



ADDIS ABABA UNIVERSITY
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**ANALYSIS OF DETERMINANTS OF ADOPTION AND *USE INTENSITY* OF
ORGANIC FERTILIZER IN EJERE DISTRICT, WEST SHOA, OROMIA, ETHIOPIA.**

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Analysis of Determinants of Adoption and Use Intensity of Organic Fertilizer in Ejere District, West Shoa, Oromia, Ethiopia.

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This is to certify that the thesis prepared by Milkessa Dejene, entitled: Analysis of Determinants of Adoption and use intensity of Organic Fertilizer in Ejere District, West Shoa, Oromia, Ethiopia and submitted to department of Economics in partial fulfillment of requirements for Degree of Master Science in Economics (Economic Policy Analysis) complies with the regulations of the university and meet accepted standards with respect to originality and quality.

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ABSTRACT

The main objective of this study is to investigate the determinants of Adoption and use intensity of Organic Fertilizer in Ejere District, West Shoa, Oromia, Ethiopia. Primary cross-sectional data was collected from systematically selected 53 adopters and 151 non- adopters of organic fertilizer. The study employed probit model and the analysis was made using Cragg's double hurdle. The empirical Results revealed that age of household negatively influenced decision to adopt organic fertilizer while livestock numbers, extension contacts, access to information media, membership to farmer based organizations, farm experience and farm income positively influenced the decision to adopt organic fertilizer. However, the study found out that gender, household head education, and distance to near market have statistically insignificant impact on adoption of organic fertilizer. In addition, this study found that being single, divorced or widowed significantly decreases the adoption of organic fertilizer while getting married has opposite impact. What's more, farm size and membership to farmer groups influenced intensity of adoption positively while farm income and application frequency influenced use intensity of organic fertilizer negatively. This study also has an important policy implication. The findings of this study imply that appropriate and adequate extension services have to be provided in line with current agricultural development policies of the country. The government body of the district should encourage entrepreneurs to invest in organic fertilizer processing plants. The government should assign skilled and disciplined agricultural extension workers and must closely follow the performance the assigned extension workers to ensure that the farmers get the expected services. The policy makers should target at enabling farmers to have access to information media such as radio, and encouraging farmers' group formation and membership to such organizations. Improving farmer access to credit facilities needs to be enhanced. The national government along with local government should investment on the educational sector, expanding of infrastructural facilities, creating market activities, and building institutions. The government should encourage farmers to rear animals under intensive livestock management systems that support more livestock units per unit of land for provision of manure. This study would like to invite researchers to conduct more investigation on farmers' perception towards organic fertilizer and income and welfare impact of using organic fertilizer in the study area.

Keywords: Adoption, use intensity, organic fertilizer, probit model, double hurdle; Ejere district

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ACRONYMS AND ABBREVIATIONS

DAP	DIAMMONIUM-PHOSPHATE
EWNRAO	EJERE WORED A NATURAL RESOURCE AND AGRICULTURAL OFFICE
ETB	ETHIOPIAN BIRR
E.C	ETHIOPIAN CALENDER
FAO	FOOD AND AGRICULTURAL ORGANIZATION
GDP	GROSS DOMESTIC PRODUCT
GTP	GROWTH AND TRANSFORMATION PLAN
IFDC	INTERNATIONAL FERTILIZER DEVELOPMENT CENTER
IFPRI	INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
ISD	INSTITUTE FOR SUSTAINABLE DEVELOPMENT
MOFED	MINISTRY OF FINANCE AND ECONOMIC DEVELOPMENT
NPC	NATIONAL PLANNING COMMISSION
PAs	PEASANT ASSOCIATIONS
PIF	POLICY AND INVESTMENT FRAMEWORK
PSM	PROPENSITY SCORE MATCHING
R &D	RESEARCH ANDDEVE LOPMENT
TLU	TROPICAL LIVESTOCK UNIT

CHAPTER ONE: INTRODUCTION

1.1. Background of the Study

In recent years, the rising food price and food insecurity are prompting the importance of agriculture. Given that majority of the world's poor and food insecure live in rural areas of developing countries and depend on agriculture for a significant share of their livelihood, agriculture has regained much emphasis as an engine of economic development and poverty reduction. Unleashing agricultural productivity has the potential to ensure food security and provide gainful employment (World Bank, WB, 2017). It is considered as a more pro-poor than other sectors because it allows for greater participation of the poor in the growth process, and thus could be regarded as more effective at reducing poverty than non-agricultural growth (Diao *et al.*, 2010, Christiaensen *et al.* 2011, Mellor & Malik, 2017, Ivanic & Martin, 2018, and Ligon & Sadoulet, 2018).

As reported by National Bank of Ethiopia (2018), in Ethiopia, agriculture remains a dominant sector employing more than 80% of the country's population. It assumes the second position in the share of total Gross domestic product (GDP) of the country contributing 34.9 percent, being preceded by service sector (39.2 percent) and 16.5 percent of the overall growth in GDP of the country is attributed to its agricultural sector. Given that agriculture represents more than a third of the Ethiopian economy, the acceleration of agricultural growth will increase the national GDP growth rate. Faster agricultural growth will also stimulate additional growth in the non-agricultural sectors (spillover effects) by raising the final demand for non-agricultural goods and by lowering input prices and fostering upstream processing (Dorosh & Rashid, 2012).

Significant cost reduction and associated production increase occurs in agriculture, is largely derived from technological advances. Technology and innovations have tremendous potential to increase agricultural productivity, enhance the integration of value chains, and improve market performance. However, developing countries' agriculture is highly constrained with lack of finance and technological innovation in the sector. Hanjra *et al.* (2009) stated that agriculture in Africa is not developed to their full potential and it is constrained by different barriers among which financial and technology are the majors. Agricultural research intensity ratios in Africa

have fallen farther behind those in developed countries. Spending on agricultural R&D in many African countries is lower than would be expected (Alston and Pardey, 2006). Smallholder firms which dominate the African agriculture are facing serious financial constraints to invest (Lashitew, 2017). Lack of necessary capital and adequate infrastructure is also prevalent in Africa which is impeding agricultural growth (Salami et al., 2010; Baye, 2016).

Like other African economies, agriculture in Ethiopia has remained more or less static for centuries and people remained poor (Baye, 2016) and even the growth rate is on a decline. The agricultural output growth rate in 2018 alone is 3.5 percent which is lower than a 6.7 percent growth registered in the previous year. This growth in agricultural output is 4.4 percentage point lower than the 7.9 percent target for the fiscal year. The share of agriculture in total GDP of the country is falling fast relative to manufacturing and service sectors from 36.3 of previous year to 34.9 percent which is lower than the 35.4 percent GTP II target set for the fiscal year (NBE, 2018).

Though Ethiopia achieved the Maputo declaration target of 10 percent investment in agriculture, agriculture is still the underinvested sector in the country. Little progress and reforms towards the sector is driven by government expenditure on the sector in Ethiopia (Bachewe *et al.*, 2018). But reliance on public investment alone cannot bring the sector to perform to its full potential especially for less developed countries like Ethiopia where there is weak domestic saving capacity and limited private investment (Salami et al., 2010).

Moreover, despite its importance, the agricultural sector in Ethiopia is characterized by low productivity. This has resulted in increased poverty amongst most smallholder farmers. One of the major causes of low productivity is change in environmental conditions resulting from high population growth rate (International Food Policy Research Institute (IFPRI), 2018). The rapid population growth in rural and urban areas of Ethiopia has led to increased demand for energy and food. Many households use animal by-products such as manure for fuel while crop by-products are used both for fuel and animal fodder. The substitution of animal by-products and manure for fuel and animal fodder has led to low adoption of organic fertilizer by smallholder farmers. Rapid population growth has also resulted to increased demand for cultivable land leading to clearing of forests. This creates a serious problem on sustainability of the environment which has been associated with fluctuation of rainfall, exposing farm land to erosion and making

agricultural production vulnerable to weather fluctuations as well as deterioration in soil fertility which cannot be restored easily. The deterioration in soil fertility is associated with inadequate recycling of soil nutrients leading to gradual depletion of soil organic matter (Scotti et al., 2015). This leads to a reduction in agricultural productivity and hence increasing poverty levels. Reducing poverty levels as well as improving food security necessitates creation of a better performing agricultural sector. This is thus, the goal of the government and several development partners. In its first phase of five year (2010/11-2014/15) growth and transformation plan, the Ethiopian government had placed emphasis on agriculture and rural development specifically to reduce rural poverty and in general to improve overall economic growth (International Fertilizer Development Centre (IFDC), 2012). Based on the achievements, agriculture continued to be targeted in the second growth and transformation plan (2015/16 – 2019/20) giving priority to smallholder agriculture (National Planning Commission (NPC), 2015). These plans have been targeted ending poverty and making the country free from foreign aid by ensuring farmers reap maximum benefits from the agricultural sector (MoFED, 2010). To achieve this, the government has promoted different agricultural technologies in addition to scaling up the best practices of better performing farmers in overall sustainable improvement of agricultural productivity.

The major focus of the intervention was increasing land-labour ratio and adoption of new agricultural technologies by smallholder farmers; which includes use of fertilizer as the main yield-augmenting technology. Because of this, the government with other development partners gives more focuses on fertilizer adoption to improve smallholder farmers' income in Ethiopia. According to IFDC (2012) report the use of organic fertilizer in Ethiopia must essentially double by 1.2 metric tons of fertilizer products to meet the GTP target. On the other hand, Kassie et al., (2009) stated that the fertilizer adoption was initially limited to chemical fertilizer, while less attention was given to organic fertilizer. The soil had gradually deteriorated through loss of organic matter as the result of increased the use of chemical fertilizer by smallholders. It became compact, lifeless, and less able to hold nutrients and water, resulting to low productivity.

Currently, the government of Ethiopia with development partners has started encouraging the use of organic fertilizer. However, in most part of the country the technology was not well adopted by small holder farmers. For instance, the rate of adoption of organic fertilizer over the past years was not known in Ejere district. The rationale behind this is lack of well documented data over

the past. The recent report by EWAO (2018) however showed that about 32 percent of the farmers have adopted organic fertilizer in the district. Nevertheless, the culture of recycling some potential sources of organic fertilizer such as animal manure and crop residuals has been poor in Ejere district. As such, this necessitated evaluation of factors contributing to low adoption of organic fertilizer and use intensity of organic fertilizer of small holder farmers in Ejere district of Ethiopia.

