregate variety of outputs and inputs into a single index to measure productivity (Ruttan 2002). This approach is also overstates or understates productivity of inputs when input ratios change without a change in technology (Gebreeyesus 2006). Markets are also not well-functioning in the case of aggregating output and input. For example, if the market of land and labor are not well functioning, rental values and wage rates for hired labor cannot be measured with accuracy and hence TFP measure becomes intractable. This idea is supported by Kelly et al, (1995) and finds that TFP calculations in many areas of Africa is constrained by missing input prices (from missing markets), especially for land and manure and to a lesser extent for labor. As a result of these limitations, this study is considering the partial measure of agricultural productivity to address its objectives.

Partial measures of agricultural productivity are the amount of output per unit of a particular input (Diewert and Nakamura, 2005). It is commonly used partial measures yield (output per unit of land), labor productivity (output per economically active person (EAP) or per agricultural person-hour). Yield is commonly used to evaluate the progress of new production practice or technology (Wiebe et al, 2003; Zepeda, 2001). And Labor productivity is mainly used for measuring as comparing the productivity of agricultural sectors within or across the rural households. It also used to measure the rural living standard or welfare indicator as it reflects the capacity to making income through sale of agricultural production. Partial measurement of productivity is a key element towards assessing standards of living. A simple example is per capita income, probably the most common measure of living standards: income per person in an economy varies directly with one measure of labor productivity, value added per hour worked. In

this sense, measuring labor productivity helps to better understand the development of living standards (OECD, 2001).

Partial measures of productivity index also have a limitation that, it may not account for all the inputs used in production process. However, carefully constructed partial measures are applied to measures output that attributable for variations in measured factors (Alston, Anderson, and Pardey 1994). This study is considered both land and labor productivity measurements to evaluate the progress of farm production practice and the change of income per household in rural household. The stochastic front production function can be specified through the use of the Cobb- Douglass or translog production functions (Biggs 2007; Zhang and Fan 2001) used for the measurements. The Cobb- Douglass production function is a simple tool which can handle multiple inputs in its generalized form. However, use of Cobb- Douglass production function also its own limitations due to its restriction on the elasticity of substitution (Kim 1992).

Therefore alternatively, translog functions are more sufficiently flexible to use. Since it allowus for the estimation of various partial elasticities of substitution for any number of inputs, (Zhang and Fan 2001). Because it doesn't imposes a restrictions on elasticities of substitution and returns to scale and also the Cobb-Douglass production function has both linear and quadratic terms which enable for using more than two factor inputs (Kim,1992). But, the variables in such a specification are highly correlated and hence the choice among Cobb- Douglass and translog has to be based on the overall goodness of fit and other diagnostic results such as multicollinearity and Heteroskedasticity.

2.1.2 Rural Household Income Measurements Theories

The conceptual framework for the rural household income measurement is drawn from the Sustainable livelihoods framework (SLF). In the SLF framework, assets, all activities, and their access, are altogether are required for a means of living by an individual or a household to construct a livelihood (Chambers and Conway, 1991). The framework shows how, in different contexts, sustainable livelihoods are achieved through access to a range of livelihood assets which are combined in the

pursuit of different livelihood strategies to achieve certain livelihood outcomes such as increased incomes (Alinovi et al., 2010). Households can access a range of assets or resources (physical, natural, economic, human and social capital) which they can use to engage in farm or non- farm activities or both (Scoones, 1998).

The decision of rural households to participate in nonfarm activities is influenced by individual or household specific factors, as well as other social, economic and environmental factors (Barrett et al. 2001; Barrett, Reardon and Webb 2001; Escobal 2001;Lay et al. 2008; Idowu et al. 2011; etc). Various social relations, institutions, organizations, policies, as well as trends, shocks and seasonality modify access to and ability to convert livelihood assets into livelihood outcomes (Vedeld et al., 2012). As regards seasonality; in the dry season, especially in semi-arid regions some rural households obtain remittances from seasonal migrants, incomes from local nonfarm activities and, cash from the sale of crop and livestock products (Reardon 1997; Ellis 1998). While some farm households can also allocate part of their labor during the rainy season where nonfarm labor pays better than farming and where farm households can count on food markets to buy food (Reardon 1997). However, the rural household income could be measured using Ordinary least square (OLS), feasible generalized least square (FGLS) and two stage least square (2SLS) measurement technique.

2.1.3 Agricultural Output Growths and Productivity Growth

Much of the discussion in previous sections is in terms of output growth, rather than productivity growth, which is the growth in output per unit of input(s). Binswanger (1989, 1994) has long argued that in the long run agricultural supply response at the sector level is not possible without productivity growth. There are

partial productivity measures, most commonly, yield (land productivity) or labor productivity, and total factor productivity, which is outputs (aggregated with appropriate weights) per unit of all inputs (again aggregated with appropriate weights). Inputs and outputs may be in physical terms or value terms at constant prices, which is essentially the same thing. Each serves its purpose but the measures will usually differ. (Todaro, 2011).

The distinction between the output and productivity growth is not important for some of the effects, but for others it can be crucial. The two can also have opposite signs; for Hungary, during the transition of the early 1990s, liberalization led to a 25% increase in productivity while output fell by15%. Productivity gains that come from input reduction may in fact reduce output and this has indeed happened in SSA as liberalization and subsidy reduction has reduced the use of modern inputs in some areas.

A newcrop technology may reduce input use, raise yields, raise labor productivity, or in the case of say a short- season maize variety, allowthe cultivated area to be expanded. The first will increase profit, but not output and may reduce employment; the second will increase output and probably employment, but not necessarily profits; the third will raise the remuneration of labor, but probably at the expense of employment and the output effect is indeterminate. The last may raise output, employment and profits, but could well lower yields. A physical increase in productivity may vanish, if output is in value terms, due to the fall in the output price.

The relationship between labor and land productivity can be stated as an identity: where Y is output, L is labor, and K is Capital. Thus, labor productivity can be decomposed into the product of land productivity and the inverse of labor per unit of land. Land area per worker (A/ L), can be increased by animal power and technical improvements in machinery and equipment, which allow power to be substituted for labor. This process may be called mechanical technical change. Similarly, biological advances, such as high- yielding, fertilizer- responsive seed

varieties, raise the average product of land (Y/A) and may be referred to as biological/chemical technical change However, in the investigation which follows, the ratio of land to labor, taken from the FAO/World Bank statistics, is better viewed as an indicator of the land endowment of the countries in the sample, as these differences can otherwise dominate any measurement of productivity change. Bryman, A. (2014).

Public sector agricultural R&D is tends to be yield- increasing. The conditions under which yield enhancing technologies are likely to have equitable on- farm benefits are now reasonably well understood. These include a) a scale- neutral technology package that can be profitably adopted on farms of all size; b) an equitable distribution of land with secure ownership or tenancy rights; c) efficient input, credit and product markets so that farms of all sizes have access to needed modern farm inputs and information and are able to receive similar prices for their products; and d) policies that do not discriminate against small farms and landless laborers (for example, no subsidies on mechanization, or scale- biases in agricultural research and extension). These conditions are not easily met, and it typically requires a concerted effort by government to ensure that small farmers do have fair access to land and needed knowledge and modern inputs so as not to be left behind. Whilst this is useful, the literature on R&D and technology has always pointed out that agricultural research is a very blunt instrument for alleviating poverty. R&D is essential to achieve the necessary output growth, but it unlikely to solve the distribution problems. However, it is more likely to achieve this if the suggestions above are given serious consideration.

This literature review identifies the linkages between increases in agricultural productivity and poverty reduction. The evidence suggests that there are multiple pathways through which increases in agricultural productivity can reduce poverty, including real income changes, employment generation, rural non- farm multiplier effects, and food prices effects. However, barriers to technology adoption, initial asset endowments, and constraints to market access may all inhibit the ability of the poorest to participate in the gains from agricultural productivity growth.

2.2 Empirical Literature Review

2.2.1 Agricultural Productivity and Rural Household Income in Developing Countries

Literature reviewed showed that agricultural productivity increases more in developed countries compared to less developing countries. This is due to high investment in research and development, labor, land and capital and improvement in the use of inputs such as fertilizer, machinery increases and others. It must be notice that Agricultural productivity depends primarily on technological change, improved input use efficiency and conservation of natural resources. These in turn, depend crucially upon investments in agricultural research, extension and human capital.

Agricultural growth may reduce poverty through direct effects on farm productivity, incomes, and employment. It may also generate indirect impacts on the welfare of rural households through the growth linkage with the non-farm sector as well as through its impacts on food prices (Adeoti and Sinh, 2009; Bezemer and Headey, 2008; Byerlee et.al., 2005; Popli, 2010;). There have been arguments that the poor typically spend a high share of their income on staple food; therefore, they benefit from a decline in the price of staple food induced by agricultural productivity improvement.

In Asia, Chang et al (2001) determined how to promote agricultural productivity growth to achieve sustainable food security. The study looked at the role of investment, both in physical and human capital, in maintaining and increasing agricultural productivity. By using TFP and partial factor productivity functions they found that, the only way to promote agricultural productivity was through improving labor productivity. Due to the improvement in labor productivity, the agricultural output growth for these countries has remains positive from the period of 1961 to 1994. According to Haji, (2008), increased productivity in agriculture has a number of advantages. Firstly, it increases the flow of resources from one

sector to the other, thereby enhancing economic growth. Secondly, a higher level of agricultural productivity results in lower food prices that increase consumers' welfare. Thirdly, productivity growth improves the competitive position of a country's agricultural sector.

Zepeda (2001) by using number of models of production growth (index numbers or growth accounting techniques, econometric estimation of production relationships and nonparametric approaches) to measure the change in output, to identity the relative contribution of different inputs to output growth and to identify the Solow residual or output growth not due to increases in inputs. He founds that a relatively weak relationship between physical capital and growth, as compared to investment in technology and human capital. Fulginiti et al (1998) using the data of eighteen developing countries over the period 1961–1985 to examined the changes in agricultural productivity. The study used a non parametric, output based malmquist index and a parametric variable coefficient Cobb-Douglas production function to examine, whether declining agricultural productivity in less developed countries was due to use of low inputs. Econometric analysis indicated that most output growth was imputed to commercial inputs like machinery and fertilizers.

Another study made by Byerlee, Diao and Jackson (2005), Winters, McCulloch and McKay (2004), and Bezemer and Headey (2008) argued that interaction of productivity growth, farm income, employment, and food prices could lead to a pro-poor outcome depending on two key conditions. Firstly, agricultural productivity per unit of labor must increase to raise farm income, but agricultural productivity per unit of land must increase at a faster rate than that of labor in order to raise employment and rural wages. Secondly, increased total factor productivity (TFP) in agriculture must result in a decrease in real food prices, but the TFP must increase faster than food prices decrease for farm profitability to rise and for poor consumers to benefit from lower food prices.

Thomson et al (2004) indicated four transmission mechanisms when there is an increase in agricultural productivity to progress the poverty reduction in rural households. These four transmission mechanisms are the direct impact of improved

agricultural performance on rural incomes; an impact of cheaper food for both urban and rural poor; an agriculture's contribution to growth and the economic opportunity in the non-farm sector; and agriculture's fundamental role in stimulating and sustaining economic transition as shift from being primarily agricultural towards a broader base of manufacturing sector and services. Tripathi et al (2008), they study Indian agricultural productivity growth by using Cobb-Douglas production function, argued that an improvement in not only labor but also capital and land productivity can improve agricultural productivity. Their results indicated that output elasticity of land was 1.98, labor 1.06 and capital 0.15 and when added up they gave a sum greater than one. This meant that labor and land inputs had positive and significant influence on agricultural productivity growth.

Rao and Chotigeat (1981) studied the relationship between size of land holdings and agricultural productivity. They used the GLS regression technique to estimate a translog function to formalize the relation between output and inputs. Their study was conducted using farm level data from several states in South India over the period 1962 to 1970. The study finds that there was no systematic relationship between the measures of productivity and land size. They also indicated that capital had a positive effect, land and labor, a negative effect on the elasticity of gross value of output per unit of land. However, large capital infusion canceled out the negative effects of land, and led to a positive relation between land- size and productivity.

Another study made by Venkatensan and Kampen, (1998) stated that, the growth in agricultural production in Sub Saharan Africa in the past was achieved by expanding the amount of land cultivated, but today there is litter scope for increasing the area under cultivation. Further increase in agricultural production in the area could be achieved only by increasing the productivity of land and labor. Wiebe et al (2001) in their study on "Agricultural policy, Investment and Productivity in sub-Sahara Africa (SSA)", argued that an expected increase in output from improved infrastructure and price policies were difficult to quantify, but such improvements were probably prerequisites to make possible the increases

in productivity from the use of conventional inputs and research. The study concluded that education of rural labor force and agricultural research is needed to improve the future prospects for productivity growth in SSA. Owuor, (2000), study partial factor productivity measurement by using cob- Douglas production function method; founds that the determinants of family labor productivity are consistent with those of land productivity in Kenya. Agricultural land and family labor productivities are positively correlated and significant (0.64, 0.01) respectively.