1.2. Statement of the Problem

The occurrence of malnutrition is increasing and around 815 million of the planet populations are undernourished. Malnutrition is that the highest in Africa where agriculture is that the dominant sector and where there's huge yield-gap (Tigabu & Gebeyehu, 2018). One among the explanations for this is often decrease in soil fertility. Agricultural technology adoption features a role of accelerating productivity and rural farm income and hence considered together means of securing food and nutrition and thereby a fundamental instrument for sustainable development and poverty reduction.

Several studies empirically investigated the adoption decisions on agricultural technologies such as organic and inorganic fertilizers for improving the income of the smallholder farmers. However, the low adoption rate of recent agricultural inputs, like fertilizer, is usually suggested because the major reason for much of the stagnation in agricultural productivity across Sub-Saharan African Countries. Ethiopia's agricultural sector accounts about 40% of the national GDP and therefore the sector is vital in improving the livelihoods of the majority of the population. Despite its importance, studies such as Gelgo, Mshenga, & Zemedu, (2017) stated that the agricultural sector in Ethiopia is characterized by low production and productivity. To enhance this, the adoption of organic played a paramount role through maintaining soil fertility. As soil fertility features a direct deprecation on production and productivity of agricultural crops over the last years especially in developing countries where agriculture remains one among the most important sectors within the economy (Mengistu, 2011). Consistent with Chen, Zeng, Ying, & Fan, (2018) maintaining soil fertility by utilizing modern chemical fertilizer is dear for many smallholder farmers and it's proved that the chemical fertilizer imported wasn't compatible with the organic matter of soil in most parts of developing

countries. Thanks to this switching, organic may improve soil quality and reduce the value of input usage which reinforces the efficiency of production of crops.

According to FAO (2015) report in Ethiopia 44% of the population is undernourished with 47% experienced malnutrition and quite 40%, the proportion of a population living below international poverty level. Similar to this report the main reasons for food insecurity and poverty may include demographic trends, repeated drought, extensive land deprivation, shrinking, and fragmentation of landholdings, unfitting policies, poor infrastructure, ineffective agricultural practices et al. . Additionally, As Tura, Kenea, & Kaso, (2017) lack of adequate nutrient supply, the depletion of soil organic matter and erosion also are major obstacles to sustained agricultural production.

According to Sisay, Jema, Goshu, & Abdi, (2016) the means to a delayed increase in agricultural production is to enhance productivity, which may be realized through either use of recent agricultural technologies or enhancing the efficiency of production or both. Moreover, Fatimid, (2015) stated that significant characteristics related to use of organic agricultural production practices like use of compost, organic and conservation tillage may provide better information to support policies that promote adoption practices. Development programs in Ethiopia over the past 20 years have included several new technologies. Among the foremost recently introduced are improved seed, pesticides, improved farm storage techniques, methods of small-scale irrigation and fertilizer usage (Melesse, 2018). However, smallholder farmers have low habit to use organic (Mengistu, 2011). Due to this problem, the productivity of crop isn't improved over time (Teenagers, 2014).

Studies like Obisesan, Akinlade, and Fajimi (2013), Benjamin (2015), Combary (2016) and Gelgoet al. (2017) were conducted on fertilizer technology adoption. However, there are few sufficient empirical studies in Ethiopia particularly within the study area on organic user. Further, despite the efforts made by the government and other development partners to reinforce adoption of organic in Ejere district, the speed of adoption of this fertilizer remains low with only 32 percent of the households adopting organic (EWAO, 2018). There's a scarcity of data on the determinants of low adoption of this specific technology, the transaction costs involved also as effect on household incomes. Thus, to fill this gap, this

study is meant to gauge the determinants of low adoption and use intensity of organic in Ejere district. Specifically, the study tried to answer the subsequent questions:

- I. What the socio-economic characteristics of small holder farmers in Ejere district looks like?
- II. What is the level of transaction costs associated with organic fertilizer usage among smallholder farmers?
- III. What are the socioeconomic and institutional factors that influence adoption decision and use intensity of organic fertilizer?

1.3. Objectives of the Study

1.3.1. General Objective

The general objective of the study is to examine determinants of adoption and use intensity of organic fertilizer use by smallholder crop farmers in Ejere district, Oromia Regional State of Ethiopia.

1.3.2. Specific Objectives

The specific objectives are to:

- I. Examine some socio-economic characteristics of crop farmers in Ejere district.
- II. Evaluate transaction costs related with organic fertilizer usage among smallholder farmers.
- III. Investigate the socio-economic and institutional influences the adoption and use intensity of organic fertilizer.

1.4. The significance of the study

Organic fertilizers have huge importance for soil fertility improvement and cost reduction as compared to chemical fertilizer. Farmers can get this fertilizer at a lower cost and they can also prepare it locally on their farms as it requires less skill. It is more compatible with capabilities of smallholders with less skill and who lack capital to buy chemical fertilizer. Evaluation of constraints related to adoption and use intensity of organic fertilizer is relevant as it helps to provide empirical evidence to either confirm or deny the existing arguments in relation to the factors influencing adoption and use intensity of organic fertilizer. The results of this finding will support policy makers to derive sound ways of organic fertilizer adoption. Moreover, the finding of this study will also assist district agricultural office in designing future programs and strategies

of enhancing agriculture production and productivity of the area by promoting utilization of local available resources.

1.5. Scope of the Study

Agricultural productivity can be improved through employing different agricultural techniques such as conservation agriculture, adoption of improved variety of crops, fertilizer adoption and others. Although this study reviewed theoretical analysis related to some of these technologies, the main focus of analysis was adoption and use intensity of organic fertilizer in Ejere district small holder farmers. The study, as its core objective aimed at covering the determinants of adoption and use intensity of organic fertilizer of small holder farmers.

1.6. Limitation of the Study

Even if the research is properly designed it does not guarantee that it is free from constraints. In fact the researcher was undertaking this study under several difficulties that militated against meeting the objectives mentioned above. The study faced the following limitations” These are: Lack of adequate time and resource, limitation of knowledge gap in doing research, unwillingness of respondents, the absence of relevant data in the district agricultural office, the informants answer to the questions raised in an interview and questionnaires, limited knowledge of econometric model and etc. Sever political instability that has taken place in most parts of Ethiopia including Ejere woreda also put limitation on this study. The most difficult the researcher faced during data collection was corona virus pandemic. So, the data used in this study was collected under series problem and this put limitations on the result of the study.

1.7. Organization of the Paper

The rest of the paper organized as following. The second chapter provides theoretical and empirical literatures review. Chapter three focused on methodology of the study. The next chapter concerned with data analysis and presentation of the outcome. The fifth and the last chapter finally dialed with conclusion and recommendations with policy implication based on the findings and analysis. Finally, different references used and appendixes have been presented.

CHAPTER TWO: REVIEW OF RELEATEDLITERATURE

Modeling a household's decision to use a new technology is a difficult process. There is substantial variation in the methods and specifications of empirical studies of technology use. This chapter introduces theoretical reviews and some of the related work from previous studies. The types of models used in other empirical work as well as the types of variables employed in other models will provide a foundation from which the current study departs.

2.1. Basic concepts of technologies adoption

As definition of Feder *et al.* (1985), adoption of a new technology at the household level; defined adoption of a new technology is “the degree of use of a new technology in long-run equilibrium when the farmer has complete evidence regarding the new technology and its potential”. Moreover, according to Tedla (2011) explanation, the adoption decision also involves the choice of much resource; such as, land to be allocated to the new and the old technologies provided that the technology is not divisible; say mechanization and irrigation. On the other hand when the technology is divisible such as improved seed, fertilizer, and herbicides; the decision process involves area allocations as well as level of use or rate of application. So, this definition implies that adoption has two disconnected workings: a time component demonstrating length of time the technology has been used, and an intensity of use component representing the appropriateness of its use. Such long-run information is not often obtained, but, and the “adoption” of a technology is generally reduced to a binary variable indicating use of the technology or not (Kaliba *et al.* 2000).

Here, most of the time, the binary variable definition is based on whether a household adopted or did not adopt the technology. This study followed this pattern. In the first econometric analysis the binary variable approach is used and the sample is divided into two categories: households that used fertilizer and those that did not. In this approach, socio economic and institutional factors affecting the farmer's decisions to adopt organic fertilizer will be assessed. However, this approach, is not just exact; a major shortcoming is thathouseholdsemploying an inappropriate level of the technology are treated the same as those using an appropriate amount (Rauniyar and Goode 1992 and Feder et al. 1985). In spite of this limitation, the binary variable approach of modeling the use of a new technology is widely used.

The second econometric analysis performed in this thesis employs the quantity of fertilizer used as the dependent variable. The results of this second analysis indicated the household and geographic factors that affect the quantity of fertilizer a household uses. Finally, the effect of organic fertilizer usage on the household's income also analyzed using PSM procedure.

2.2. Importance of Agricultural Technology

Chi and Yamada (2002) defined agricultural technology as specific instrument designed to facilitate production in agricultural activity. It is an action designed to facilitate or improve pre-existing means of agricultural production. Therefore, agricultural technology is one of the resources in agricultural production.

There is an argument that a simple expansion of agricultural land might be dangerous to environmental conservation. Rather, if the objective of the farming community is to increase agricultural production, it is clear that adoption of agricultural technology is the key instrument. Byerlee *et al.* (1994) as cited in Makokha *et al.* (2001) concluded that although literature points out to the existence of sufficient agricultural technologies in Sub-Saharan Africa to increase food production, an appropriate policy environment coupled with an active technology transfer program has been lacking. To support this, several studies have been conducted suggesting the importance of agricultural technologies for better agricultural productivity.

As stated by Uaiene *et al.* (2009) the issue of improving agricultural productivity can be solved by adoption of better agricultural technologies. According to their conclusion except new technologies are adopted, increase in production will be slow posing rural poverty to remain widespread. These facts made intensification of such technologies continues to be necessary to increase agricultural productivity in most parts of Ethiopia. To ensure this sustainably, it was important to address core problems related to availability of agricultural technologies for farmers. This helps to ensure that smallholders have access to right technologies in the form that is appropriate to their local conditions accompanied with right information (IFDC, 2018).

But, in Ethiopia, as found by Spielman *et al.*, (2010) most small holder farmers have little chance to adopt new agricultural technologies on their farms. This is attributed to several constraints such as low human capital primarily low level of farmers' education. Most studies have evaluated the household heads' education level as the main determinant of technology adoption. However, even

though household head is not educated, if the education level of any of family member is higher than that of the household head, this may affect their decision to adopt new technology. Thus, there is a need to evaluate technology adoption based on the highest level of education of any of the household's family member. On the other hand, Endale (2011) stated that providing a platform for regular interaction of agricultural experts with farmers could enable farmers to adopt new technologies to boost their production. He tried to explain that this is valuable as it helps in gaining insights and sharing experiences amongst farmers and experts.

2.3. Overview of Organic Fertilizer Use in Ethiopia

Different sources such as crop residues, manure and municipality wastes, etc can be used to prepare organic fertilizer. In Ethiopia, Animal manure and agricultural residues are the most common sources of organic fertilizer. Other sources of organic fertilizer such as sewage sludge, slaughter house wastes and municipality solid waste (ISD, 2007) can also be processed to organic fertilizer. In Ethiopia, there are plenty of plant manure and agricultural residues to prepare organic fertilizer. However, the demand for organic fertilizer has been low in the country ("*Profile for Organic...*" n.d.). Few studies have evaluated adoption of organic fertilizer in Ethiopia (Terefe *et al.*, 2014; Ketema, 2011) while most of them were biased toward adoption of chemical fertilizer (Yu and Nin-Pratt, 2014). Further, the trend or rate of adoption of organic fertilizer over the past years has not been well documented in this country.

2.4. Role of Organic Fertilizer in Increasing Agricultural Production

It is that all agricultural crops require important nutrients in the soil for their growth. However, low productivity in Africa has been highly associated with low availability of nutrients for agricultural crops. Low soil nutrients associated with low application of fertilizer; particularly organic fertilizer has led to low productivity over the past decades. This has contributed to high food insecurity in most African countries including Ethiopia.

Ethiopian economy is highly dependent on agriculture. However, although the sector has been growing fast in this country, productivity remains low due to depletion of soil nutrients associated with low usage of organic fertilizer. The potential sources of organic fertilizer such as livestock dung and crop residuals in this country have not been appropriately used. Many smallholders

remove a large proportion of crop residuals during the time of harvesting though these residues are an important source of nutrients. Due to this, the estimated annual national loss of nutrients was equivalent to the total amount of chemical fertilizer use in Ethiopia (PIF, 2018).

The study conducted by Kassa et al. (2014) revealed that the adoption of organic fertilizer has positive impact on the agricultural productivity. The study showed that fertilizer adopters get better yield hence more farm income compared to their non-adopter counterparts. Moreover, ISD (2007) showed that productivity can be increased by more than double if organic fertilizer is used compared to when chemical fertilizer is used while IFPRI (2010) revealed that productivity increases by 10-20 percent when organic fertilizer is used compared to when only chemical fertilizer is used thus increasing household income. This shows that the adoption of organic fertilizer is important for improving productivity thus contributing to increased farmers farm income. The special characteristic and the very advantage of this fertilizer is that once it is applied, the farm can stay fertile for about four years and there is no need to apply it frequently therefore increasing productivity over several years. However, it was indicated that demand for organic fertilizer in Ethiopia has been low. This might be as a result of low understanding of its advantages (IFPRI, 2010).

2.5. Transaction Costs in Organic Fertilizer Adoption

It is important to estimate transaction costs (TC) related to technology adoption. According to Coase (1937) transaction costs include; search and information costs, bargaining and decision costs, and policing and enforcement costs which may be incurred between two or more parties (buyers and sellers and sometimes third body called mediator.) As Lavisson (2013) search and information costs are costs incurred to determine that the required organic fertilizer is available at right time, place and price in a given market and bargaining costs are costs incurred between parties in case the buyer reaches the desirable agreement with the seller. In addition, according to Lavisson, (2013) policing and enforcement costs are costs incurred in insuring that both parties stick to the terms agreed upon to facilitate the exchange. Thus, estimating these costs in relation to the technology being introduced in a given area is important because adoption of any technology has its own cost implication for the adopters.

According to Coase (1960) as cited in Lavison (2013) smallholder farmers may incur higher transaction costs on marketing compared to large scale farmers because of low bargaining ability. Due to this, transaction cost can serve as a barrier to smallholder farmers to participate in input and product market. Farmers may face several transaction costs while adopting organic fertilizer. These include cost of searching for the sources of organic fertilizer, bargaining costs, and others. In Ethiopia, particularly in Ejere district, organic fertilizer lacks well-structured markets, that is, traders who make transaction formally; rather the exchange usually takes place within the village. This may also contribute to increased transaction costs of obtaining organic fertilizer.

According to Jagwe (2011), transaction costs vary among farmers based on factors such as remoteness of farmers from the point of exchange place. He further elaborated those factors such as household size and ownership of means of transportation are directly proportional to the transaction costs.

Transaction costs can be measured directly or indirectly from the costs of getting or using the technology. For example, finding the sources of organic fertilizer can be done through telephone calls, texts or internet therefore incurring costs which can be estimated directly. However, in the absence of these means of searching for information, a household may walk or get any other means of transportation and search for information. In this case, the value of the best alternative forgone can be measured indirectly which is commonly known as opportunity cost.

Reducing transaction costs related to adoption of organic fertilizer is important as it helps to encourage farmer's participation in adoption of this technology. However, despite the importance of analysis of transaction costs, several studies conducted on adoption of organic fertilizer have not assessed this cost (Akpan et al., 2012; Terefe et al., 2013; Martey et al., 2013; Yu and Nin-Pratt, 2014).

2.6. Empirical Literature on Adoption of Organic Fertilizer

As any other kinds of technology, Adoption of an organic fertilizer may not be automatic. This is mainly due to the fact that a producer is rational and therefore prefers to see the benefit of a new technology before she/he adopts it. Therefore, farmers also see the performance of new technology by different ways. For example, according to Uaiene et al. (2009) if the technology is new, they can see its performance on any of local development partners' demonstration area and if the technology is only new to some farmers while others have already adopted, new adopters

may prefer to see its performance on neighbouring farmers' farm. In addition, once it is adopted, the technology must be properly used if agricultural productivity is to increase. Still, without close consideration to the use and adoption of improved agricultural technologies, production growth is likely to slow. Therefore, in addition to adoption, monitoring as well as technical advice from agricultural experts is important for effectiveness of these technologies. This type of advice as well as assistance holds only if the technology is adopted. However, in most developing countries such as Ethiopia, adoption of agricultural technology such as organic fertilizer has been low. Different scholars have been identified several factors as the main constraints of adoption of agricultural technologies. Moreover, these factors have been grouped into various categories by different researchers. For instance, Mwangi and Kariuki (2015) grouped these factors into technological factors, economic factors, institutional factors and household specific factors. They also found that perception of farmers toward new technology adoption is a means to adoption. Furthermore, their results pointed out that the determinants of agricultural technology adoption do not always have the same effect on adoption rather the effect varies depending on the technology being introduced. For example, the effect of farm size on adoption of some technologies such as intensity of chemical fertilizer adoption can be positive and the same variable may have negative impact on some other technologies such as zero grazing technology.

On the other hand, personal characteristics of the farmers, resource use and production characteristics, institutional and technological attributes taken by Ajewole (2010) as groups of variables affecting adoption of agricultural technologies. His study result found that a household head who is younger with lower farming experience, higher education level, many extension visits, and larger farm size and closer to the source of commercial organic fertilizer is more likely to adopt organic fertilizer compared to the households with opposite characteristics. However, Lavion (2016) noted that there is no generally acceptable criterion to group these variables. In his study he has therefore grouped these variables as socioeconomic characteristics and institutional factors. Accordingly, socioeconomic characteristics include age, gender, household size, education level, number of family who can provide labour, soil fertility, plot ownership, size of the plot, livestock holding, transaction costs and farm income while institutional factors include access to credit, access to extension services, access to information media, membership in local farmers' associations, access to organic inputs and distance from the residence to the nearest

market. These factors have been shown in different literature to have either negative, positive or no statistically significant impact on fertilizer adoption.

Endale (2011) in a study of use of DAP and Urea revealed that fertilizer adoption has high positive effect on production of some cereal crops such as teff, maize, wheat and barley. He also found that chemical fertilizers have insignificant effect on sorghum production due to specific characteristics of this crop whereby it usually grows in low rainfall area. This shows that technology adoption depends on the type of the crops under production as well as the climatic condition of the area. Thus, the type of crops grown and variation in weather conditions may affect the farmers' decision to adopt agricultural technology. For example, in some parts of Ethiopia, application of fertilizer on production of teff depends on the weather condition. Farmers in dry areas apply more fertilizer compared to farmers in high rainfall areas. Therefore, the compatibility of such technologies should be examined independently in different farming locations.

Uaiene et al. (2009) demonstrated the relationship between households' membership to different local farmer associations and fertilizer adoption decision. They revealed that better information dissemination through farmers' associations has positive impact on the decision to adopt new agricultural technologies. Better networked farmers may have better information about new technologies. Associations may also help to overcome credit markets failure. It helps farmers to get credit in terms of 'collective action.' This is also crucial for smallholder farmers to reduce transaction costs related to cost of bargaining in buying organic fertilizer.

As per study of Endale (2011) and Uaiene et al. (2009) better access to credit, livestock ownership and having a large family size have positive impact on fertilizer adoption. Access to credit helps farmers to overcome financial problems existing between harvesting and land preparation (Endale (2011). Moreover, Uaiene et al. (2009) found that inadequate access to credit is one of the major challenges of technology adoption. Having a large number of livestock may act as collateral to accessing credit from local financial institutions. In the absence of finances, farmers may sell the livestock and buy fertilizer during planting season. In addition, having a large number of livestock provides dung which is a potential source of organic fertilizer. Thus, any farmer who does not own livestock may not easily adopt organic fertilizer.

An empirical study made by Ketema and Bauer (2011) on fertilizer consumption, stated that a farmer with a large family is likely to adopt manure than chemical fertilizer. This is because such a farmer can get enough labour for both manure preparation and planting. Thus, a household with many members is more likely to demand more manure compared to a small household. Chemical fertilizer is relatively more capital intensive. Availability of enough capital increases the demand for chemical fertilizer. Therefore, availability of credit services coupled with small households may shift demand for organic fertilizer to chemical fertilizer.

In some parts of Ethiopia, women, in farming activities are treated differently from men. Culturally, some jobs are only for men while others are reserved for women. In this regard the study of Ketema and Bauer (2011) about fertilizer consumption in East and West Hararghe Zone of Ethiopia revealed that manure application is considered as women's job. Therefore, a household with more women is more likely to adopt organic fertilizer than that with fewer women. The study conducted by Birungi (2007) pointed out that an increase in distance of the plot from the farm site decreases manure application as it requires more labour and cost to transport the organic fertilizer from the village to the farmstead while increase in plot size increases likelihood of manure application. In addition, Ketema and Bauer (2011) also found that land size is positively related to manure application. As land size increases, it encourages investment through improving cost related to its application; therefore, the advantage of economies of scale is achieved. However, as the farm size becomes smaller, steeper and more fertile less manure is applied.