Most of the literature suggests that rural household income is increases trough agricultural farm land and agricultural labor productivity. This could be due to the fact that, agricultural productivity has a positive impact on real rural household incomes. This idea is consistent with Blunck, (2006) argued that a high standard of living can be sustained by improvements in agricultural productivity, either through achieving higher productivity in existing farms or through successful entry into higher productivity farms. Another literature shows that the standard of living or household wealth in most nations is determined by productivity with which a nation's human capital and natural resources are deployed and the output of the economy per unit of labor and/ or capital employed (Porter, 2001; Blunck, 2006).

2.4.2. Agricultural Productivity and Rural Household Income In Ethiopia

It is important to identify factors that influence on agricultural productivity in Ethiopian agriculture because these factors would automatically have indirect impacts on the poverty incidence if the force of agricultural productivity to the household income is significant. The determinants of agricultural productivity in particular country are different and distinctive from others. This section would refer to some studies in indicating of determinants of agricultural productivity rural household income in Ethiopia.

By using a cross- sectional data, a study conducted in walaita and Gemugofa zones

of South nation, nationalities and people of Ethiopia for assessing productivity and technical efficiency of smallholder farmers, shows that, there was significant level of productivity improvement among maize producing farmers (Geta et al., 2013). They were used a two stage estimation technique, translog production function to determine the levels of productivity and Tobit regression model to identify factors influencing technical efficiency. The model result depicted that productivity of maize was significantly influenced by the use of labor, fertilizer, and oxen power.

Another literature studies by Berg and Kumbi (2006) were suggested that agriculture was the main source of rural income inequality in Oromia national states of Ethiopia. Their results showed that 90 percent of total inequality was due to farm source of income. On the other hand, nonfarm income was found to be inequality decreasing source of rural income. As Adugna (2002) identifying the determinants of household income in rural households of Ethiopia indicates that, the household demographic characteristics like family size, educational status of the household head and sex of the household head is determining the income of the household to enhancing or to lowering. The study conducted by Bogale, Hagedorn and Korf (2005), in the assassination of the determinants of poverty in rural Ethiopia shows that cultivated land per adult in the household, the living geographical locations of the rural household, educational status of the household head and owning of oxen are significantly important determinants for holding the household resource endowments or households are deprived from basic livelihood assets.

Another study made by Endale, (2011) by using the panel data of cereal crops and translog estimation technique followed by FGLS for the fixed effect estimation, founds that the land size and family labors are significant for agricultural productivity in the study area of four regional state of Ethiopia.

The study made by Gebru and Holden (2013), for the aim of investigating productivity difference among land certificate owner and non owner in Tigray Regional state of Ethiopia by using DEA based on malmquist productivity index, founds that on aggregate farmers those who are not owned the land certificate

are less productive than those who are already owned the land certificate. The study also found no evidence to suggest that, the agricultural productivity difference between the two groups is due to difference in technical efficiency.

2.2.2 Factors of Agricultural Productivity and Farm Income

The structural adjustment program and the policies of Washington Consensus rejected pectoral policies that focused on the macro fundamentals and promoted the significant role of market forces. Conversely, in the case of Africa, agriculture has suffered from major market failures and there was a need for government intervention to ensure growth and development which was ignored by the Washington Consensus (de Janvry, 2010, p. 32). There are views that the Green Revolution in Africa should be designed differently from others because African in general and Sub-Saharan Africa in particular, have mainly a rain-fed agriculture and varying agro-ecological conditions (de Janvry, 2010, p. 32). In order to achieve the Millennium Development Goals of eliminating hunger and poverty, the growth of the agricultural sector is vital.

2.2.2.1 Household Characteristics of Farm Operators

The household characteristics consist of many variables that affect the agricultural production of farm operators. Some of these variables are: age, gender, education level, family size, landholding size and possession of oxen, as reviewed below.

2.2.2.2 Education and agricultural production

Research findings have indicated the importance of education in agricultural production and income. The contribution of education to the growth of national income was recognized in the 1960s.To achieve agricultural development, the investment in production techniques and technology should be supported by a comparable investment in human capital. This is because information and knowledge are prerequisites for farmers to adopt technology, access input, change ways of doing things and market their produce (Chowa, Garforth, &Cardey, 2012, p.

8).

Formal education enhances farmers' engagement in environmental programs and methods for the sustainability of agriculture. Education is also believed to stimulate economic growth by enhancing the productive capability of farmers as well as eliminating the customs that are contrary to growth such as traditional word-of-mouth communication methods (Asfaw, &Admassie, 2004, p. 216). If there is inequality in educational endowments, the returns from irrigation are likely to remain low for poor farmers, thereby supporting the notion that "knowledge poor will remain income poor". There is agreement that the accumulation of knowledge through education is an important factor for economic development (Asfaw, &Admassie, 2004, p. 216).

2.2.2.3 Gender and Agricultural Production

In enhancing agricultural production and income, the full participation of men and women is very important. Women tend to be the major players in the farm labor force engaged in production, harvesting and processing activities. It is also known that the majority of food is produced by women farmers and they are responsible for fulfilling the basic needs of the family. Studies have also indicated that women farmers are more environmentally conscious compared to men farmers (Asfaw, &Admassie, 2004, p. 216). Nevertheless, there are research findings that indicate the existence of gender inequalities in the agricultural sector. Researchers are also interested in investigating the productivity differences between male and female headed households. In this respect, researchers found mixed results.

2.2.3 Age, Family Size, Landholding Size and Agricultural Production

Agricultural production is influenced by other household characteristics such as the farm operator's age, family size and landholding size. The age of the household head is a proxy variable for the farming experience of farm operators. Farmers are highly dependent on their previous knowledge of farm practices in cultivating different crops. Hence, experienced farmers are expected to enhance

the productivity of their holdings. However, it is not without limit as older farmers lack the required physical strength on the farm and lowers the probability of technology adoption (Asfaw, &Admassie, 2004, p. 216).

Land is the most critical natural resource for countries like Ethiopia where the agricultural sector is the engine of the national economy (Amsalu, Stroosnijder, & de Graaff, 2006, p. 448). Farm operators with larger landholding sizes would have a better farm income if sufficient family labor was available. This leads to an increased demand for children who can work on the land. It is not possible to expand the landholding size without matching it with an increase in the size of the household. Hence, households with larger families face a challenge to feed each of the family members and this will have its own negative effect on the nutritional status of the family

2.2.4 Possession of Oxen and Agricultural Production/ Income

Historically, for thousands of years, oxen have been recognized as the first draft animals to serve human beings, to cultivate land and pull heavy loads. The possession of oxen determines the farming ability of farm operators because if farmers do not have oxen they would be appreciative to rent out their land to other farmers (Gilligan, Hoddinott, &Taffesse, 2009, p. 106). In this case, farmers would enter into sharecropping. This further diminishes the production and income of the household as the yield is shared with oxen owners. There are advantages associated with owning oxen. Oxen owners can cultivate and implant their land at the right time. This has a positive impact on the productivity of land. In addition, oxen could also be rented out on a daily payment basis to till the land for other households. Therefore, they may serve as a source of additional income for the owners.

2.2.5 Agricultural Production Technologies

Agricultural production technologies include biological and chemical technologies. Specifically, these technologies include chemical fertilizers, selected seeds or High

Yielding Varieties, irrigation and soil quality enhancing technologies. Farmers use these technologies in order to enhance the production (income) and productivity of the land. It is also indicated that, for poor farmers, adoption of technology places newdemands on their limited resource base (Adenew, &Abdi, 2005, p. 24).

2.2.5.1 Chemical Fertilizer and Improved Seeds

African governments have promoted the increasing use of agricultural inputs in their own countries. The objectives of input promotion strategies have many features such as financial, economic, social and political objectives. The financial aspect of the input promotion strategy is to increase the net income of farmers, traders or other participants in the agricultural economy. The economic feature of input promotion strategy is also to increase the real income of the society as a whole. The social aspect of the input program is the improvement of welfare indicators that are difficult to measure in terms of monetary values. Some of the social objectives are to improve nutrition intake and national food self-sufficiency. The political objective of the input program arises because of the government intervention for the sake of equalization of benefits. Some programs may be designed intentionally to build political support; as a consequence, they may benefit one or more groups at the expense of others.

The application of fertilizer in sub-Saharan Africa (SSA) is considered as the lowest rate in the world.This is a clear indication that the intensification of African agriculture remains a critical development challenge because the fertilizer application in a hectare of land in SSA is belowstandard (Crawford et al., 2003, p. 281). The insufficient use of fertilizer in Africa has resulted in the area productivity being belowthe world average. The major reasons for lowfertilizer use could be because of demand and supply factors (Crawford et al., 2003, p. 285). On the demand side, farm households may not accept the profitability of fertilizer use; alternatively, they may accept it as profitable but too risky in financial terms. Other possible reasons for lack of profitability could be due to high input prices or lowoutput prices because of high transportation costs, policy interventions or non-

competitive behavior of marketing agents. The problem may not be profitability but rather the inability of farmers to pay for goods and services due to limited access to credit to finance fertilizer purchases (Crawford et al., 2003, p. 285).

On the supply side, the high costs at the source by importers and local manufacturers may limit the access to fertilizer. In addition, inadequate arrangements for financing the purchase of fertilizer by importers and traders, poor port, rail and road infrastructure, transportation costs and non- competitive behavior of suppliers may also affect the supply of fertilizer (Crawford et al., 2003, p. 285).

2.2.5.2 Irrigation Facilities

Irrigation is one of the critical inputs in agriculture which benefits the socio-economic status as it leads to poverty reduction. However, irrigation can also trigger socio- economic upheavals when it causes problems such as disease, land degradation, water pollution and destruction of living beings and natural ecosystems (Hussain, &Hanjra, 2004, p. 4). Hussain&Hanjra (2004, p. 4) further stated that poor populations are most affected by the potential negative effects of irrigation. Access to good irrigation allows the poor to increase production, gives them opportunities to diversify their income base and reduce their vulnerability to the seasonality of agricultural production and external shocks (Hussain, &Hanjra, 2004, p. 4).

2.2.5.3 Crop Rotation and Intercropping

As declining soil fertility is a major challenge for Sub- Saharan Africa, farmers in Nigeria use shifting cultivations as a means of sustainable agriculture. Crop rotation is a regularly recurrent succession of different crops on a given plot of land (Tulu, 2011, p. 57). Intercropping is another practice of cultivation used by farmers to improve soil quality and productivity. The aim of intercropping is to enhance the yield of farm land by using resources that cannot be used by a single crop. Intercropping is becoming crucial for increasing crop productivity and

fulfilling the food requirements of the world's growing population (Karlidag, &Yildirim, 2009, p. 108).

2.2.6 Agricultural Credit

Agricultural credit is described as banking finance for primary production, processing and trade of agricultural products, and the production and distribution of inputs (Aggelopoulos, Mamalis, &Soutsas, 2011, p. 234). Poor farmers have very little chance to borrow from the formal sector because they rarely have collateral acceptable to banks. They may not have clear title deeds for the land they cultivate but even if they do, rural land markets may not function well enough for land to be considered a "bankable" asset (Kindness, &Gordon, 2001, p. 29).Smallholder farmers may have access to credit from Micro-credit institutes which do not have the collateral requirements. Micro-credit schemes are often associated with group lending where peer pressure is an effective substitute for collateral and group members may take action to prevent one member from defaulting (Kindness, &Gordon, 2001, p. 29).

There are different views regarding the involvement of governments in agricultural development. One view is that the involvement of the governments in the economy results in a danger of rent seeking and corruption (Gilligan, Hoddinott, &Taffesse, 2009, p. 134). In this regard, the focus of the structural adjustment program in Sub-Saharan Africa was to get governments out of agricultural credit, input supply and reduce or eliminate agricultural subsidies (Bingen et al., 2003, p. 406). This was because government support policies such as commodity and input subsidies were financially unsustainable and contributed to the macroeconomic crises seen in the 1980s (Crawford et al., 2003, p. 278). The stagnation of the economic growth and the increasing deficit of state budgets in this period led to the adoption of stabilization and structural adjustment plans.