Most of the above literature concluded that there is a trade-off between chemical and organic fertilizer. However, generally, organic fertilizer adoption is low in Ethiopia; particularly, in Ejere district. Thus, there is a need to look for policy options which target at enabling farmers to increase adoption of organic fertilizer.

2.6.1. Farmers Perception on Adoption of Organic Fertilizer

Another important factor in adopting a new technology is perception about that technology. Van de Ban and Hawkin (1988) cited by Chi and Yamada (2002) defined perception as the process by which we receive information or stimuli from our environment and transform it into psychological awareness.

Farmers' perception about the performance of agricultural technologies significantly influences the decision to adopt them. Farmers may perceive that the performance of the technology being introduced is better than the earlier technologies. However, though they have positive perception about the specific technology, they may not adopt it because of lack of know how to use the technology, financial shortage or other constraints. Thus, positive perception is not a guarantee for a farmer to adopt a given technology (Mwangi and Kariuki, 2015 and Akpan et al., 2012).

The results of a study conducted by Diagne and Zeller (2001) in Malawi on adoption of agricultural technology showed that a farmer with low plot fertility has positive perception toward adoption of farm technology. This might be due to farmers' expectation of better returns from adoption of this technology. However, in Ethiopia, specifically in Ejere district, even if the plots of some farmers are not fertile they have never adopted organic fertilizer (EWAO, 2018).

2.7. Theoretical Framework

In this study three theories have been used to evaluate determinants of adoption of organic fertilizer and its effect on income. These are: - utility maximization theory, transaction cost theory and Solow growth model framework.

2.7.1. Utility Maximization Theory

Different models have been used by different researchers to build up on theories of adoption of new agricultural technologies. Most of these models are built on the theory of rational expectation. It is assumed that a firm's belief is always rational (maximum profit). However, for smallholder farmers, the reason for technology adoption is not necessarily profit maximization (Njane, 2007). They could have some primary objectives such as continuation of social status, fulfilling minimum subsistence requirements and others. To achieve these objectives, which can be represented by maximum utility a farmer need to adopt new technologies. On the other hand, according to Mendola (2007), farmers' decision making of technology adoption is guided by risk and uncertainties. Generally, based on the expectation, farmers decide either to adopt or not adopt new technologies.

Let U_{i1} and U_{i0} represent a firm's utility derived from two choices, in this case; adoption of organic fertilizer and not adopting organic fertilizer respectively. The assumption is that a firm derives maximum utility as much as possible from his/her efforts which depends on expected

utility to be obtained from either adopting or not adopting the new technology. Farmer is likely to adopt a new technology (organic fertilizer) if the expected utility of adoption (U_{i1}) is larger than the expected utility of not adopting (U_{i0}). Therefore, farmer i adopts organic fertilizer when expected utility to be derived from adoption of organic fertilizer is larger than expected utility to be derived from not adopting organic fertilizer subject to some exogenous variables such as level of income, experience, information and other constraints.

That is, if $U_{i1} > U_{i0}$, then

$$U_i = U_{i1} - U_{i0} > 0 \dots\dots\dots 1$$

But, utility is unobservable. Instead, a binary random variable Y_i (taking the value of one if the technology is adopted and zero otherwise) can only be observed. This variable for which its real value is not observable is also called latent variable. Based on the theory of utility maximization, a rational firm adopts a given new technology if $U(1, x) > U(0, x)$. Where, 1 represent the state with new technology and 0 represent the state with old technology, and x representing vector of additional attributes that may influence decision to adopt. Mathematically:

$$U_{i1} = W' \beta_{i1} + Z'_{i1} \gamma_{i1} + \varepsilon_{i1} \dots\dots\dots 2$$

And

$$U_{i0} = W' \beta_{i0} + Z'_{i0} \gamma_{i0} + \varepsilon_{i0} \dots\dots\dots 3$$

In both equations (equation 2 and 3), the observable (measurable) vector of characteristics of the household is denoted by w' . The vectors Z'_{i0} and Z'_{i1} denote attributes of the two choices that might be choice specific. The random terms, ε_{i0} and ε_{i1} represents the stochastic elements that are not known by the observer, but known only by individuals.

Based on the outcomes of equations (2) and (3) individual preferences are ranked. Therefore, if $y = 1$ denoting the individual choice of alternative 1, from $y = 1$ we can conclude that $U_{i1} > U_{i0}$.

Since the outcome is driven by the random elements in the utility function, we have:

$$U_i = W'(\beta_{i1} - \beta_{i0}) + Z'(\gamma_{i1} - \gamma_{i0}) + (\varepsilon_{i1} - \varepsilon_{i0}) = W' \beta_i + Z' \gamma_i + \varepsilon_i = \sigma x + \varepsilon \dots\dots\dots 4$$

$$\varepsilon_{i1} - \varepsilon_{i0} = \varepsilon_i$$

Assuming the error terms (ε_{i1} , ε_{i0} and ε_i) in equation (4) are independent and normally distributed; following probit specification, probabilities of choice can be estimated. After probit estimation, the above equation will have the following form:

$$P(Y = 1|x) = \beta_0 + \beta_1x_1 + \beta_2x_2 + \dots + \beta_nx_n + \varepsilon \dots \dots \dots 5$$

Where β represents estimated parameters and x represents factors influencing adoption of organic fertilizer such as age, gender of household head, level of schooling, and other institutional and socio-economic variables and ε represents error term.

This theory has been used to analyze determinants of adoption of organic fertilizer in Ejere district, Ethiopia. Therefore, it was assumed that farmers adopt organic fertilizer when they expect higher productivity from adoption of organic fertilizer than other types of fertilizer.

2.7.2. Transaction Cost Theory

Transaction cost presents costs to the parties involved in transaction (Coase, 1937). The theory of transaction cost states that difficulties in economic exchange between sellers and buyers arise because of three exchange related problems, namely; opportunism, bounded rationality and asymmetric information. Incorporating this cost into agricultural model is also possible (Lavison, 2013). The theory of transaction cost suggests that costs associated with market sometimes favour hierarchies. This could be due to adverse selection which occurs when sellers value the good more than its actual value. Adverse selection makes the buyer (who is not sure of the value of the good) to be unwilling to pay more than the expected value of the good. On the other hand, in the presence of contracts, it can be difficult for the buyers to control the behaviour of the sellers or vice versa known as moral hazard. Moral hazard occurs when one party (buyer or seller) is careless because he/she is already in the contract. This can make smallholder farmers not to participate in the market as their paying capacity is low. For example, smallholder farmers may get organic fertilizer easily if there is no barrier in terms of transaction costs which can be high in the presence of moral hazard and adverse selection. This theory also used in this study to evaluate transaction costs related to adoption of organic fertilizer.

2.7.3. Solow Growth Model

Solow growth model is a model of capital accumulation in production economy which is strictly interested in output (real income). The model was developed by Solow in 1956 and has been

applied to the study of growth problems. It assumes that all people work all the time and therefore no labour/leisure choice. Producers save a fixed portion of income and own the firms thus collecting their income, rent and profit in the form of output. The theory assumes that output (Q) is a function of labour (L) and capital (K):

$$Q = f(K, L) \dots\dots\dots 6$$

This model uses a production function of the Cobb-Douglas type presented as follows:

$$Q = AK^aL^b \dots\dots\dots 7$$

Where; Q, A, K and L are output, multifactor productivity, capital and labour respectively. a and b are less than one, indicating diminishing returns to a single factor and $a + b = 1$, indicating constant returns to scale. According to Solow (1956), an increase in output takes place due to an increase in multifactor productivity as well as an increase in capital per worker. It was therefore in this case assumed that, increase in use of organic fertilizer increases farm output hence income. The model states that output grows throughout. However, since production exhibits diminishing returns, at some point, the change in output slows down.

2.8. Conceptual Framework

Although set of agricultural technologies (for instance, fertilizer adoption) are available to farmers, their adoption has been constrained by several factors overtime. In Ejere district of Ethiopia, fertilizer adoption was among the highly promoted agricultural technologies to improve farm productivity. This promotion included both organic and inorganic fertilizer. However, adoption of organic fertilizer remains low up today compared to chemical fertilizer due to some exogenous factors determining acceptance of this technology. These factors were classified into socio-economic factors and institutional factors. Socio economic factors include household related variables such as household characteristics, ownership, and transaction costs while institutional factors include access to the market, information and credit.

Following different theories discuss above, this study has put the following pre-hypothesis. A younger household with less experience, more formal education level and higher number of working family member is likely to adopt organic fertilizer. Thus, the more the level of education, number of working family members and farming experience of household, the higher the likelihood of adopting organic fertilizer. Female headed households are likely to adopt organic

fertilizer compared to male headed. Land and livestock ownership have positive effect on adoption of organic fertilizer. If a household owns livestock, he would have better sources of organic fertilizer such as animal manure. This increases likelihood of adopting organic fertilizer. Better access to information has positive effect on farmers' decision of adoption of organic fertilizer. Farmers can get information from local farmers associations, extension services and information media. Thus, improvement in access to information could increase farmers' propensity of organic fertilizer adoption. Availability of organic fertilizer at a lower cost for farmers increases likelihood of adopting organic fertilizer. Thus, the lower the transaction costs related to organic fertilizer adoption, the higher the likelihood of adopting organic fertilizer. Finally, adoption of organic fertilizer improves soil fertility therefore increasing farm income. Generally, these variables and their relationship are presented diagrammatically as follow in Figure 2.1.