The adoption of the structural adjustment program was considered as a paradigm shift from the widely accepted idea that the government "could solve the problem", in the 1960s and 1970s, to the government "is the problem" in the 1980s (Crawford

et al., 2003, p. 278). After structural adjustment programs were implemented in many countries, non- governmental organizations provided micro- finance services in the rural areas to fill the gap caused by the abolishment of the agricultural credit previously provided by the government. The credit provided by the NGOs was criticized as the loan periods were too short and the amount of the loan too small for agricultural investment (Bingen et al., 2003, p. 406).Hence, farmers were reluctant to apply yield- enhancing technologies because they were afraid of risks such as drought, pest attacks and unstable prices.

The other concern was the state intervention and support program to ensure agricultural transformation. Avoiding government assistance (to avoid rent seeking and corruption) is similar to throwing away the baby with the bath water (Bezemer, &Headey, 2008, p. 1346). It is the neo- liberal paradigm advocates who argue that the role of the government in the economy should be limited to the protection of individuals and property rights, the enforcement of contracts voluntarily entered into and the safeguarding of competition among economic actors.In a similar context, found that the development of cotton production in Mali was highly supported by government policies such as credit, input distribution and guaranteed prices. Developed countries continued to subsidize the agriculture sector regardless of the imposition of structural adjustment programs in the developing countries. (Zenawi, 2012, p. 140)

2.2.7 Environmental Factors

Environmental factors influence agricultural production and therefore the income of farm operators. The environmental factors included in this review are rainfall, erosion, vegetation and soil type of the area. The extension and intensification of agriculture has contributed to climate change by accounting for between 25and 30 per cent of global greenhouse gas emissions (Zenawi, 2012, p. 140) stated that one of the causes of the reduction in productivity and environmental quality is the intensive land use of farm operators. The extent of rainfall is one of the critical factors that influence the agricultural production of

farmers. The erratic nature of rainfall makes rain fed agriculture unreliable for farmers and it is for this reason that the agricultural productivity of rain fed areas is lower than irrigated areas (Bewket, 2011, p. 54). Ethiopia has a rain-fed agriculture therefore production is sensitive to variations in rainfall.

2.2.7.1 Erosion and Vegetation

Soil erosion is one of the challenges of agricultural productivity especially in areas where there is poor vegetation cover and the soils are not resilient. In Ethiopia, soil erosion has contributed to the existing problem of food insecurity and is becoming a real threat to the sustainability of the country's dominantly subsistence agricultural system (Bewket, 2011, p. 54).

2.2.8 Physical and Institutional Infrastructure Facilities

In the physical and institutional infrastructure facilities, roads and extension services are reviewed below.

2.2.8.1 Roads Infrastructure

Roads are major physical infrastructures that allow people and goods to move faster and easier. Roads provide new possibilities for people to access different areas and reduce segregation (Barrios, 2008, p. 12). Hence, improving rural roads helps rural communities to engage with the market economy and lift themselves out of poverty (Warr, 2010, p. 152). The majority of poor people live in the rural areas which have lowlevels of road infrastructure (Warr, 2010, p. 152). As a result, farmers are hindered from building links that may improve their livelihoods. It also increases the transportation cost for farmers to sell their products, purchase consumer goods and exploit the opportunities of off-farm activities (Warr, 2010, p. 152).

2.2.8.2 Extension Facilities

The main task of extension agents is to support and encourage farmers to enhance their productivity (Adesoji, 2009, p. 335). They are responsible for translating the

findings of the research institutes to the farmers and sending the agricultural challenges of farmers back to the research institutes (Ajani, &Onwubuya, 2013, p. 19). Farmers also have the opportunity to influence the research agenda for the research institutes to focus on relevant outputs (Kibwika, Wals, &Nassuna-Musoke, 2009, p. 9). Hence, the extension agents attempt to improve the livelihood of farmers by transferring research based knowledge to the agricultural sector (Rivera, 2011, p. 165).

The communication approaches and channels used by the extension agents influence farmers to adopt new innovations (Akinbile, &Otitolaye, 2008, p. 343).Worth (2006, p. 182) reported two major schools of thought related to agricultural extension. The first one considers extension as the transferring of technology and the second considers it as part of the human development program. Worth further illustrated the importance of the extension agents being cognizant of the objective of extension whether it is to develop the agricultural sector or the people.

The doubtful and traditional view of extension services and agents is that extension agents are government agencies whose activities are to distribute any information they are told to deliver without the required motivation and training (Christoplos, 2012, p. 188). A study conducted in China by Hu, Yang, Kelly and Huang (2008, p. 305) indicated that extension agents are assigned duties which are not related to agricultural extension such as family planning, budget management, elections, fire protection, legal matters and others.Hu et al. (2008, p. 305) also found that extension agents whose primary duty is to provide agricultural extension services to farmers spent less than one-third of their working time on extension related activities.

According to Kibwika et al. (2009, p. 10), agro-ecological conditions are changing and the needs and concerns of farmers are dynamic therefore fixed packages which are provided to farmers are becoming less appropriate as the result of increasing climate variability and unpredictability. Extension services which follow

the path of "business as usual" may be challenging to farmers (Christoplos, 2012, p. 188). To be effective, the extension services need to focus on the way the services are delivered and the socioeconomic and agro- ecological conditions of farmers (Asfaw, A., &Admassie, A. 2014, p. 42).

The country's agriculture is characterized by smallholder farming. Yields are uniformly low across all the country. The smallholder farmers lack transport, inputs and technology to help them increase their production and reduce pests and disease. They also lack access to financial services, to give them capital for improving and expanding their productivity. The poor performance of agriculture is also exacerbated by poor implementation of agricultural support programs and the neglect of the sector in development priories by the government. Neglect of agriculture and the bias towards investment in urban industrial economy can be traced historically to the misplaced emphasis on rapid industrialization via import substitution and exchange rate overvaluation. (Todaro, 2011)
The modest increases in aggregate crop production have been achieved from the expansion of cultivated land rather than increased investment in production technologies to raise crop yields per unit area of land. As access to land is increasingly constrained by high population growth, further expansion of cultivated land will be unsustainable. Although literatures indicate that agricultural productivity growth is effective in reducing poverty and enhancing economic development, the effects are so varied and unclear on economic development across many developing countries including Ethiopia.

Despite the fact that, the agriculture sector is mostly vulnerable in seasonal rain fall, the rural households are generating their family income from difference sources to averse the risk associated in agricultural farm sector. As a result the main source of income in most rural household of Ethiopia is derived from farm and non- farm activities. Agriculture is the primary source of rural income as 80% percent of the rural labor force is engaged in this sector (CSA, 2015). Non- farm income of the rural household referred to an income that the rural households generate from none of crop or livestock production during a one year of

agriculture production period. Non-agricultural activities are not getting prevalence in rural Ethiopia because households are rarely practicing dominated by a subsistence agriculture sector. As a result of this, the income from nonfarm activity is also very low. This subsistence agriculture and low level of rural household income is socially and economically could make unstable the rural society. Therefore, it is significantly important to identify the determinants of agricultural productivity and find the methods of the rural household income improvements.

Whilst this is useful, the literature on R&D and technology has always pointed out that agricultural research is a very blunt instrument for alleviating poverty. R&D is essential to achieve the necessary output growth. However, it is more likely to achieve this if the suggestions above are given serious consideration. Most of the studies regarding agricultural productivity and rural household income are done at woreda level, and this is one of the gaps of previous studies. Therefore, this study tries to fill this gap by doing national level study using country level panel data collected for three survey period of 2012, 2014 and 2016 by central statistical agency (CSA).

By considering the above literature reviewed, this study result contributes for the future literature in Ethiopia on the following points:

- ✓ It could contributes the factors that determines farm productivity in rural households of Ethiopia
- ✓ It could contributes the factors that determines the rural household income in Ethiopia

CHAPTER THREE

3. Data and Methods

3.1 Introduction

In assessing the determinants of agricultural productivity and rural household income in the study area, quantitative research techniques are used in the study. The type and source of data are explained. The dependent and independent variables of the models used in the study are properly explained and operationalized. The methods of data processing and analysis as well as the measures that have been taken to address the issues of validity and reliability are part of this chapter.

3.2 Data Type and Data Sources

The focus of this study is to investigate the determinants of agricultural

productivity and rural household income in Ethiopia. To this end, a quantitative research method was used. The application of these research methods is vital for answering different types of research questions. In a quantitative study, the focus is on the relationships between the different variables under consideration. The major determinants of agricultural productivity and rural household income are the household characteristics, technologies, credit markets, environmental (soil and climate) and rural infrastructure facilities (Endale, 2011, p. 23).

The data for this study was secondary data and obtained from the survey of Ethiopian Rural Socioeconomic survey (ERSS), conducted by Central Statistical Agency (CSA) in collaboration of world bank in full sample coverage at National level which is panel data collected for three survey period of 2012, 2014 and 2016. This data contains two part namely agriculture and households different socioeconomic characteristics. The agriculture part contains cultivated land area the types of input used, crop production in quintal and Livestock production of the farm households. The Household socio- economic characteristic contains household borrowing, lending, from where they borrow and to whom they lend, food consumption items, the income from different source including remittance and source of their income, educational status of the household members and household demographic characteristics etc. This socioeconomic survey also asked the number of household asset, the loan amount of money in cash or in kind that the household received, time of repayment, if the household repay on time or not and the amount will be paid back and the reasons for those who don't get loan etc.

3.3 Methods of Data Analysis

The data from the survey were entered into STATA Software for analysis. In the analysis of the data, descriptive statistics and econometric models were employed. Descriptive statistics such as Mean tabulation, percentages and frequency distribution was used to analyze in detail. In order to determine the influence of independent variables on the dependent variables, the log- linear of Cobb Dauglas production function model is used for the determinants of agricultural

productivity and multiple regression models were employ for the estimation of the determinants of rural household income.On top of that F- test and Chi- square statistics is implemented to measure the mean and percentage difference between productivity and income of the rural households.

3.3.1 Econometric Models Specification for Agricultural Productivity

The econometric models that will use in this research are based on the scientific requirements of the dependent and explanatory variables that are considered. Cobb- Douglas production model is among the best well known production function utilized in applied production and productivity analysis (Enaami et al, 2011). Agricultural labor productivity levels are determined by many causes, including in any production function of the agricultural sector except the labor force since it is already the labor productivity denominator and it goes in the same manner in measuring agricultural land productivity. These agricultural productive factors have been included in all estimations of agricultural productivity (Hayami and Ruttan, 1985; Kawagoe et al, 1985). However, the current analysis consider all the factors of production and household characteristics such as cultivated area of land, chemical fertilizer, number of oxen as proxy for capital input, age, family size, education level, sex, agricultural credit, extension service, market distance ,irrigation, crop rotation, drought, ….etc are considered.

Functional form of Cobb- Douglas production model:-

$Y_i = \beta_0(L_{it}^{\beta_1}K_{it}^{\beta_2})e^{\varepsilon_{it}}$…….. (1)

Where: Y_i= is the value of the i^{th}household's all farm output in Ethiopian birr

L_{it}= is the i^{th}labor inputs used in period t

K_{it}= is the i^{th} capital inputs land in period t

ε_{it}= the disturbance or an error term in period t

β_1 And β_2= are output elasticity of labor and capital

If we transform equation (1) in its log- transformation form, it will give us:

$\ln Y_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \varepsilon_{it}$……(2)

Therefore, in the case of our several dependant variables the ln - linear model would be:

$\ln Y_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 \ln FERT_{it} + \beta_4 \ln OXEN_{it} + \beta_5 AG_{it} + \beta_6 EDUC_{it} + \ldots\ldots\ldots \beta_7 FS_{it} + \beta_8 SEX_{it} + \beta_9 PEST_{it} + \beta_{10} DRUT_{it} + \beta_{11} CREDT_{it} + \beta_{12} EXTS_{it} + \beta_{13} IRG_{it} + \beta_{14} CROPROTATION_{it} + \beta_{15} PLOTDIST_{it} + \varepsilon_{it}$

……(3)

Where,

Y_{it}=total farm output produced by i^{th} household in Ethiopian birr in period t

L_{it}= the i^{th} household agricultural labor inputs in period t

K_i= the cultivated land area of the i^{th} household in period t

$FERT_{it}$= the amount of chemical fertilizer used by i^{th} household in period t

OX_{it}= the number of oxen used for plough by i^{th} household in period t

AG_{it}= The Age of the household head in period t

$EDUC_{it}$= Educational level of the i^{th} household head in period t

FS_i= family size of thei^{th} household in period t

SEX_{it}= Sex of the i^{th} household head

$PEST_{it}$= thei^{th} household were used pesticide or not in period t

$DRUT_{it}$= drought was happened or not to the i^{th} household farms in period t

$CREDT_{it}$= the i^{th} household was got credit or not in period t

$EXTS_{it}$= the household used extension service or not in period t

IRG_{it}= the household used irrigation or not in period t

$CROPROTATION_i$=the household used crop rotation or not in period t

$MKTDIST_{it}$= the i^{th} household distance to the nearest market

$PLOTDIST_{it}$ = the i^{th} household average plot distance from the vilage

However our interest is to come up with the labor and Land productivity equation and hence, let us first divide both sides of equation (3) by agricultural farm labor force (L) and cultivated area of land (K) to determine the labor and land

productivity equation as follow:

A. For Labor productivity:

$$\ln\left(\frac{Y_{it}}{L_{it}}\right) = \beta_0 + \beta_1 \ln\left(\frac{K_{it}}{L_{it}}\right) + \beta_2 \ln\left(\frac{FERT_{it}}{L_{it}}\right) + \beta_3 \ln\left(\frac{OXEN_{it}}{L_{it}}\right) + \beta_4 AG_{it} + \beta_5 EDUC_{it} + \beta_6 FS_{it} + \beta_7 SEX_{it} + \beta_8 PEST_{it} + \beta_9 DRUT_{it} + \beta_{10} CREDIT_{it} + \beta_{11} EXTS_{it} + \beta_{12} IRG_{it} + \beta_{13} CROPROTATION_{it} + \beta_{14} PLOTDIST_{it} + \varepsilon_{it} \ldots \text{(4)}$$

B. For Land productivity:

$$\ln\left(\frac{Y_{it}}{K_{it}}\right) = \beta_0 + \beta_1 \ln\left(\frac{L_{it}}{K_{it}}\right) + \beta_2 \ln\left(\frac{FERT_{it}}{K_{it}}\right) + \beta_3 \ln\left(\frac{OXEN_{it}}{K_{it}}\right) + \beta_4 AG_{it} + \beta_5 EDUC_{it} + \beta_6 FS_{it} + \beta_7 SEX_{it} + \beta_8 PEST_{it} + \beta_9 DRUT_{it} + \beta_{10} CREDIT_{it} + \beta_{11} EXTS_{it} + \beta_{12} IRG_{it} + \beta_{13} CROPROTATION_{it} + \beta_{14} PLOTDIST_{it} + \varepsilon_{it} \text{ (5)}$$

3.3.1.1 Dependant Variable

The dependent variable of **$\ln Y_{it}$** is the logarithm form of the value of the **i^{th}** rural household total agricultural output (in Ethiopian birr). We were convert the out puts by using the survey price data of CSA annual farm get price or producer price for all farm outputs.

3.3.1.2 Explanatory Variables of The Study

In identifying those variables the researcher looks different previous studies and reports. Among a number of factors, which have been related to agricultural productivity, in this study, the following conventional inputs and demographic, socio- economic factors were hypothesized to explain the dependent variable.

1. Agricultural labor input (L): This refers to the total number of labor used who have directly involved on the farm activity measured in adult equivalent and the total hired labor during the production process. The number of all family members those

who were involved in farm activity was included as family labor. The more the labor force utilized for the farm production process the more farm land preparation will be made. Therefore, agricultural labor was hypothesized to have a positive impact on agricultural productivity (Endale, 2011, p. 35).

2. Cultivated area of land (K): It is a continuous variable which is the total cultivated area of land (it is the sum of owned cultivated land, rented- in land and land secured through sharecropping arrangements during the survey period) by the household. Larger firms might benefit from economies of scale, but larger farms can also practice less intensive forms of agriculture, which will result in a lower productivity per hectare, but not necessarily per worker. The larger the cultivated land size the more households may produce farm output which required additional labor and capital demands. The main hypothesis was that the households who cultivates larger size of land can utilize more labor and will be more productive than household those who cultivate small size of land (Bewket, 2011, p. 54).

3. Crop rotation: Crop rotation is a method of growing different crops in the same plot overtime. Crops are rotated in order to maintain the productivity of land (Tulu, 2011, p. 57). Hence, farmers applying crop rotation are expected to get a higher farm and crop income. It is a dummy variable measure as 1 if the farmer applies crop rotation and 0 otherwise (Gebreeyesus 2006).

4. Chemical fertilizer (FERT): It is a continuous variable that the total amount of chemical fertilizer used by sampled households to produce farm output. The agricultural productivity of the household those who are the user of chemical fertilizer and do not user varies due to may be chemical fertilizer input. Therefore, Chemical fertilizer was expected to hypothesize that it is positively related with farm productivity (Geta et al., 2013).

5. Number of oxen (OX): These are the key assets in the rural areas of the country. A household needs two oxen to plough a plot. For smooth management and timely cultivation of land, a household needs a pair of oxen. Agricultural production is directly influenced by the ownership of oxen. It is, therefore, hypothesized that

the larger the number of oxen the household has, the more productive and the income from agriculture will be Endale (2011, p. 24).

6. Age of the household head (age): This variable is a proxy for experience of farm households. The variable age is associated with the learning process of households in handling their overall agricultural practices. It is expected to influence farm income positively as long as farmers are in the active age range.

7. Gender of household head (gender): In Ethiopia, the contribution of both women and men to the productivity of agriculture is vital. But the opportunities are relatively skewed towards men compared to female household heads. According to Endale (2011, p. 24) gender bias towards access to land and education for men is the cause of poor performance of women in agriculture. Hence, it is hypothesized that male household heads are expected to produce more and get better agricultural income compared to female household heads. Gender is a dummy variable 1 if the household head is male and 0 otherwise.

8. Family size of the household: Family members of the household are a potential source of labor in the agricultural sector. Households with many family members will have the chance to diversify their agricultural activities and rent the land of others. Hence, it is hypothesized that the larger the number of members of the family who are engaged in agricultural activities, the greater the income from agriculture will be.

9. Educational level of the household head (EDUC): Educated households are expected to have better exposure to information that enhances agricultural production. They are also expected to be innovators in accepting newways of doing things. This variable is measured in terms of the number of years of schooling that is expected to have a positive impact on agricultural production and hence income (Gebreeyesus 2006).

10. Pesticide (PES): It takes a dummy variable the households were used pesticide or not to produce output during the three survey period. The labor productivity of the

household those who are the user of pesticide and do not user varies due to may be the use of pesticide input. Therefore, pesticide was expected to hypothesize that it is positively related with farm productivity Endale (2011, p. 24)

11. Irrigation used (IRG): It is also a dummy variable which measured whether the household used the irrigation system or not during survey period. Households those who were used irrigation for crop production process during the survey period would expect to increase the probability of farm productivity.

12. Drought (DRT): it takes dummy variable if there was the households face a drought during the last 12 months prior to the survey period is ''1'' and ''0'' otherwise.

13. Extension service (EXTN): It is a dummy variable which measured whether the household used the extension program or not during the survey period. Households those who were used extension service during their farm production process would expect to increase the probability of farm productivity (Endale (2011, p. 24).

14. Credit access (CREDT): Capital is the scarcest asset in the developing countries in general and rural areas in particular. There is a need for money to adopt new technologies such as yield increasing inputs. In line with this, Ellis (1992, p. 128) stated that input delivery should be combined with credit provision in order to reduce the working capital constraints to adopting newinputs for farm households. In Ethiopia different Credit and Saving Institutions provide the microfinance accessible to farmers in the rural areas. Farmers may also get "in- kind" loans such as fertilizers and improved seeds from the farmers' cooperatives in their communities. Thus, this variable is measured in terms of the Ethiopian currency (Birr) that the household took in the production year. It is hypothesized that the availability of rural credit is expected to increase agricultural production and income (Kibwika, Wals, &Nassuna- Musoke, 2009, p. 9).

3.3.2 Econometric Model Specification for Rural Household Income

The factors affecting agricultural productivity are expected to affect the total agricultural income of farm operators. In analyzing the rural household income

the multiple regression models will be used. The livestock income (estimated value of livestock) is included in the total income model. The justification for using multiple regression models is that rural household income is continuous dependent variables and it is expected to take a non-zero value for all farm households (Endale, 2011, p. 35).

Accordingly, the following regression model is specified:

$$Y_{it} = \alpha_0 + \alpha_1 X_{it} + \alpha_2 X_{it} + \alpha_3 X_{it} + - - - - + \alpha_i X_{it} + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

This means, in short term, $Y = \alpha X' + \varepsilon$

Where:

y= is the dependent variable.

X= vector of explanatory variables.

α = the parameter to be estimated.

ε= the error term.

Then, the functional notation of the dependent and independent variables is:

$$Totalincom_{it} = \alpha_0 + \alpha_1 L_{it} + \alpha_2 K_{it} + \alpha_3 FERT_{it} + \alpha_4 OXEN_{it} + \alpha_5 AG_{it} + \alpha_6 EDUC_{it} + \alpha_7 \ldots\ldots\ldots FS_{it} + \alpha_8 SEX_{it} + \alpha_9 DRUT_{it} + \alpha_{10} CREDT_{it} + \alpha_{11} EXTS_{it} + \alpha_{12} IRG_{it} + \alpha_{13} MKTDIST_{it} + \alpha_{14} OFE_{it} + \varepsilon_{it}$$

$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

3.3.2.1 Variables used in the rural household Income model which is not described under the productivity model.

1. Distance to the nearest market (MKTDIST): this is one of the indicators of how easily the farm households are able to access the nearest market. This variable is measured in terms of the distance (in kilometers) of the farm area from the nearest market. And it hypothesized as, the shorter the distance to the nearest market, the higher the income from the agricultural produce should be (Endale (2011, p. 24).

2. Off-farm employment (OFE): These major off-farm employments are: agricultural wage, non-agricultural wage, self-employed and other income generating activities. This variable will have a dummy nature. There is expected to a positive relationship with the household income those who have off-farm employment and negative for don't have (Geta et al., 2013).
3. Household income: This is the dependent variable in rural household income model. Household income is the total value of crops & livestock produced in the production year (Asfaw, &Admassie, 2004, p. 216).

CHAPTER FOUR

4. Results and Discussion

4.1 Introduction

This chapter presents the results and discussion of the determinant factors that affect agricultural productivity and rural household income in Ethiopia. In addition, the socio-economic characteristics, the major factors affecting agricultural productivity and rural household income are analyzed. Agricultural productivity and rural household income influencing factors such as land size and irrigation, utilization of inputs, off-farm participation of the farmers, crop rotation and intercropping, credit availability, drought conditions, access to markets and extension agents' support are presented and discussed.

Finally, the secondary sources dealing with the conditions of agricultural productivity and rural household income in Ethiopia are critically reviewed. Based on the nature of the data, a respective presentation and analysis are presented.

4.2 Descriptive Statistics for the Data

4.2.1 Socio- Economic Characteristics

The socio- economic characteristics sub- section included the age, gender, and family size and education levels of respondents in the survey study. The results are discussed in the context of national level as indicated below.

As shown in table 4.1 the majority of the respondents were in the age range of 45 and 56 years. And Gender wise, the majority of the female farmers were in the age range of 33 to 44 years. This implies the majority of the farmers were in the active working age category therefore the researcher take the age of the farmer was also taken as a proxy variable for his/ her experience in the sector.

Table 1: Age and gender description.

Age group	Male	Female	total
21- 32	50	100	150
33- 44	679	573	1252
45- 56	1370	458	1828
57- 68	780	140	920
69- 80	250	30	280
81- 92	60	10	70
Total	3189	1311	4500

Source: ERSS 2012- 2016

4.2.2 Descriptive Results of Continuous Variables

The performance of agricultural sector can be measured in inter- related variables: change in agricultural productivity (production per unit of inputs used i.e. land and labor) and the agricultural household income. Productivity is the most important factor to indicate both the characteristic of current performance, future trends and sustainability of the system. Even though increased production

is also important, without improved productivity, it is either an indication of the presence of large unused land and other scarce resources or it is a warning that the present generation used the resources unsustainably which will put the livelihood of the future generation at risk. Therefore it is needed to describe and analyze critically both the determinant variables of agricultural productivity and rural household income as follow.

According to the survey result as indicated in table 4.2 below, which is summarized from the rural household survey data of 2012- 2016 conducted by the Central Statistics Agency of Ethiopia, the mean value of rural households' crop total agricultural income was 33982.57 in birr with its minimum of 9650 birr and maximum of 249800 birr. And this includes livestock income remittance and other non farm incomes.

Similarly the mean value of rural farm household's value of output per unit of farm labor input which means the mean value of labor productivity is 10.3 birr with its minimum 2.64 and maximum 16.7 birr. Likewise the rural farm household's value of output per unit of cultivated area of land in hectare was used as the mean value of land productivity is 8.6 with its minimum of 1.2 and maximum of 14.83 it shows land productivity a little lower than labor productivity during the analysis period (2012 - 2016).

The number of owned oxen used for ploughed, is 1.5, with its minimum of 0 and maximum 6. This implies most of the farmers do not have a potential to buy oxen from the market for ploughed purpose, therefore it is needed to support low income farmers.