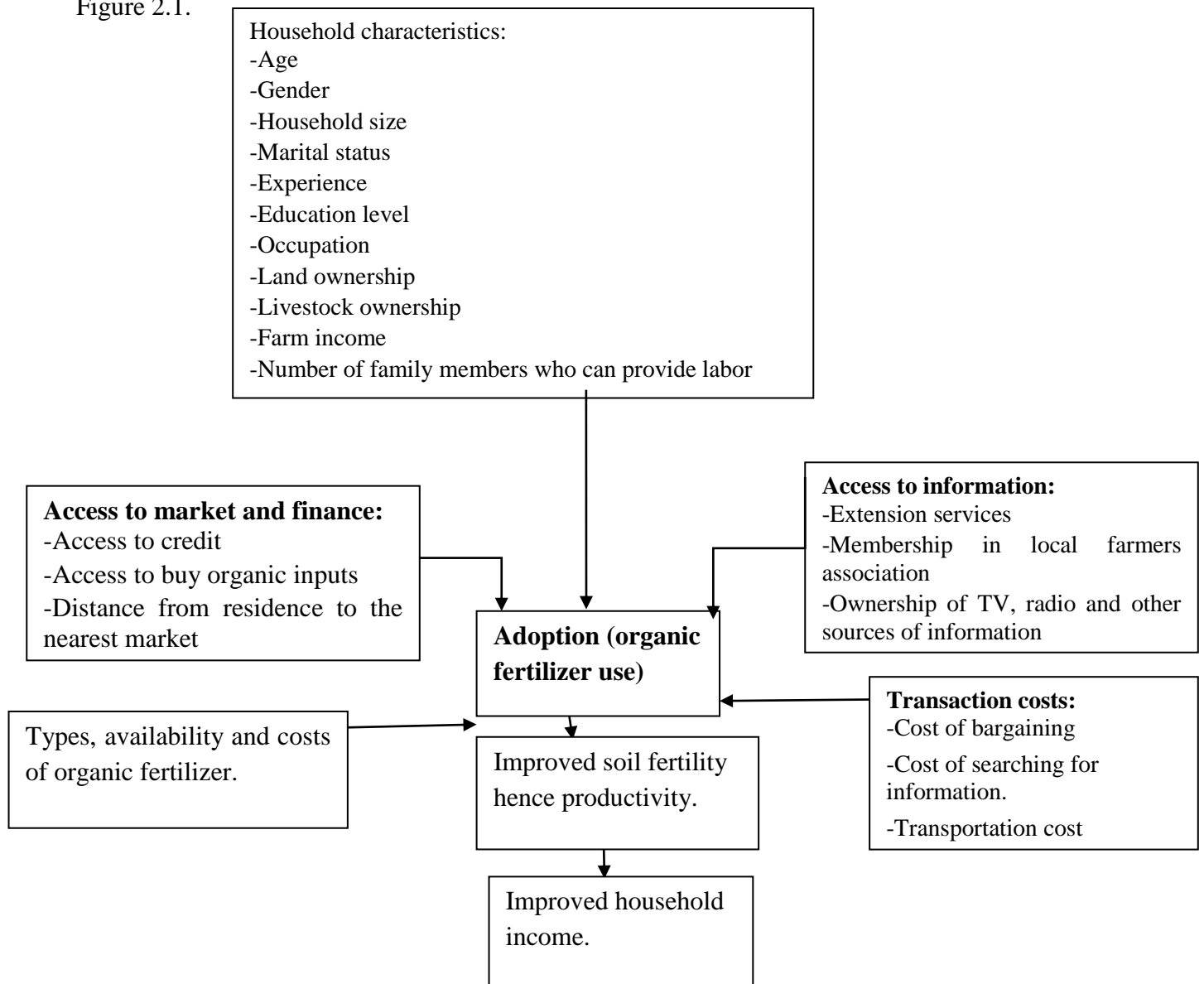


Figure 2. 1: Factors influencing organic fertilizer adoption

2.9. Definition of Terms

Woreda:-is the fourth administration level from the higher to the lower administration division in Ethiopia. It comes after National, Regional and Zonal administration. It is also known as *district*.

Kebele: – is the bottom unit of local government in Ethiopia. It comes after National, Regional, Zonal and woreda administration. It is also known as Peasant Association.

Transaction cost: – is a cost resulted from the transfer of property right.

Opportunity cost: – is the best value forgone because an alternative course of action has been chosen.

Smallholder: – is a farmer owning less than 5 hectares of land.

Adoption: – is the choice of acquiring and using something. In this study “adoption of organic fertilizer” shows the stage or choice of using organic fertilizer.

Collective action: – is an action taken by a group of people whose objective is to enhance resource use and achieve common goal.

Organic fertilizer: – is a plant food rich in carbonic content (Lavison, 2013) which is mainly prepared from animal matter, plant matter or minerals occurring in nature.

Productivity: – is a measure of efficiency with which inputs are utilized in production. It is the ratio of agricultural outputs to agricultural inputs.

Technology – is a new or improved means of producing goods and services aimed at improving a given situation or changing status quo to a more desirable level.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Study Area

The study was conducted in West Shoa Zone, specifically, in Ejere District. Ejere district, having an area of 620.065 square km, is located in West Shoa Zone of Oromia Regional State, with the capital located at 43 km west of Addis Ababa. It is bordered in the South by the Southwest Shoa Zone, in the West by Ejersa Lafo district, in the Northwest by Jeldu district, in the North by Meta Robidistrict, in the Northeast by Ada Berga district, and in the East by Walmara district (EWAO, 2019).

The district has a total of 29 kebeles of which 26 are rural based kebele administration areas and 3 are town kebeles. Total human population of the district is estimated at 114,714 of whom 58,265 are males and 56,449 females. Of the total households 94.2% are rural of which only 14064 are agricultural households (12.26 percent of total population) (CSA, 2017). The altitude of the district varies from 2,060 meters to 3,085 meters above sea level. It receives an annual rainfall of 910-1,200 mm, and has an annual temperature range of 9⁰C-25⁰C. The district has two agro ecologies which is Dega (45%) and Weina Dega (55%) (EWAO, 2019).

The soils types in the district are predominantly red (58%), black (32%) and mixed (10%). The district is characterized by subsistence mixed farming system in which production of both crops and livestock is common economic activity. The total land of the district is estimated to be 55,318 ha, out of which 39,445 ha (about 71%) is cultivated land, 4,436 ha (8%) is grazing land, 4,421ha (8%) is forest and 7,036ha (12.7%) is covered with others (EWAO, 2019).

The district is known for its high production potential of crops and livestock. Crop production takes the lion's share of consumption and income generation of the household. Cereals crops widely produced in the area include *teff*, wheat, barley and maize, pulse crops like chickpea, haricot bean, fababeans and noug are the major crops grown. Moreover, vegetables and root crops produced in the area include onions, potato, tomato, pepper, cabbage and sweet potato. Annual crops are predominant and rain-fed agriculture is mainly practiced using animal power. Livestock production is also another source of income and food source next to crop production. In addition to providing food and income livestock is the source of footing power and used as a means of transpiration. Farmers keep a significant number of livestock (cattle, sheep, donkey and horse) for

various purposes in the study area (EWAO, 2019). Although agriculture has been the main activity in the district, agricultural productivity remains low.

As discussed above, Ejere district is rich in livestock, Cereals crops, pulse crops, vegetables and root crops. It has more than 260,697 heads of livestock comprising 37 percent of cattle, 19 percent of goats, 16 percent of sheep, 4.3 percent improved livestock and 14.7 percent others. This shows that the district has ample resources for preparing organic fertilizer especially from animal dung which could enable the districts' smallholder farmers to overcome the problem of low crop productivity. The high potential for organic fertilizer production with low adoption rate (32%) made the district to be chosen for the study. Moreover, the report of the district agricultural development office showed that fertilizer to land ratio in the district is 60 kg per hectare whereas the recommended level is 100 kg per hectare. This is another reason which has made this area to be chosen for the study to identify constraints of organic fertilizer adoption.

Generally, Ejere district is shown below on the map depicted in Figure 1

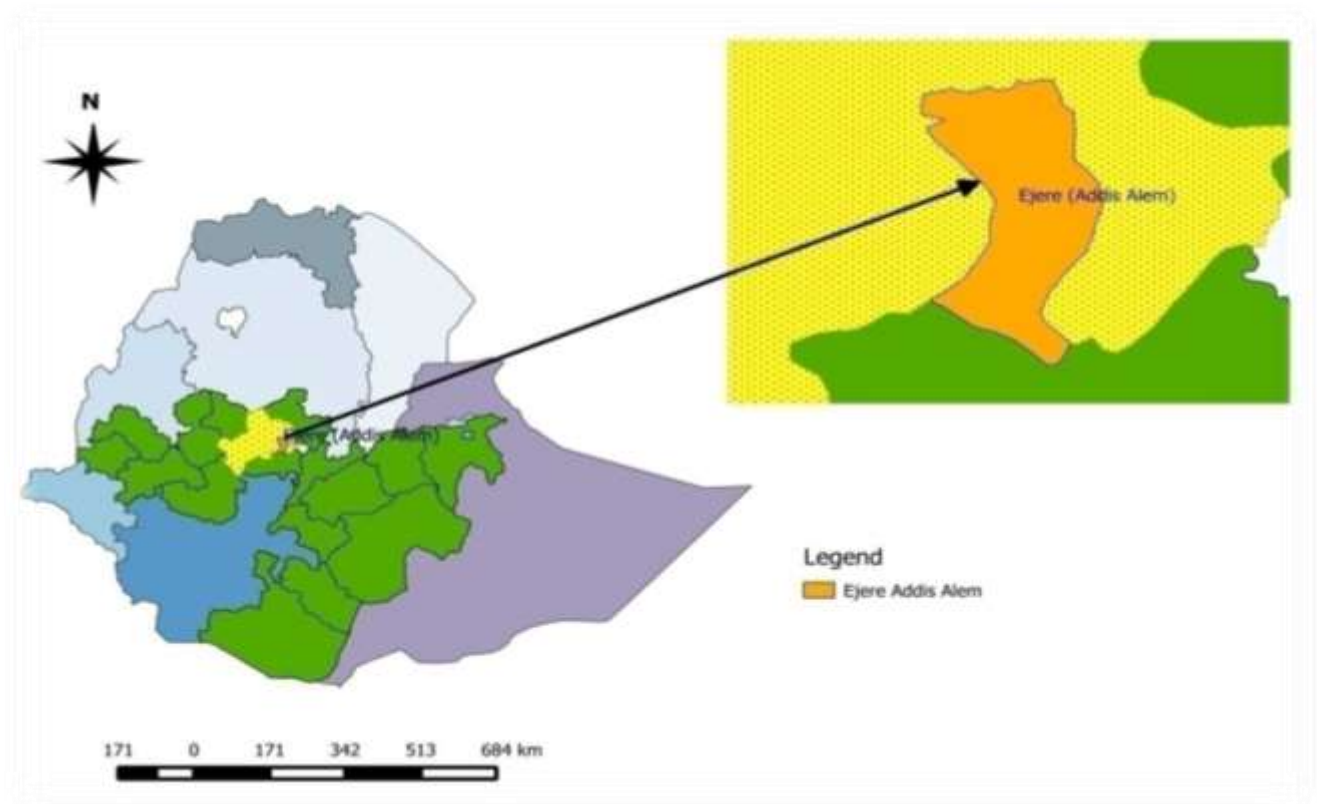


Figure 3.1:_ Map of Ejere district

3.2. Research Design

Primary cross-sectional data was collected using a household sample survey design. This is preferred because it allows collection of primary data where the population is large. The study also used descriptive survey design and the design is preferred because it allows analysis of both quantitative and qualitative data. Descriptive survey also helps to describe characteristics of targeted individuals or groups.