However, the mean value of land per unit of labor is only 0.25 hectare with its minimum of 0.02 and a maximum of 6 hectares. This implies that there is a sign of cultivated land scarcity for labors and work to increase the land- labor ratio.

According to the survey result indicated in table 4.2 below, which is summarized from the rural household survey data of 2012- 2016 conducted by the Central

Statistics Agency of Ethiopia, the average family size of the rural households was 6.75 persons, with 2 and 12 being the minimum and the maximum family sizes respectively. The average age of the household heads was 46 years where the minimum is 21 years and the maximum was 92 years. The study also indicates that, the mean value of Dependency ratio is 0.49 with 0 and 2.5 minimum and maximum values. And this is very high ratio especially for lowincome country like ours. Level of education: The average years of formal schooling of the farmers was grade 4 with the minimum 0 and maximum of grade 12. The average family labor consumed by the rural household for agricultural activity was 549 man days with the minimum 200 and maximum 1400. Further the study indicated that, the average Amounts of chemical fertilizer used by the rural household were 2.46 quintals with the minimum amount 0.25 and maximum amount used 9 quintals. Whereas the average Amounts of improved seed used by the rural households were 1.76 quintals with a minimum 0.75 quintals and maximum of 3 quintals.

Finally, market distance is a determinant of profitability and sustainability of agricultural produce or proxy to agricultural marketing services and the mean distance between the villages and the market in kilometers for the rural households was found to be 13.6 kilometers with a minimum of 1.5 kilometers and maximum of 30 kilometers.

Table 2: Descriptive Results for Continuous Variables

Variables	Mean	Minimum	Maximum
Total income	33982.57	9650	249800
Labor productivity(output/labor in birr)	10.3	2.64	16.70
land productivity (output/land in hectare)	8.6	1.2	14.83
Number of oxen	1.5	0	6
Age	46	21	92

Family size	6.75	2	12
Plot distance	0.49	0	2.5
Education level	4	0	12
Cultivated land area	0.25	0.02	6
Number of Labor	549	200	1400
Fertilizer used	2.46	0.25	9
Improved Seeds used	1.76	0.75	3
Market distance	13.6	1.5	30

Sources; ERSS 2012- 2016.

4.2.3 Descriptive Results of Dummy Variables

According to the survey result as indicated in table 4.3 below, which is summarized from the rural household survey data of 2012- 2016 conducted by the Central Statistics Agency of Ethiopia, out of the total sampled 4500 households 1311 which means 29.01 percent of the rural households were headed by females and the rest 3189 which means 70.90 percent were headed by male. The study result showed that only 6 percent of the rural households have used irrigation this implies that there is no significant number of irrigation users. While the study result showed that 2115 or 47.5 percent of the sample households use Pesticides in their farming practices and the remaining 52.5 percent does not.Furthermore, 3330 of the sampled households or 74 percent are practice crop rotation in their lands and the remaining 26 percents does not.

Drought is also a sensitive issue in the rural area; regarding this the study results showthat out of 4500 sampled households 1440 or 32 percent face drought related issue in the survey period. Therefore since is a global issue it needs to attend critically

Table 3: Descriptive statics for sample household (discrete variables)

Variables	Option	Frequency	%
Sex	Male	3189	70.9

	Female	1311	29.1
Irrigation	Yes	270	6
	No	4230	94
Extension service	Yes	3825	85
	No	675	15
Pesticides	Yes	2115	47.5
	No	2385	52.5
drought	yes	675	15
	no	3825	85
Crop rotation	Yes	3330	74
	No	1170	26
Non- farm income	Yes	1125	25
	No	3375	75
Credit access	Yes	1215	27
	No	3285	73

Source: ERSS 2012- 2016.

However, the mean values of the number of households those who get an income from non- farm activity and the number of household those who are get credit access are very small in magnitude which is 0.25 and 0.27 respectively. This implies that, only few rural household have earns non- farm income and have got a few credit accesses.. Lastly, the study result showed that out of the total 4500 households which are 85 percent of the sample households get extension service. It is better if Farmers training given by extension agents and by different responsible organs at a farmers training center without any political issue and other unnecessary discussion, the farmers' at a farmers training center ability to adopt new technology, crop and animal yield, marketing services, input application and natural and water resource conservations. But most of the agents does not do us it is and fail to achieve their objective.

4.3 Empirical findings of the Econometric models and their Discussions

The econometric analysis of the study is mainly deals with the analysis of major factors that determine agricultural productivity and rural household income of the panel sampled of the rural agricultural households of Ethiopia; and in this chapter, the study provide the analyses focusing on the research questions. The first part of this econometric result is about the determinants of agricultural labor productivity analysis, while the second part focuses on the determinants of agricultural land productivity and the third part deals with the determinant of the rural household income based on the model used for the regression.

4.3.1 Econometric Results of the Agricultural Labor Productivity Model

There were different demographic and socio-economic factors that were contributing in the determinants of agricultural labor productivity of the rural farm household's in Ethiopia. In order to identify the significant factors, for agricultural labor productivity the within-group, the fixed effect and the random effect models are applied on the panel data set which we could choose the best among them. However, an F-test of the null hypothesis that all household-specific intercepts are identical rejected the within-group in favor of the fixed effect model and also the random effect model was rejected by the Hausman test.

F-test for labor productivity:

An F test has been carried on to know whether the model is best or not. The null hypothesis is that all the intercepts are the same and the alternative hypothesis is at least one of the intercept is not the same. The F value of 110.84 (for 14 numerator degree of freedom and 4500 denominator degree of freedom) is highly significant. Therefore, based on the F test, we rejected the null hypothesis in favor of fixed effect.

Test statistic: F (14, 4500) = 110.84

With p- value = P (F (14, 4500) > 110.84) = 3.38
On the basis of the F- statistics test, we decided to use the fixed effect model, and therefore, only the fixed effect model results will be presented and discussed.

Hausman- test:

For choice between the fixed effect and the random effect model, this study was employed the Hausman test to select the best estimation model since the selection of between the two model would be problematic. Despite the fact that, the Hausman test clearly shows the P- value is 0.000 which was less than 0.05.
Test: Ho: difference in coefficients not systematic
chi2 (14) = 251.46
Prob>chi2 = 0.0000

Therefore, we reject the random effect model in favor of fixed effect. The analysis of this study is made on the bases of the result of the fixed effect model, due to the random effect model was rejected in favor of fixed effect model by Hausman test.

The model is also tested for the possible appearances of Heteroscedasticity and multicollinearity problems. The Heteroskedasticity problem was adjusted by regressing all model used for estimation with robust standard, and the multicollinearity problem was also checked and tested using the observed information matrix (OIM) during the estimation of the variance–covariance matrix. As a result we don't find any multicollinearity problem during the estimation for the determinants of labor productivity.

Therefore, The parameters of the fixed effect estimators of the partial factor labor productivity of the Ethiopian rural farm household indicates that, most of the variables were statistically significant. This implies that the variables used in the panel model of the fixed effect estimation are significant determinants of agricultural labor productivity in the sampled rural farm households of Ethiopian during the period of productivity analysis (2012- 2016).

However, educational level of the household head, gender of the household head and irrigation were not significant for the determinants of labor productivity. One known reason for educational level of the household head do not significant is that, out of 4500 household head there were only about 942 household heads were educated in the survey data set and off these 942 households only 76 household heads were completes grade 8 and above. Regarding to irrigation user, out of the total 4500 sampled household, there were only 429 households were used irrigation during the survey period.

Despite the fact that, the finding of the fixed effect estimation model shows that cultivated area of land per unit of labor, the use of chemical fertilizer, the use of pesticide, family size , number of oxen, use of irrigation, credit access and age of the household head are found to the a positive determinants of the agricultural productivity. However, use of extension service, market distance, plot distance and the drought variable was significantly and negatively affects the agricultural labor productivity of the sampled rural households.

More specifically, cultivated area of land was a significant contribution for the positive change of labor productivity with 1 percent significance level during period of analysis. The result indicates that, other things remain constant, as the cultivated area of land increases by one percent, the labor productivity increases by 0.76 percent. This finding is consistence with the finding of Joseph Owuor's in Kenya. He was concluded that, labor productivity and land productivity are consistent, positively correlated and significant. The result implies that, the availability of agricultural cultivated land increases labor productivity in the sampled area of rural households. Therefore, it could be good if the government facilitate the access of land to landless, especially for the young people those who are within the household.

Chemical fertilize is another significant determinants of labor productivity with a significant level of 10 percent. This means there is a significant labor productivity difference between chemical fertilize user household and non user. As the

household are increases use of chemical fertilizer inputs by one unit the labor productivity increases by 0.237 percent, citrus paribus. The use of pesticide input in farm production processes was also statistically significant at 5 percent level, which means, as the household is user of pesticide the labor productivity increases by about 0.013 percent compared to non users of pesticides. Therefore, accessing and advising the rural household to the use of pesticide inputs during their farm production processes would enhance labor productivity in rural households.

Family sizes: surprisingly, as the number of household member increases by one unit the labor productivity of the household increases by 0.203 percent and it is also significant at 5 percent level of significant. One known reason behind this is that, the rural household of Ethiopia uses more family labor than hired labor in their farm production processes. As a result having more labor with in a household would be able to a high possibility of farm management work to increase farm output. Crop Rotation is also important variables for the rural household labor productivity enhancement, which shows that, the labor productivity increases by 0.07 percent as the farm household's uses crop rotation for their farm production process in one production period. The finding is also consistent with Wassie (2014) in Ethiopia.

A very surprising result of this study is negative relation of extension service and agricultural labor productivity, the use of extension service is also statistically significant at 10 percent significant level with a coefficient of - 0.007. This means, agricultural household labor productivity decrease significantly by 0.007 percent as the households were got the service during one production seasons of the survey period. It is also consistence with the finding of Asres Elias el.al (2013) in Ethiopia, during their study of the Effect of agricultural extension program on small holder's farm productivity. This is because the extension agents do not focus on their job description rather they discuss on other issues like, repayment of input credit and other political issues.

The number of ploughed oxen variable is also statistically significant at 1 percent

level and it shows a positive change in labor productivity as the household use the one extra more ploughed ox, labor productivity changes by 0.324 percent. This implies that the possession of an ox is the critical asset in the rural areas. As it was hypothesized, for a smooth management and timely cultivation, a household needs a pair of oxen. If farmers have at least a pair of oxen, they will be able to cultivate and sow their land at the appropriate time. In addition, they can cultivate more land by renting from households who do have plough oxen. Along the same argument, Rahmato (2015, p. 39) reported that it is not hard to imagine what a debilitating handicap the shortage of farm oxen can be especially in the predominantly plough- based farming Zones of the country.

There is also age of the household head is statistically significant at 5 percent level. The result indicates that, holding other variables constant, as the age of the household heads increases by one more year, the labor productivity shows a slightly increases by 0.025percent. One reason would be most of the household head age is in active working age group which is below 56 years old and the mean of the household head age is 46 years, as a result the possibility of young household head to be matured and increases his/her farm practicing experience would be high which able to increase household's farm labor productivity.

The distance of the village from the nearest market is also a determinant variable of labor productivity at a significance level of 1 percent. The result indicates that, as the distance of the village from the nearest market is increased by one kilometer, the labor productivity increased by 0.022 percent. However, unlike the other variables, it is with the unexpected sign. The hypothesis was the shorter the distance, the better estimated value of labor productivity. The assumption was that farmers who are near to the market can access inputs when they are scarce at the village. The result and the unexpected negative correlation might be because the farmers frequently visited the town and the time they devoted to their plots could be minimal.

Finally, the average distance of all plots from the homestead is significant

determinants of agricultural labor productivity at a 10 percent level. The result indicates that increasing the average distance of the plots leads to a decrease in the labor productivity. This is a logical result as farmers might have a frequent presence and care for plots which are located at nearby areas.

One of the important finding of this study was that, when the drought occurs in one agricultural season in Ethiopia, the labor productivity of the rural household declines by about 0.24 percent and it is statistically significant at 10 percent level. This implies that the rain dependent agriculture is risky for the farm household labor productivity enhancement. Therefore, promotion of the use of irrigation system or any other source of water is useful during the drought season so as to increase the labor productivity of rural farm households.

Credits Access is also important variable with 5 percent significant level in the labor productivity model. As it is hypothesized the household that are rural credit users are 0.171 percent more productive than non users. Capital is the scarcest asset in the developing countries in general and rural areas in particular. There is a need for money to adopt new technologies such as yield increasing inputs. In line with this, Ellis (1992, p. 128) stated that input delivery should be combined with credit provision in order to reduce the working capital constraints to adopting new inputs for farm households.