3.3. Sampling Procedures and Sample Size

The target of the study was smallholder farmers producing crop in Ejere district of West Shoa, Oromia, Ethiopia. Ejere district has 29 kebeles of which 26 are rural kebeles and 3 are urban kebeles. The district has 14064 rural agricultural household. Of 26 rural kebeles, 13 kebeles are Woina dega and 13 kebeles are Woina dega. A multi-stage sampling technique which involves combination of simple random, systematic random and stratified sampling methods was used to select smallholder farmers. The sample was determined in three stages as follow.

Stage I: stratification.

In this stage, the researcher purposefully stratified a total of 26 rural kebeles into two agro-ecological zones (Dega and Woina dega). The Following Table shows the list of rural kebeles in Ejere district with their respective total agricultural household and their agro-ecologies.

Table 3.1. list of Ejere woreda kebeles with their respective number of agricultural household and agro-ecological zones.

S. No	Name of Kebele	No of agricultural household	Agro-ecology
1.	Cirri	528	Woina dega
2.	Kusaye	372	Woina dega
3.	Gollii	327	Woina dega
4.	Indode	336	Woina dega
5.	Talbo	461	Woina dega
6.	Hiddi	895	Woina dega
7.	Amarro	891	Woina dega

8.	Bollongo	293	Woina dega
9.	Dibu	577	Woina dega
10.	Kimoye	566	Woina dega
11.	Hora	565	Woina dega
12.	Tullu Korma	313	Dega
13.	Inaftu	760	Woina dega
14.	Arrabsa	473	Woina dega
15.	Damottu	545	Dega
16.	Gaba jimata	603	Dega
17.	Lanqisa	469	Dega
18.	Gullit	596	Dega
19.	Liti Mado	448	Dega
20.	Arertu	466	Dega
21.	Gorba	645	Dega
22.	Borce	406	Dega
23.	Daka bora	573	Dega
24.	Ilu aga	719	Dega
25.	Baso	465	Dega
26.	Tuqa	772	Dega
Total		14064	

NB: Ejere district natural resource and agricultural office considers and follows only rural kebeles, so the researcher took sample from rural kebeles.

Stage II: Simple Random sampling.

In this stage Simple Random sampling (lottery method) was used to draw sample kebeles from each agro-ecology. At this stage the researcher selected 14 (about 50% of each stratum) of which seven kebeles from dega and seven kebeles from woina dega. Accordingly, the following kebeles has been select (identified) by lottery method.

Table 3.2: list of selected kebeles

S.No	From Dega	From Woina dega
1.	Baso	Hora
2.	Lanqisa	Golli
3.	Ilu-aga	Indoddee
4.	Gorba	Inaftu
5.	Dhamottu	Hiddi
6.	Gaba jimata	Talbo
7.	Gullit	Bollongo

Sample size to be taken from each kebele depends on their respective number of agricultural household and level of precision. The sum of agricultural household of selected kebeles (14) is 7677 of which 4042 and 3635 are from dega and woina dega respectively.

To determine the sample size the Yamane (1976) formula was used because the population is known. The formula is given as

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

Where n is sample size, N is total population and e is error margin, so the sample size of this study by allowing the lower level of precision (0.07) was

$$\frac{7677}{(7677 + 1)(0.07)^2} = \frac{7677}{37.6222} = 204.0551 \sim 204$$

The sample size allocated to each kebele was according to their total number of agricultural household (sample allocation was proportional). Accordingly, the following table shows how many agricultural household is taken from each selected kebele at e is equal to 0.07. The researcher took 0.07 level of error margin because the researcher wanted to minimize the sample size since it was difficult to collect data from large sample because of mainly corona virus. In addition to this, taking financial accessibility and time constraints into account at this level, 14 peasant associations were selected randomly. Regarding the sample size determination, Storck et.al.(1991) showed that the size of the sample depends on the available fund, time and other

reasons not necessarily on total population. Hence, the researcher took a total sample size of 204 households of which 53 households are adopters and the rest are non-adopters of the technology from these 14 peasant associations using simple random sampling.

That is, if P_i represents the proportion of population included in stratum i , and n represents the total sample size, the number of elements selected from stratum i (n_i) is $n.P_i$. i.e. $n_i = n (N_i/N)$

Table3.3: list of selected kebeles and sample drawn from Dega.

S. No	Name of kebele	No of agricultural household(N_i)	Sample to be taken from each selected kebele
1.	Baso	465	$\frac{204 * 465}{7677} = 12$
2.	Lanqisa	469	$\frac{204 * 469}{7677} = 12$
3.	Ilu aga	719	$\frac{204 * 719}{7677} = 19$
4.	Gorba	645	$\frac{204 * 645}{7677} = 18$
5.	Dammotu	545	$\frac{204 * 545}{7677} = 15$
6.	Gaba jimata	603	$\frac{204 * 603}{7677} = 16$
7.	Gullit	596	$\frac{204 * 596}{7677} = 16$
Total		4042	107

Table3.4: list of selected kebeles and sample drawn from Woina dega

S. No	Name of kebele	No of agricultural household	Sample to be taken from each selected kebele
1.	Hora	563	$\frac{204 * 563}{7677} = 15$
2.	Golli	327	$\frac{204 * 327}{7677} = 9$
3.	Indoddee	336	$\frac{204 * 336}{7677} = 9$
4.	Inaftu	760	$\frac{204 * 760}{7677} = 20$
5.	Hiddi	895	$\frac{204 * 895}{7677} = 24$
6.	Talbo	461	$\frac{204 * 461}{7677} = 12$
7.	Bollongo	293	$\frac{204 * 293}{7677} = 8$
Total		3635	97

Then, agricultural household of each selected kebeles grouped into two categories (adopters and non-adopters).

The following table shows number of adopters and non-adopters of each selected kebeles.

Table 3.5: Number of adopters and non-adopters

S. No	Name of Kebele	No of agricultural household	Number of adopters	Number of non-adopters
1.	Baso	465	147	318
2.	Lanqisa	469	126	343
3.	Ilu aga	719	117	602
4.	Gorba	645	137	508
5.	Dammotu	545	130	415
6.	Gaba jimata	603	142	461
7.	Gullit	596	129	467
8.	Hora	563	147	416
9.	Golli	327	137	190
10.	Indoddee	336	124	212
11.	Inaftu	760	184	576
12.	Hiddi	895	176	719
13.	Talbo	461	159	302
14.	Bollongo	293	116	177
Total		7677	1971	5706

From the above table one can see that adoption rate of the selected kebeles is 26% which is too low. The data were collected from 204 agricultural household, of which 26% were adopters and 74% were non-adopters of organic fertilizer. The samples were assigned to adopters and non-adopters proportionally. Accordingly, the data set contains 204 observations, of which 53 were adopters and 151 were non-adopters of organic fertilizer. The following table shows how and how many adopters and non-adopters sample was taken from each kebele.

Table 4.6: Number of adopters and non-adopters and how sample was taken from each kebele

S. No	Name of Kebele	No of agricultural household	Number of adopters	Sample size	Number of non-adopters	Sample size	Total Sample Size
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1.	Baso	465	147	4	318	8	12
2.	Lanqisa	469	126	3	343	9	12
3.	Ilu aga	719	117	3	602	16	19
4.	Gorba	645	137	4	508	14	18
5.	Dammotu	545	130	4	415	11	15
6.	Gaba jimata	603	142	4	461	12	16
7.	Gullit	596	129	3	467	12	15
8.	Hora	563	147	4	416	11	15
9.	Golli	327	137	4	190	5	9
10.	Indoddee	336	124	3	212	6	9
11.	Inaftu	760	184	5	576	15	20
12.	Hiddi	895	176	5	719	19	24
13.	Talbo	461	159	4	302	8	12
14.	Bollongo	293	116	3	177	5	8
Total		7677	1971	53	5706	151	204

Stage III: Systematic random Sampling:

In this stage systematic random sampling was used to select the sample for the adopters and non-adopters in each kebele. This was done after having list of adopters and non-adopters from their respective kebele office.

3.4. Methods of Data Collection

A structured questionnaire was used for this study as the data collection instrument. The questionnaire was administered to the respondents after the permit obtained from the district agricultural development office. The permit will mainly used to get list of farmers from respective PAs. For the collection of these data in this way 8 enumerators from the local area who have at least diploma were trained well and sent for data collection. Before data collection, the questionnaire was pre-tested on three to five (3-5) farmers to evaluate the appropriateness of the design, clarity and interpretation of the questions, relevance of the questions and to estimate time required for an interview. Subsequently, appropriate modifications and corrections were made on the questionnaire. The questionnaire covered different topics in order to capture relevant information related to the study objectives. After data collection ended, the researcher randomly

picked 3-5 respondents from each PA and checked whether the enumerators really collected an accurate. To support the data collected from the field, secondary data, which was be collected from different published or non-published research journals and reports of woreda agricultural development office has been taken.

3.5. Data Analysis Techniques

In order to analyze the data, simple descriptive statistics, inferential statistics and econometrics techniques was applied. Simple descriptive statistics such as mean, standard deviation, frequency, inferential statistics techniques such as t-test, and chi-square test and probit econometrics model was be used using STATA as a tool of analysis. To achieve the objectives of the study, the following task has been performed.

A) Estimating and Characterizing Transaction Costs Associated with Organic Fertilizer Usage amongst Smallholder Farmers

Transaction cost measures all costs incurred by farmers' when using organic fertilizer. It is the sum of the costs for searching information, bargaining, and enforcements. Like any other costs, transaction cost is divided into variable and fixed cost. Thus, to arrive at a total transaction cost, it is important to consider both variable transaction cost and fixed transaction cost elements. These costs can also be determined directly or through the opportunity cost. Lavison (2013) used transaction cost formula given in equation (9) to estimate transaction costs associated with adoption of organic fertilizer in vegetable production in Ghana. The formula was introduced by Coase (1937). It has been used to estimate aggregate transaction costs incurred by the households' in using a given technology. Transaction costs also differ from one household to the other household or from one technology to another technology. Following Coase (1937), this study employed the following formula to estimate transaction costs associated with organic fertilizer use among smallholder farmers in Ejere woreda. Accordingly:

$$T_i = \sum_{i=1}^n C_{ij} \dots\dots\dots 9$$

$$C_i = C_{info} + C_{opcost} + C_{barg} + C_{oth} \dots\dots\dots 10$$

considered as optimum in the study area, and Di as explained earlier. Then, the following empirical models will be specified to evaluate factors affecting adoption decision and use intensity of organic fertilizer using double hurdle model:

1st hurdle: Adoption decision model (Probit output);

$$Adop = \beta_o + \beta_i X_i + \mu_i \dots \dots \dots 15$$

2nd hurdle: Outcome equation model (Truncated output);

$$Y_i = \gamma_o + \gamma_i Z_i + \mu_i \dots \dots \dots 16$$

Where $Adop$ is organic fertilizer adoption taking values of 1 for adopters and 0 for non-adopters, X_i is a vector of explanatory variables hypothesized to affect decision to adopt organic fertilizer, Y_i is quantity of compost being used by the respondents in the study area and μ_i is normally distributed error term with zero mean and constant variance.

C) Detecting Multicollinearity, Outliers and Statistical Specification Problems

There are different types of statistical problems which should be checked during analysis before executing the final model. Multicollinearity is one of the most common problems. Thus, in this study, all the hypothesized explanatory variables will be checked for the existence of such a problem. Multicollinearity arises due to the existence of linear relationship between explanatory variables. The problem may cause the estimated regression coefficients to have wrong signs, smaller t -ratios for many variables and high R^2 in the regression. It may also cause variances and standard errors to be high with a wide confidence intervals making the estimation accuracy of the impact of each variable low (Gujarati, 2004; Greene, 2012).

Different methods have been suggested by several scholars on the ways of detecting multicollinearity among explanatory variables. Variance-inflating factor (VIF) technique is among these methods. The technique shows how variance of an estimator is inflated by the presence of multicollinearity (Greene, 2012). VIF can be computed mathematically as follows:

$$VIF = \frac{1}{1-R^2} \dots \dots \dots 17$$

Where; R^2 is coefficient of determination among explanatory variables and VIF is variance inflating factor. The larger the value of VIF , the more the degree of collinearity among explanatory variables (Greene, 2012). This study employed VIF method to check for the existence of multicollinearity. If the VIF of a variable exceeds 10, which could happen if a multiple R^2 exceeds 0.9, that variable is said to be highly collinear (Greene, 2012).

3.6. Variables of the Model

The dependent variable for the first hurdle of the second objective was participation in organic fertilizer adoption. The variable was dummy and represented by 1 for the households who have adopted organic fertilizer and 0 otherwise. In the second hurdle, the dependent variable was intensity of organic fertilizer adoption and it was continuous. The possible explanatory variables hypothesized to have impact on adoption of organic fertilizer including dependent variables are summarized in the following Table.

Table 3.7: Definition and Prior Assumptions of the Variables will be used in Empirical Analysis

Variables	Unit	Nature	Description	Hypothesis(expected size)
Adop	1 or 0	Dummy	Organic fertilizer adoption; 1 = if adopted, 0 = otherwise	Dependent variable
Intensity	Quintal	Continuous	Intensity of organic fertilizer use in quintal	Dependent variable
Age	Year	Continuous	Age of household head in years.	-
Gend	1 or 0	Dummy	Gender of household head; 1 = male, 0 = female	+/-
Educ	Year	Continuous	Household head education level in years.	+
Mstatus	1,2,3 or 4	Dummy	Marital status of household head; 1 = married, 2 = widowed, 3 = divorced, 4 = single.	
Wfam	Number	Discrete	Number of labourers; family members within the age of at least 18 years.	+
Hsize	Number	Discrete	Household size; total number of family members.	+

Exp	Number	Continuous	Length of time household head practiced farming in years.	-
Incom	Birr	Continuous	Household head's per hectare farm income in ETB	+
Powner	Hectare	Continuous	Households' farm size in hectare.	
Sfertility	1,2,or 3	Dummy	Perception about the soil fertility; 1 = less fertile, 2 = medium, 3 = fertile.	
Lstock	TLU	Continuous	Ownership of livestock measured as tropical livestock units (TLU).	+
Dist	Km	Continuous	Distance from the residence to the nearest market in kilometres.	-
FreqAppl	1,2,3 or 4	Dummy	Frequency of organic fertilizer application; 1 = every season, 2 = per two season, 3 = per three season, 4 = above three season.	-
Cred	Birr	Continuous	Amount of credit in Ethiopian Birr.	
Exten	Number	Continuous	Access to Extension services; number of extension meeting during previous agricultural season.	+
Memb	Number	Discrete	Number of organizations a household is a member in.	+
Tc	Birr	Continuous	Transaction costs associated with organic fertilizer adoption in ETB.	-
Aces	1 or 0	Dummy	Access to information media such as radio and television; 1 = have access, 0 = no access.	

Note, TLU is a unit that represents an animal of 250 kg live weight. Following Runge-metzger (1988), the unit was 1.0 for cattle, 0.1 for sheep and goat, and 0.04 for

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1.Socio-Economic and Institutional Characteristics of respondent Households

4.1.1. Results on Gender and Marital Status

The following figures show the total numbers and percentage of respondents. Accordingly, the results presented in figure 1 Shows that about 13 percent of the households were female headed while about 87percent were male headed. Among the adopters of organic fertilizer, about 13.6 percent of the households were female headed against 86.4 percent of the male headed households. On the other hand, amongst the non-adopters of organic fertilizer, about 12.8 percent of the households were female headed while the remaining 87.2 percent were male headed. The results showed that the proportion of male headed households were higher both among the adopters and non-adopters of organic fertilizer compared to that for female headed households. Among the adopters of organic fertilizer, the higher proportion of male headed households could be due to better exposure that the male headed households have to different technologies and trainings delivered by extension agents. According to IFPRI (2011 E.C), male heads are more likely to attend community meetings and visit demonstration plots or research centers compared to female heads. This could possibly make male headed households to be more adopters of organic fertilizer.

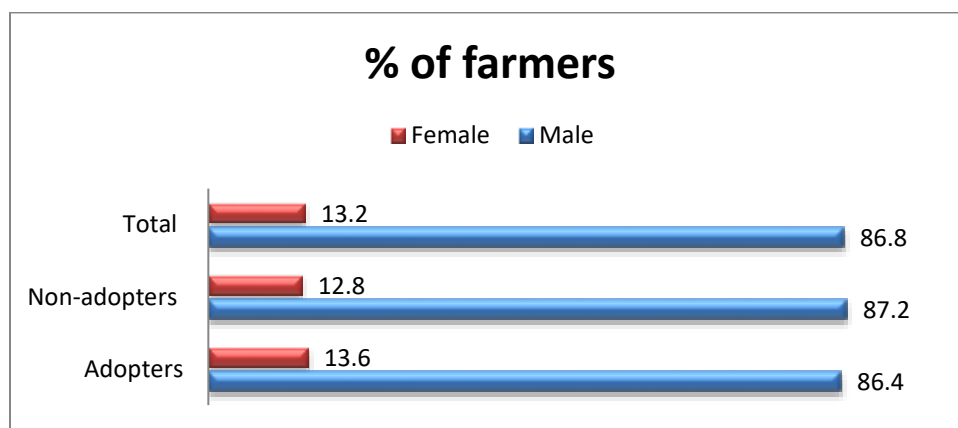


Figure 4.1a: Distribution of households by gender using percent.

Source: own survey, 2020

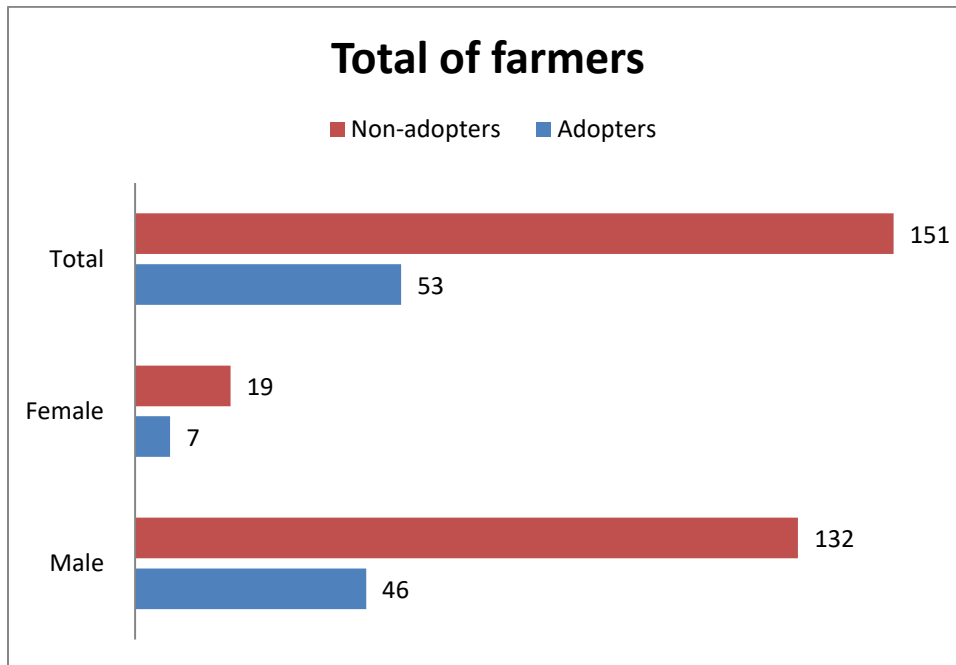


Figure 4.1b: Distribution of households by gender using number.

Source: own survey, 2020

The results on the marital status indicated that overall 95.1 percent of the household heads were married, 0.98 percent were single, 1.98 percent were widowed and 1.98 percent were divorced. Amongst the organic fertilizer adopters, 98.1 percent of the household heads were married while the proportion was about 94 percent among the non-adopters of organic fertilizer. The proportion of married household heads was higher among the adopters compared to the non-adopters implying that respondents who are the heads as a result of being married are more likely to adopt organic fertilizer. This could be due to the heavy concern that the married households have to improve output at minimal possible cost over the limited and competing resources (Bonabana-Wabbi, 2002). Martey *et al.* (2013) noted that marriage increases farmer's concern for household welfare thus increasing farmer's participation in agricultural technology adoption. Further, among the widowed household heads, 25 percent were adopters against 75 percent of non-adopters while all the divorcee and single household heads were found to be non-adopters of organic fertilizer.