Table 4: Regression results of factors that affect labor productivity model

Number of observations=4500

F(15, 4484)

=341.6

Prob>F =0.0000

R- squared =0.5674

Adj. R- squared

=0.5481

Explanatory Variables	Within-group	Fixed effect	Random effect
cultivated area of land	0.826 (0.000***)	0. 761 (0.000***)	0.681 (0.000***)
age	0.024 (0.03**)	0.025 (0.04**)	0.019 (0.02**)
gender	0.112 (0.103)	0.125 (0.109)	1.52 (0.002*)
educlevel	0.019 (0.148)	0.026 (0.151)	0.19 (0.141)
fimily size	0.210 (0.011*)	0.203 (0.018**)	0.031 (0.054)
oxenown	0.311 (0.000***)	0.324 (0.000***)	0.520 (0.000***)
Fertilizer used	- 0.123 (0.021*)	0.237 (0.052*)	0.313 (0.039*)
Pesticide used	0.003 (0.021**)	0.013 (0.032**)	0.032 (0.041**)
Irrigation	0.228 (0.205)	0.285 (0.114)	0.821 (0.155)
extension service	- 0.002 (0.074*)	- 0.007 (0.082*)	- 0.003 (0.089*)
Access to credit	0.297 (0.003***)	0.171 (0.023**)	0.009 (0.135)
Drought	- 0.077 (0.059*)	- 0.24 (0.072*)	- 0.231 (0.061*)

Mkt dist	- 0.017 (0.003***)	- 0.022 (0.005***)	- 0.813 (0.027**)
Plot dist	- 0.024 (0.056*)	- 0.014 (0.060*)	- 1.89 (0.081*)
Crop rotation	0.009 (0.091*)	0.07 (0.081*)	0.078 (0.062*)
_cons	7.586 (0.000***)	7.580 (0.000***)	7.052 (0.000***)

***Significance at 1%**significance at 5% *significance at 10%

Source: Own estimation result

4.3.2 Econometric Results of the Agricultural Land Productivity Model

Here also there are different demographic and socio- economic factors that were contributing in the determinants of agricultural land productivity of the rural farm household's in Ethiopia. In order to identify the significant factors, the within- group, the fixed effect and the random effect models were applied on the panel data set which we could choose the best among them. However, an F- test of the null hypothesis that all household- specific intercepts are identical rejected the within- group in favor of the fixed effect model and also the random effect model was rejected by the Hausman test.

F- test for land productivity

An F test has been carried on to choose the best model between the within- group and the fixed effect estimation. The null hypothesis is that all the intercepts are the same and the alternative hypothesis is at least one of the intercept is not the same. The F value of 93.99 (for 17 numerator degree of freedom and 4482 denominator degree of freedom) is highly significant. Therefore, based on the F test, we rejected the null hypothesis in favor of fixed effect.

Test for differing group intercepts -

Null hypothesis: The groups have a common intercept
Test statistic: F (17, 4482) = 93.99
With p- value = P (F (17, 4482) > 93.99) = 3.41

Hausman- test:
To choice between the fixed effect and the random effect model, this study was employed the Hausman test to select the best model due to the choice between the two model is problematic. The Hausman test clearly shows that the P- value is 0.0000 which is less than 0.05.
Test: Ho: difference in coefficients not systematic
chi2 (17) = 248.21
Prob>chi2 = 0.0000

Therefore, we reject the random effect model in favor of fixed effect. As a result, the analysis of this study was made bases on the result of the fixed effect model.

On the basis of the F- statistics test and hausman- test, we decided to use the fixed effect model. And hence, only the fixed effect model results will be presented and discussed.

The model is also tested for the possible appearances of hetroscedasticity and multicollinearity problems. The Heteroskedasticity problem was adjusted by regresses of the entire model used for estimation, with robust standard and the multicollinearity problem was also checked and tested using the observed information matrix (OIM) during the estimation of the variance–covariance matrix. As a result we don't find any multicollinearity problem during the estimation for the determinants of land productivity.

The parameters of the fixed effect estimation model of the partial factor land productivity of the Ethiopian rural farm household indicate that, most of the variable was statistically significant. This implies that the variables used in the panel model of the fixed effect estimation (Equation 5) are significant determinants of agricultural productivity in the rural farm households of

Ethiopian during the period of analysis (2012- 2016).

However, educational status of the household head, sex of the household head, and irrigation were not significant for the determinants of land productivity. One known reason for educational level of the household head do not significant is that, out of 4500 household heads there were only about 942 household heads were educated in the survey data set and off these 942 households only 76 household heads were completes grade 8 and above. Regarding to irrigation user, out of the total 4500 sampled household, there were only 429 households were used irrigation during the survey period.

Despite the fact that, the finding of the fixed effect estimation model shows that, agricultural labor per unit of cultivated area of land, the use of fertilizer, the use of pesticides, family size, the number of oxen used for ploughed, credit access, crop rotation and the age of the household head were found to be the positive determinants of agricultural land productivity of rural households.
However, extension service, plot distance from the homesteads and the occurrence of drought during the production season were significantly and negatively affects the rural households land productivity. It was also a slight change when it compares to labor productivity changes during the same period of analysis.

The result shows number of labor is a significant determinant of land productivity with 5 percent significant level. It shows that, as the agricultural labor per unit of cultivated area of land increases by one percent, land productivity increases by 0.019 percent. The result implies that, the increase of labor- land ratio results very small increases in land productivity of rural households. This means the marginal productivity of labor is very small and it indicates their is a shortage of cultivated land for the gangsters. Therefore, it could be good if the government facilitate the access of land to landless, especially for the youngsters those who are within the household. The finding is also consistence with Joseph Owuor in Kenya. The results of this study in fixed effect estimation model, exactly answer the question of the most potent of agricultural productivity so as labor productivity is the most potent

for agricultural productivity than land productivity in the rural households.

Chemical fertilize is also statistically significant variable at 10percent level. The fixed effect result shows that, there is a significant land productivity difference between chemical fertilize user household and non user. As the household are increases the use of chemical fertilizer inputs by one quintal, the land productivity increases by about 0.172 percent.

The use of pesticide input in farm production processes was also statistically significant at 5 percent level. This means, as the household increases the use of pesticide by one unit, the land productivity increases by 0.10 percent. Therefore, accessing and advising the rural household to the use of pesticide inputs during their farm production processes would enhance of land productivity of rural households.

One of the important finding of this study was that, when the drought occurs in one agricultural season in Ethiopia, the land productivity of the rural farm household declines by 0.241 percent and it is also statistically significant at 10 levels. This implies that the rain dependant agriculture is risky for the farm household land productivity enhancement.

Surprisingly, as the family size increases by one unit, the land productivity increases by 0.101 units and it is also significant at 5 percent level. One known reason behind this is that, the rural household of Ethiopia uses more family labor than hired labor in their farm production processes. As a result having more labor with in a household would be able to a high possibility of farm management work like timely land preparation to increase farm output.

Here also a negative relation between land productivity and extension service which is a very surprising result of this study. The use of extension service is statistically significant at 10 percent significant level with a coefficient of - 0.013. This means, agricultural household land productivity decrease significantly by 0.136 percent as the households were got the service during one production seasons

of the survey period. It is also consistence with the finding of Asres Elias el.al (2013) in Ethiopia, during their study of the Effect of agricultural extension program on small holder's farm productivity. This is because the extension agents do not focus on their job description rather they discuss on other issues like, repayment of input credit and other political issues.

The number of ploughed oxen variable is also statistically significant at 5 percent level and it shows a positive change in land productivity as the household use the one extra more ploughed ox, land productivity changes by 0.016 percent. This implies that land productivity is positively associated with number of oxen in rural farm households of Ethiopia. Use of crop rotation is also statistically significant 10percent level, indicates that as the household increases the uses crop rotation in the production period the land productivity increases by 0.014 percent.

There is also age of the household head is statistically significant at 10 percent level. This implies that as the age of the household heads increases by one more year, the land productivity of the rural household is shows a slightly increases by 0.025 percent. One reason would be most of the household head age is in active working age group which is below56 years old and the mean of the household head age is 46 years, as a result the possibility of young household head to be matured and increases his/her farm practicing experience would be high which able to increase household's farm labor productivity.

Credit Access is also important variable with 5 percent significant level in the land productivity model. As it is hypothesized the household that are rural credit users are 0.179 percent more productive than non users. Capital is the scarcest asset in the developing countries in general and rural areas in particular. There is a need for money to adopt newtechnologies such as yield increasing inputs. In line with this, Ellis (1992, p. 128) stated that input delivery should be combined with credit provision in order to reduce the working capital constraints to adopting newinputs for farmhouseholds.

The distance of the village from the nearest market is a determinant variable of

land productivity at a significance level of 1 per cent. The fixed effect result indicates that, as the market distance increased by 1kilo meter the agricultural land productivity decreases by 0.021 percent. However, since most of the agricultural products are perishable in nature, as the markets is far from the village the farmer does not timely sale their products and this in turn decline the market value of their product therefore the birr value of unit of land productivity decreases.

Finally, the average distance of all plots from the household's homestead is significant at a 10 percent level. The result indicates that increasing the average distance of the plots by 1 kilometers leads to a decrease in the land productivity by about 0.011 percent. This is a logical result as farmers might have a frequent presence and care for plots which are located at nearby areas.

Table 5: Regression results of factors that affect land productivity model

Number of observations=4500
F(15, 4484) =93.99
Prob>F =0.0000
R- squared =0.6770
Adj. R- squared =0.6451

Explanatory Variables	Within-group	Fixed effect	Random effect
Number of labor	0.019 (0.021**)	0. 016 (0.033**)	0.023 (0.022**)
age	0.024 (0.062*)	0.025 (0.053*)	0.019 (0.110)
gender	- 0.003	- 0.191	0.014

	(0.103)	(0.109)	(0.117)
educlevel	0.008 (0.048**)	0.026 (0.051*)	0.183 (0.041*)
fimily size	0.210 (0.011**)	0.101 (0.018**)	0.031 (0.054**)
oxenown	0.008 (0.000***)	0.016 (0.000***)	0.003 (0.000***)
Fertilizer used	0.109 (0.053*)	0.172 (0.065*)	0.211 (0.058*)
Pesticide used	0.033 (0.034**)	0.114 (0.022**)	0.172 (0.081*)
Irrigation	0.028 (0.105)	0.085 (0.63*)	0.281 (0.053*)
extension service	- 0.029 (0.072*)	- 0.013 (0.066*)	- 0.023 (0.069*)
Access to credit	0.027 (0.004***)	0.179 (0.043**)	0.029 (0.165)
Drought	- 0.094 (0.053*)	- 0.241 (0.084*)	- 0.253 (0.059*)
Mkt dist	0.023 (0.004***)	- 0.021 (0.003***)	- 0.714 (0.039**)
Plot dist	- 0.004 (0.054*)	- 0.011 (0.063*)	- 1.31 (0.072*)
croprotation	0.077 (0.078*)	0.014 (0.054*)	0.491 (0.063*)
_cons	6.659 (0.033**)	6.801 (0.024**)	6.072 (0.048**)

***Significance at 1%**significance at 5% *significance at 10%

Source: Own Estimation Result

4.3.3 Econometric Results of the Rural Households Income Model

The household's total income differential that measured in birr is determined by different factors. In addition to the descriptions given in different part of this paper, the rural household income analysis in this sub- section was estimated using the multiple linear regression models. The study has tried to address the objective and give empirical evidence for result obtained for regression estimation method. And some basic assumption tests were carried out and are attached in the appendices section.

To avoid the problem of multicollinearity, all explanatory variables were checked prior to estimating the regression model. In addition, theoretical relevance was considered to determine the inclusion and exclusion of variables in the model. Following Gujarati [16]2004, multicollinearity problem for all explanatory variables was assessed using a technique of variance inflation factor (VIF) The Variance Inflation Factor result indicated that there was no multicollinearity problem among the explanatory variables. Because the value of VIF for each independent variable is less than 10, with its mean VIF=2.16, this shows that multicollinearity was not a problem (Appendix). And the test resulted ends in the rejection of the existence of multicollinearity hypothesis. Moreover, heteroscedasticity was tested by using Breusch- Pagan test. This test resulted in rejection of the existence of heteroscedasticity hypothesis as (p= 0.147). The Ramsey results have also accepted the assumption that the model has no omitted variables.

The dependent variable considered in the analysis is the total annual household gross income derived from agricultural crop income, remittance and livestock income.

Table 6: Multiple Regression results of rural household income differential

Number of obs = 4500

F (17, 4482) = 16.84

Prob> F = 0.0000

R- squared = 0.6919

Adj R- squared = 0.6508

Total income	Coefficient	Std. Err	T	P>t
Family size	- 84.2018	540.129	- 0.16	0.876
Age of HH's Head	305.2897*	163.6464	1.87	0.065
Sex of HH's Head	2596.902	3580.484	0.73	0.470
Education of HH's Head	968.5178*	474.6322	2.041	0.061
Cultivated area	14368.64**	6390.555	2.25	0.027
Number of oxen	1679.781***	622.5768	2.70	0.008
Off farm Employment	4839.071**	2319.349	2.09	0.021
Extension	1624.921	2663.005	0.61	0.543
Irrigation	13525.57**	6121.972	2.21	0.029
Market distance	- 107.0354	390.3436	- 0.27	0.784
Number of labor	14.83235	14.32904	1.04	0.303
Fertilizers	3847.395***	924.9647	4.16	0.000

Drought	- 641.6653	390.1334	- 1.64	0.103
Credit access	2440.29	1549.474	- 1.57	0.118
Constant	- 18782.29*	10464.62	- 1.79	0.076

*, ** And *** mean significant at 10%, 5% and 1% probability level, respectively

Source: Own Estimation Result

As shown in Table 3, the R^2 and the adjusted R^2 values are 0.69 and 0.65 respectively. It means that about 69% of the variations in the dependent variable explained by the independent variables included in the model, indicating relatively high explanatory power of the model. Depending on economic theories and data availability, the variables believed to influence of the rural household have been included.

Looking into the estimated results, age, cultivated area of land, education level of the household head, number of oxen, irrigation participation of household, off farm employment, and amount of chemical fertilizers are the independent variables explain the farm income differentials. Those variables are explained as follows.

Age: The result of the model indicates that the variable has positive relationship with rural household gross income. It is significant at 10% level. The coefficient implies that, keeping other factors constant, the rural household income increase by Birr 305 as the age of the household head increase by one year. This result is in agreement with the findings of Tesfaye (2011). Rural households base their livelihoods on agriculture. The older the household head, the more experience he/ she has in farming. Moreover, older persons are more risk averters, and mostly they intensify and diversify their production activities.

Educational level of household head: it was found significant at 10% probability level and positively influence farmers income indicating that relatively more

educated farmers recognize the advantages of farm technology than farmers with less educated. The marginal effect indicated that as education level of household head increased by one year the rural household income increased by 9.68%.This is because of the fact that education enhances farmers' ability to perceive, understand, and respond to newtechnology. It also enables farmers to be more aware of the improved technology. Tefera (2014) reported the same result that education is positively influencing the income of farm household.

Cultivated area of land: Size of cultivated land has positive influence on the rural household's income. It was significant at 5%. Increase in size of cultivated land has positive relationship with the amount of production to be harvested. Therefore, those farmers who cultivated more become in a better income position than those who cultivated less. The coefficient implies that with all other factors kept constant, the rural household's income increase by Birr 14368 with increase in size of cultivated land by one hectare.

Number of oxen: this variable is statistically significant at 1 percent probability level. The positive relationship indicates that households with larger livestock holding may have the opportunity to plough at any time with minimum labor cost, especially for oxen. The coefficient of the variable shows that as the household gets one more oxen the rural household income increases by Birr 1679.8 and this may lead to improved income from household farm crop production. This result is in conformity with the finding of Takele (2013).

Use of irrigation: this variable was found to be a significant variable at 1% probability level. This variable has a positive relation with rural household income indicating that using irrigation increases the vegetable and non vegetable farm income among the rural households. This might be because of the fact that participation in irrigation would improve agricultural production pered. Moreover, farmers can generate higher income from their limited farm land as they tend to produce high value crops through irrigation. This result is consistent with the finding of Abebaw(2014) which indicated the negative relation between irrigation

water use and food insecurity. The coefficients of rural household increase by Birr 13525 as households become user of irrigation, citrus paribus.

Amounts of chemical fertilizers: Use of fertilizer for crop production plays an important role for production and productivity. In the study area, use of fertilizer is very important input for production of crop. Agricultural production by its very nature demands high use of improved agricultural inputs like fertilizer in order to produce high value crops like vegetables. In most cases, availability of irrigation encourages farmers to use fertilizer for production of high value crops, which fetches high prices and cover incurred costs. The coefficient is significant determinant of rural household income at 1 percent level of significance and it showed that all other factors remain constant, the households total income increases by Birr 3847 as the households fertilizer use increases by one unit.

Off farm employment is another significant determinant factor of rural household income with 5 percent level. The result indicates that, citrus paribus there is an income difference of 4839.071 birr between households engaged in off farm activities and nonparticipations. Therefore, because the scarcity of land and the further fragmentation of small landholdings mean that the off- farm sector has to be expanded to absorb the growing population in the rural areas. There is a need of opportunity for an alternative source of income strategy because the demand for labor in the agricultural sector varies from peak to off- peak seasons.
Income diversification is needed the involvement of farmers in different income generating activities such as farm and off- farm to fulfill their household needs. Off- farm employment helps farmers to get working capital and secure income to finance inputs in a credit constrained situation.
Agriculture, as the only means of livelihood, is becoming a risky occupation on this continent. As a result, there are many reasons and motivations for a household to participate in off- farm employment. Off- farm employment is for households to be self- insured from the innate variability of farm income and to stabilize their total household income. In areas where access to credit is limited, off- farm income is expected to help households purchase inputs such as fertilizers and

selected seeds and to introduce newtechnologies.

CHAPTER FIVE

5. Summary, Conclusion & Policy Implication

5.1 Summary

The aim of this study was to assess the factors that affect agricultural productivity and rural household income in Ethiopia. To this end, all nine regions of the country were investigated.

The purpose of this chapter is therefore to present the overall summary of the results of the study, conclusions and recommendations together with highlighting

gaps for future research.

The specific objectives of the study were to investigate major factors of agricultural productivity and rural household income at a national level. These objectives were taken as a theme to present the main finding of the paper in Chapter 5. The summary of these results was also made considering the specific objectives as a theme as shown below.

The three panel data analysis methods: the within- group method, fixed effects (FE) method and random effects (RE) method, national level panel data of Ethiopian Rural Socio- economic Survey (ERSS) collected for three survey period 2012, 2014 and 2016, this study investigates the determinants of agricultural productivity and rural household income in Ethiopia. Based on Husman test, fixed effect (FE) method was found the most appropriate model. Since it is not possible to include all the rural farm households in Ethiopia, due to limited availability of data and period, only 4500 households were formulated the three years panel data set from selected sample area of the country.

The determinants of agricultural productivity in rural households do not much vary across labor productivity and land productivity. Cultivated area of land, the use of chemical fertilizer, the use of pesticide, the use of crop rotation, family size, and number of oxen, use of irrigation, credit access and age of the household head are found to have positive determinants of the agricultural productivity. However, use of extension service, market distance, plot distance and the drought variable was significantly and negatively affects the agricultural labor productivity.

This could imply that, households' labor productivity gain could be attained if we focus on those variables accordingly. However, land- labor ratio is more challenging than other variables since there is increased rural yang agricultural labor force population pressure. But it is possible by mobilizing the farm labor force to the other potential cultivable area of land.

Similarly, The fixed effect results of land productivity model showthat, number of labor, the use of fertilizer, the number of oxen, family size, the use of crop rotation, irrigation, use of pesticide, extension service, credit access and age variables are significant variables through which we may improve farm land productivity of rural households. This also could imply that, households' land productivity gain could be attained if we focus on improving the labor- land ratio, the use of fertilizer, pesticide inputs and extension service. However, improving labor- land ratio is more challenging than improving the use of pesticide and extension service with increased rural yang population pressure. But it is possible by mobilizing farm labor force to the other potential cultivable area of land.

Of all the variables used in the regression of agricultural productivity, cultivated area of land per unit of labor is the most significant effect on the determinants of labor productivity and fertilizer inputs and family size is found to the most significant effect on the determinants of land productivity in the rural household's of Ethiopia. Therefore this study concludes that, the agricultural labor productivity is the most potent factor of production than land productivity for the change of agricultural productivity in rural households. However, plot distance, market distance, drought variable and extension service included in the regression also significantly and negatively affects both labor and land productivity of rural farm households in Ethiopia.

The multiple regression result shows that, labor and land productivity, households off farm employment, the number of oxen and credit access of the household are the main determinates of rural household income in Ethiopia. The result also shows that, labor productivity has the major effect among the variable used in the regression for the change of rural household income improvement. The finding of the multiple regression models supports the viewthat improvements in agricultural productivity can have considerable positive impacts on household income. Especially improvements in labor productivity of household through better resource allocation and use of necessary inputs can increase the per capita income of the rural households.

5.2 Conclusions

The central focus of this thesis was to investigate the factors affecting agricultural productivity and rural household income Ethiopia. The landholding size of rural households was found to be too small to fulfill the annual food requirements of households. This was exacerbated by the large family size of farmers and the dependence on rain fed agriculture which was unpredictable. The proportion of irrigated land to the total cultivated land was small and that hindered farmers from achieving multiple harvests in a year.

The off- farm sector has to be expanded to absorb the growing population in the rural areas. There is a need of opportunity for an alternative source of income strategy because the demand for labor in the agricultural sector varies from peak to off- peak seasons. In areas where access to credit is limited, off- farm income is expected to help households purchase inputs such as fertilizers and selected seeds and to introduce new technologies. Therefore, the responsible government organs facilitate other job opportunity for the rural households especially for the youngsters.

The majority of the farmers used chemical fertilizers but the chemical fertilizer transactions were found to be full of tension in Ethiopia because Extension agents and local administrators were worried with achieving the quotas set for chemical fertilizer sales to farmers. Hence, farmers were forced to purchase fertilizers for the sake of fulfilling the sales targets set and there is no reasonable credit access in kind or in cash for the farmers.

Farmers used the farming practices of agricultural technologies without enough support from the experts. These farming methods were practiced by farmers without having the scientific knowledge to manage their farming activities. Most of the contact between extension agents and farmers was during the annual free labor mobilization for soil and water conservation activities and chemical fertilizer distribution. The professional advice of extension agents to farmers' specific problems was found to be minimal. In addition, extension agents were engaged in

activities which were not related to their field of study. They were involved in listing down the names of party members of the ruling party and the status of their membership fees and attending a series of unrelated meetings.

5.3 Recommendation

Based on the results obtained from the study, we suggest some policy intervention areas should be required. The policy implications that can be derived from this empirical study are:

- ✓ The assignment of crop, natural resource, livestock and irrigation experts is a good move to improve the production and productivity of the agricultural sector. Each of the experts should set a clear plan to meet and advise farmers in the area of their specialization. The primary task of experts should be to advice and support farmers and the primary task of an irrigation expert should be in irrigation related activities. To be specific, each of the experts should have an annual schedule to reach out and attend to the specific problems of these households in the areas of their specializations. This fixes most of the variables related to agricultural technologies

- ✓ It is better to strengthening the capacity of the local and federal administrative level, about the environmental protection system and rehabilitation program to protect the variations of climate over time, especially in areas adversely affected by a drought factor. All the responsible stakeholders use their possible efforts to reducing the drought risk through rural environmental protection and this contribute for productivity and production of rural households of Ethiopia.
- ✓ To increase the rural household income, needs improvements in land- labor ratio of farmers through better allocation of financial resource. the possible ways of application could be through different methods like arranging financial sources that can used for the purchase of different variable inputs and developing a work frame for non farm income employment opportunities in the rural labor market as well as shift the excessive farm labor force to the other potential cultivable area.

- ✓ Promotion of both farm labor productivity and non farm income are best focusing to speed up the enhancement of rural household per capita income.

5.3.1 Areas for Further Research

There are other relevant issues that are not addressed in this study. Hence, the following areas of future research are recommended.

The focus of this study was on agricultural productivity and rural household income. There is a need for research to investigate the marketing practice, channels and price determination of agricultural products of farmers in the study areas.

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Appendix

APPENDIX I: The within- group model regression outputs

i. Labor Productivity Model Output

Number of obs	4500
F(14,4482)	135.46
Prob > F	0.0000
R- squared	0.57781
Adj. R- squared	0.54128

Dependent variable logL/ Y				
Explanatory Variables	Coef.	Robust std.err.	T- value	p>t
Logk	0.826	0.024	34.270	(0.000***)
age	0.024	0.003	7.060	(0.03**)
gender	0.112	0.214	0.520	- 0.103
educlevel	0.019	0.031	0.61	- 0.148
fimily size	0.21	0.012	17.500	(0.011*)

oxenown	0.311	0.026	11.960	(0.000***)
Fertilizer used	- 0.123	- 0.059	2.080	(0.021*)
Pesticide used	0.003	0.001	2.010	(0.021**)
Irrigation	0.228	0.254	0.897	- 0.205
extsservice	- 0.002	0.001	2.000	(0.074*)
Access to credit	0.297	0.024	12.375	(0.003***)
Drought	- 0.077	0.038	2.263	(0.059*)
Mkt dist	- 0.017	0.001	17.000	(0.003***)
Plot dist	- 0.024	0.012	2.000	(0.056*)
Crop rotation	0.009	0.004	2.250	(0.091*)
_cons	7.586	0.361	21.013	(0.000***)

***Significance at 1%**significance at 5% *significance at 10%

Source: Computed from Ethiopian Socio economic survey data 2012- 2016

ii. Land Productivity Model Output

Number of obs	=4500
F(14, 4482)	=50.97
Prob > F	=0.0000
R- squared	=0.1124
Adj. R-squared	=0.1080

Dependent variable logK/ Y				
Explanatory Variables	Coef.	Robust std.err.	T- value	p>t
Number of labor	0.019	0.004	4.75	(0.021**)
age	0.024	0.011	2.18	(0.062*)
gender	- 0.003	0.169	- 0.018	(0.103)
educlevel	0.008	0.0028	2.86	(0.048**)
fimily size	0.210	0.067	3.13	(0.011**)

oxenown	0.008	0.0012	6.67	(0.000***)
Fertilizer used	0.109	0.054	2.02	(0.053*)
Pesticide used	0.033	0.013	2.54	(0.034**)
Irrigation	0.028	0.025	1.12	(0.105)
extsservice	- 0.029	0.0145	- 2.000	(0.072*)
Access to credit	0.027	0.0023	11.74	(0.004***)
Drought	- 0.094	0.043	2.19	(0.053*)
Mkt dist	0.023	0.0016	14.375	(0.004***)
Plot dist	- 0.004	0.0019	2.105	(0.054*)
Crop rotation	0.077	0.0357	2.157	(0.078*)
_cons	6.659	0.7132	9.3368	(0.033**)

***Significance at 1%**significance at 5% *significance at 10%

Source: Computed from Ethiopian Socio economic survey data 2012- 2016

APPENDIX II: The Fixed effect model regression outputs

I. Labor Productivity

FIXED- EFFECT REGRESION	
NUMBER OF OBS	=4500
R- sq	=0.5674
Adjusted R- sq	=0.5481
F(15, 4484)	=341.6
Prob>F	=0.0000

Dependent variable logL/ Y				
Explanatory Variables	Coef.	Robust Std. Err.	T	P>t
cultivated land	0. 761	0.034003575	22.38	(0.000***)
age	0.025	0.012493753	2.001	(0.04**)
gender	0.125	0.125125125	0.999	- 0.109

educlevel	0.026	0.619047619	0.042	- 0.151
fimily size	0.203	0.074358974	2.73	(0.018**)
oxenown	0.324	0.076941344	4.211	(0.000***)
Fertilizer used	0.237	0.11855928	1.999	(0.052*)
Pesticide used	0.013	0.0064261	2.023	(0.032**)
Irrigation	0.285	0.476588629	0.598	- 0.114
extension service	- 0.007	- 0.003327	2.104	(0.082*)
Access to credit	0.171	0.063239645	2.704	(0.023**)
Drought	- 0.24	- 0.10230179	2.346	(0.072*)
Mkt dist	- 0.022	- 0.0019942	11.032	(0.005***)
Plot dist	- 0.014	- 0.00694858	2.0148	(0.060*)
Crop rotation	0.07	0.037017451	1.891	(0.081*)
_cons	7.58	0.814440744	9.307	(0.000***)

*, ** And *** mean significant at 10%, 5% and 1% probability level, respectively

Source: Computed from Ethiopian Socio economic survey data 2012- 2016

II. Land Productivity

FIXED- EFFECT REGRESION	
Number of observation	=4500
F(15, 4484)	=93.99
Prob>F	=0.0000
R- squared	=0.6770
Adjusted R- sq	=0.6584

Dependent variable logK/ Y				
Explanatory Variables	Fixed effect	Robust Std. Err.	T	P>t
Number of labor	0. 016	0.007952286	2.012	(0.033**)

age	0.025	0.012506253	1.999	(0.053*)
gender	- 0.191	- 0.227110583	0.841	- 0.109
educlevel	0.026	0.01338826	1.942	(0.051*)
fimily size	0.101	0.04997526	2.021	(0.018**)
oxenown	0.016	0.002321195	6.893	(0.000***)
Fertilizer used	0.172	0.085089542	2.0214	(0.065*)
Pesticide used	0.114	0.04305136	2.648	(0.022**)
Irrigation	0.085	0.042842742	1.984	(0.63*)
extension service	- 0.013	0.006496752	- 2.001	(0.066*)
Access to credit	0.179	0.086223507	2.076	(0.043**)
Drought	- 0.241	- 0.125717267	1.917	(0.084*)
Mkt dist	- 0.021	- 0.003575685	5.873	(0.003***)
Plot dist	- 0.011	- 0.0055	2	(0.063*)
croprotation	0.014	0.007017544	1.995	(0.054*)
_cons	6.801	2.573212259	2.643	(0.024**)

*, ** And *** mean significant at 10%, 5% and 1% probability level, respectively

Source: Computed from Ethiopian Socio economic survey data 2012- 2016

APPENDIX III: The Random effect model regression outputs

I. Labor Productivity

Number of obs	=4500
F(14, 4482)	=50.97
Prob > F	=0.0000
R- squared	=0.1124
Adj. R-squared	=0.1080

Dependent variable logK/ Y				
Explanatory Variables	Coef.	Robust std.err.	T- value	p>t
Number of labor	0.681	0.338469	2.012	(0.000***)
age	0.019	0.009505	1.999	(0.02**)
gender	1.52	1.807372	0.841	(0.002*)
educlevel	0.19	0.097837	1.942	- 0.141
fimily size	0.031	0.015339	2.021	- 0.054
oxenown	0.52	0.075439	6.893	(0.000***)
Fertilizer used	0.313	0.154843	2.0214	(0.039*)
Pesticide used	0.032	0.012085	2.648	(0.041**)
Irrigation	0.821	0.41381	1.984	- 0.155
extsservice	- 0.003	0.001499	- 2.001	(0.089*
Access to credit	0.009	0.004335	2.076	- 0.135
Drought	- 0.231	0.338469	1.917	(0.061*)
Mkt dist	- 0.813	0.009505	5.873	(0.027**)
Plot dist	- 1.89	1.807372	2	(0.081*)
Crop rotation	0.078	0.097837	1.995	(0.062*)
_cons	7.052	0.015339	2.643	(0.000***)

***Significance at 1%**significance at 5% *significance at 10%

Source: Computed from Ethiopian Socio economic survey data 2012- 2016

II. Land Productivity

Number of obs	=4500
F(14, 4482)	=50.97
Prob > F	=0.0000
R- squared	=0.1124
Adj. R-squared	=0.1080

Dependent variable logK/ Y				
Explanatory Variables	Coef.	Robust std.err.	T- value	p>t
Number of labor	0.023	0.01013216	2.27	(0.022**)
age	0.019	0.00269122	7.06	- 0.11
gender	0.014	0.02692308	0.52	- 0.117
educlevel	0.183	0.09331973	1.961	(0.041*)
fimily size	0.031	0.0124	2.5	(0.054**)
oxenown	0.003	0.00025084	11.96	(0.000***)
Fertilizer used	0.211	0.10144231	2.08	(0.058*)
Pesticide used	0.172	0.08557214	2.01	(0.081*)
Irrigation	0.281	0.31326644	0.897	(0.053*)
extsservice	- 0.023	- 0.0115	2	(0.069*)
Access to credit	0.029	0.02109091	1.375	- 0.165
Drought	- 0.253	- 0.1117985	2.263	(0.059*)
Mkt dist	- 0.714	- 0.22884615	3.12	(0.039**)
Plot dist	- 1.31	- 0.655	2	(0.072*)

Crop rotation	0.491	0.21822222	2.25	(0.063*)
_cons	6.072	0.28896397	21.013	(0.048**)

***Significance at 1%**significance at 5% *significance at 10%

Source: Computed from Ethiopian Socio economic survey data 2012- 2016

Appendix V: Hausman tests

i. Labor productivity

Coefficients				
variables	B	B	b- B	sqrt(diag(V_b-V_B))
	Fixed	Random	Difference	S.E.
logAAL	0. 761	0.681	1.117	0.0150287
logRAVAL	0.025	0.019	0.006	0.0136178
FLTAL	0.125	1.52	- 1.395	0.0001765
OXAL	0.026	0.19	- 0.164	0.0729519
AG	0.203	0.031	0.172	0.0045118
EDU	0.324	0.52	- 0.196	0.0470322
HHS	0.237	0.313	- 0.076	0.0198617
SEX	0.013	0.032	- 0.019	0.1420381
PES	0.285	0.821	- 0.536	0.0259274
DRT	- 0.007	- 0.003	- 0.004	0.0324071
CRD	0.171	0.009	0.162	0.0254817
EXTN	- 0.24	- 0.231	- 0.009	0.0298674
IRRN	- 0.022	- 0.813	0.791	0.0479

MANURE	- 0.014	- 1.89	1.876	0.0264067
b = consistent under Ho and Ha; obtained from xtreg				
B = inconsistent under Ha, efficient under Ho; obtained from xtreg				
Test: Ho: difference in coefficients not systematic				
chi2(14) = (b- B)'[(V_b- V_B)^(- 1)](b- B)= 251.46				
Prob>chi2 = 0.0000				

Source: Computed from Ethiopian Socio economic survey data.

ii. **Land productivity**

Coefficients				
variables	B	B	b- B	sqrt(diag(V_b-V_B))
	Fixed	Random	Difference	S.E.
Number of labor	0. 016	0.023	- 0.007	0.007952286
age	0.025	0.019	0.006	0.012506253
gender	- 0.191	0.014	- 0.205	- 0.227110583
educlevel	0.026	0.183	- 0.157	0.01338826
fimily size	0.101	0.031	0.07	0.04997526
oxenown	0.016	0.003	0.013	0.002321195
Fertilizer used	0.172	0.211	- 0.039	0.085089542
Pesticide used	0.114	0.172	- 0.058	0.04305136
Irrigation	0.085	0.281	- 0.196	0.042842742
extension service	- 0.013	- 0.023	0.01	0.006496752
Access to credit	0.179	0.029	0.15	0.086223507

Drought	- 0.241	- 0.253	0.012	- 0.125717267
Mkt dist	- 0.021	- 0.714	0.693	- 0.003575685
Plot dist	- 0.011	- 1.31	1.299	- 0.0055
b = consistent under Ho and Ha; obtained from xtreg				
B = inconsistent under Ha, efficient under Ho; obtained from xtreg				
Test: Ho: difference in coefficients not systematic				
chi2(14) = (b- B)'[(V_b- V_B)^(- 1)](b- B)= 251.46				
Prob>chi2 = 0.0000				

Source: Computed from Ethiopian Socio economic survey data.

Appendix VI: Diagnostic Test for Heteroscedasticity

1. Heteroscedasticity Test for Labor Productivity Model

Modified Wald test for GroupWise Heteroskedasticity

In fixed effect regression model

Ho: sigma (i) ^2 = sigma^2 for all i

Chi (2215) = 4.9e+37

Prob>chi = 0.0000

2. Heteroscedasticity for Land Productivity model

Modified Wald test for GroupWise Heteroskedasticity

In fixed effect regression model

Ho: sigma (i) ^2 = sigma^2 for all i

Chi2 (2215) = 9.6e+36

Prob>chi2 = 0.0000

3. Heteroscedasticity for Rural Household Income model

Modified Wald test for GroupWise Heteroskedasticity

In fixed effect regression model

Ho: sigma (i) ^2 = sigma^2 for all i

Chi (2233) = 8.3e+35

Prob>chi2 = 0.0000

APPENDIX VII: Melticollinearity Test for Rural Household Income variables

. vif		
Variable	VIF	1/VIF
totalland	1.85	0.540541
fertitotal	1.73	0.578035
oxenown	1.6	0.625
gender	1.6	0.625
adultequiva	1.51	0.662252
educlevel	1.41	0.70922
age	1.39	0.719424
irritotal	1.34	0.746269
disaverage	1.24	0.806452
amountborro	1.21	0.826446
imprseed	1.2	0.833333
villawerema	1.17	0.854701
contactmonth	1.16	0.862069
zerograze	1.11	0.900901
croprotation	1.1	0.909091
enoughrain	1.06	0.943396
overall	1.04	0.961538
Mean VIF	1.34	

PPEDIX- VIII: Total Sample Households with Respective Regions During the Survey period

REGION	TOTAL SAMPLED HH'S
TIGRAY	650
AFAR	200
AMHARA	800
OROMIA	850
SOMALIE	500
BENSHANGUL_GUMZ	200
SNNP	900
GAMBELLA	200

HARARI	200
COUNTRY_LEVEL	4500