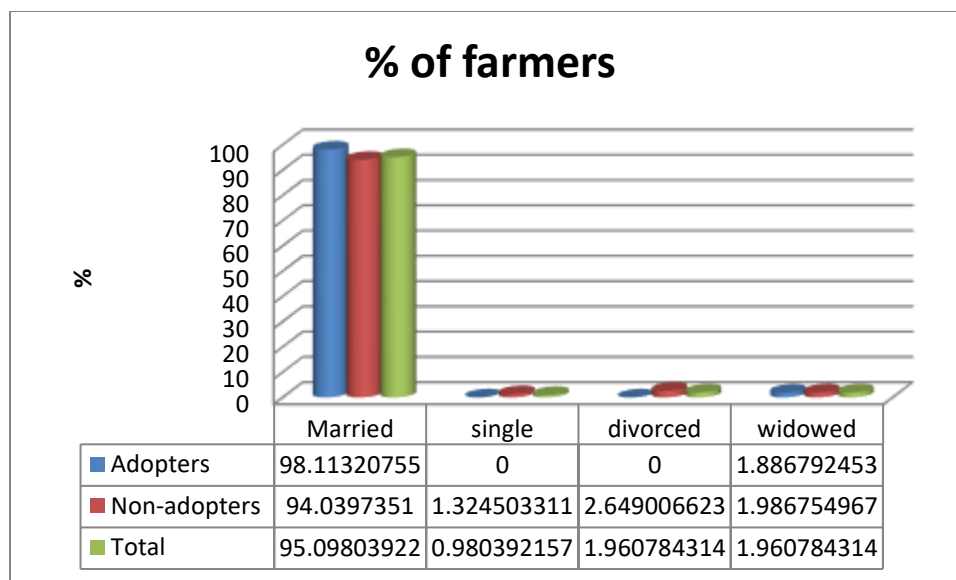


Figure 4.2: Distribution of households by marital status

Source: own survey, 2020

4.1.2. Results on Age, Education, Household Size, Labour, Livestock Ownership, Farm Size, Income and Farming Experience

The results of continuous socio-economic variables are given in Table 4.1 and 4.2. Results on age show that the average age for the sampled farmers was 43.85 years (Table 4.1) with the standard deviation equal to 12.79. The average age of organic fertilizer adopters and non-adopters were found to be 43.11 and 44.11 years and their standard deviations are 11.74 and 13.17 respectively. These results show that majority of the households were at productive stages of their lives in terms of the capacity to work. Although the difference was quite low, on average, adopters were younger than non-adopters. Ajewole (2010) argued that younger household heads are more likely to adopt organic fertilizer on their farms in Nigeria. This might be due to the fact that younger farmers are typically less risk-averse and are more willing to try new technologies (Mwangi and Kariuki, 2015). Older households are less dynamic and innovative in terms of the technology adoption (Enete and Igbokwe, 2009).

Education is the potential source of knowledge which enables one to understand instructions, access and comprehend information about the new technology (Okuthe *et al.*, 2013). In this study, education level was measured as the number of years of schooling starting from zero or no

education to university graduate. The average year of formal schooling for the sampled farmers was 6.32 years (Table 4.1). Among the organic fertilizer adopters, the average years of formal schooling was 6.38 while among the non-adopters, it was about 6.29. This shows that more educated farmers were adopters in the study area which might be the result of better education. Education could likely allow farmers to make efficient decision, and be the early adopters who can take the advantage of the new technology (Orinda, 2013). There is mean difference between users and non users. Further, about 11.32 percent of the adopters and 8.61 percent of the non-adopter household heads were found to be illiterate (Appendix 2).

In relation to family size, the overall average household size among the respondents was found to be 7.13 (Table4.1). Among the adopters of organic fertilizer, the average household size was about 7.47 whereas it was about 7.01 amongst the non-adopters. On average, the household size was higher among the adopters compared to non-adopters. The fact that organic fertilizer is labour intensive compared to the other types of fertilizer supports the results. Larger family size may enable one to provide additional labour needed in use of the organic fertilizer (Ajewole, 2010). Furthermore, about 96.6 percent of the households have had family size ranging from 2 to 14, 2.45 percent of the households have had family size of 15 and above while the remaining 0.98 percent had a family size of only 1 (Appendix 2).

A family member was presented as being able to provide labour if he or she is at least within an age of 18 years. This is because the age at which one is allowed to work in most places is 18 years and above. The results indicated that the overall average family member who can provide labour among the sampled households was 3.66 (Table 4.1). The average family members who provide labour was about 3.72 among the adopters of organic fertilizer and 3.64 among the non-adopters showing that adopters were having larger average family member who provide labour for farm activities. This further indicated better capacity of adopters in terms of labour supply for their farm activities which might have helped them to adopt labour intensive organic fertilizer. The finding was concurrent with Ajewole (2010). He claimed that ability of the household members to provide additional labour could increase possibility of organic fertilizer use.

Table 4.1: Results on Age, Education, Household Size and Labour ($N=204$).

Characteristics	Adopters		Non- Adopters		Overall mean	Test statistics
	Mean	SD	Mean	SD		
	t – value					
Age (years)	43.11 321	11.74023	44.11258	13.16589	43.85294	48.9715
Household head education (years)	6.377 358	4.114825	6.298013	3.419151	6.318627	25.0527 *
Household size (family number)	7.471 698	3.261688	7.013245	3.336639	7.132353	30.7259
Labour (number)	3.716 981	2.46028	3.642384	2.447705	3.661765	21.3897

Source: own survey, 2020. Note, *** and * indicate significance at 1% and 10% probability level respectively while SD denotes standard deviation.

The number of livestock owned was presented in terms of the tropical livestock unit (TLU) giving different weights for different types of livestock's. According to Runge-metzger (1988), TLU is a unit that represents an animal of 250 kg live weight where, 1 is assigned for cattle, 0.1 for sheep and goat, and 0.04 for chicken. The manure from animals such as donkeys, horses and mules are not used as sources of organic fertilizer in the study area. During composting, farmers totally exclude the manure of such animals because these manures cannot be easily decomposed as those obtained from the cattle's, sheep, goats and chicken. Due to this, excluding donkeys, horses and mules, other livestock's such as cattle's, sheep, goats and chicken were used as the potential sources of organic fertilizer in the study area. Accordingly, the survey results indicated that the overall average livestock holding among the farmers was about 4.37 units (Table 4.2). The average livestock holding was about 7.11 among the adopters and 3.4 among the non-adopters. The fact that the livestock has the potential resources (animal manure) for organic fertilizer preparation could make the number of livestock units to be quite important for adoption of organic fertilizer (Tefera *et al.*, 2013). Due to this, the larger average livestock holding shown among the adopters possibly had intensified organic fertilizer adoption compared to low livestock

holding farmers. The difference was significant at 1 percent probability level showing the importance of livestock in adoption of organic fertilizer. Further, the results show that about 3.77 percent of the adopters and 35.76 percent of the non-adopters of organic fertilizer did not own any livestock (Appendix 2).

Regarding to farm size, the average farm size among the sampled households was 0.075 hectares (Table 4.2). On average, the organic fertilizer adopters own about 1 hectare of farm land while the non-adopters own about 0.66 hectare of the farm land. The current study had predicted that farmers with relatively larger farm size are likely to adopt organic fertilizer. This could be primarily due to lower marginal costs associated with adoption of labour intensive technology on the larger area of the farm land. The results indicated that the households with larger farm land were adopters of organic fertilizer possibly due to lower marginal costs. The mean difference of the farm size between the adopters of organic fertilizer and the non-adopters of organic fertilizer was significant at 1 percent probability level. Martey *et al.* (2013) argued that an increase in cultivation plot is associated with financial constraints for smallholder farmers in Ghana thus reducing adoption of chemical fertilizer. Lower use of chemical fertilizer could possibly result in more use of organic fertilizer in Ethiopia. Ketema (2011) claimed that manure use is negatively correlated with application of chemical fertilizer in Tigray region of Ethiopia as these two types of fertilizers are substitute for each other. Moreover, majority of the households (67.2 percent) own less than or equal to 0.75 hectares of the farm land. About 7.5 percent of the adopters of organic fertilizer own 2 to 3 hectares of the farm land while the corresponding proportionate for non-adopters was 2.6 percent showing that adopters own larger farm land than non-adopters (Appendix 2).

In relation to farmers' income, the average farm income among the respondents was found to be 12078.13 ETB per annum (Table 4.2). Amongst the respondents who have adopted organic fertilizer, the average farm income was about 15441.7 ETB while the non-adopters of organic fertilizer had an average farm income of 10897.54 ETB. The higher average farm income among the adopters may justify that adopters of organic fertilizer are more dependent on agricultural activities. Dependency of farmers on agricultural activities makes them to be more concerned about yield increasing technologies such as organic fertilizer. On the other hand, according to Makokha *et al.* (2001), a household whose income depends on farm activities does not have enough capital to use chemical fertilizer in Kenya thus they opt to use manure to compensate

outflow of nutrients. Moreover, the difference of the average farm incomes among the adopters and the non-adopters of organic fertilizer were found to be significant at 1 percent probability level (appendex2).

When we look at farming experience, the average farming experience of the respondents was 22.47 years while that for the adopters and non-adopters of organic fertilizer was found to be 23.42 years and 22.14 years respectively (Table 4.2). According to Obisesan (2014), more years of farming experience help farmers to evaluate the advantage of agricultural technology and be the early adopters of new technology. More experienced farmers seem to have better information and knowledge accumulated over time. Years of experience for majority of the organic fertilizer adopters were distributed between 21 and 30 while for majority of the non-adopters of organic fertilizer, it was distributed between 11 and 20 (Appendix 2). This implies that relatively most adopters of organic fertilizer had more years of farming experience. Akpan *et al.* (2012) claimed that farming experience improves farmer’s behavior of coping up with problems of soil infertility and reduces likelihood of chemical fertilizer adoption while in support of this; Ketema (2011) noted that lower use of chemical fertilizer could possibly result in more use of organic fertilizer. Moreover, the maximum farming experience reported among the respondents was 50 years while 1 year was the minimum farming experience.

Table 4.2: Results on Livestock Ownership, Farm size, Income and Farming Experience (N=204)

Characteristics	Adopters		Non- Adopters		Overall mean	Test statistics
	Mean	SD	Mean	SD		
	t – value					
Livestock (ownership (TLU))	7.113208	3.332015	3.403974	4.179599	4.367647	14.54***
Farm size (hectares)	1.009434	0.65406	0.655629	0.585763	0.747549	17.16***
Farm income	15441.7	8271.779	10897.54	7648.729	12078.13	21.44***

Experience (years)	23.41509	12.13773	22.13907	12.0631 9	22.47059	26.5998
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Source: own survey, 2020. Note, *** and * indicate significance at 1% and 10% probability level respectively while SD denotes standard deviation.

In this study, farm fertility represents the household’s perception about the fertility of their farm. The results -presented in Table 4.3 show that about 22.6 percent of the adopters believed that their farms were not fertile. In comparison, the corresponding figure for non-adopters was about 21.9 percent. Relatively, a higher proportion of households who perceived that their plots are not fertile were found to be adopters of organic fertilizer. Low farm fertility has been reported to be a major constraint to agricultural production by an increasing number of farmers in Ethiopia (Makokha *et al.*, 2001). This shows that low fertility of the farm could be one of the reasons for adoption of organic fertilizer. Kpadonou *et al.* (2015) noted that the problem of soil fertility (decrease in farm fertility) is associated with greater likelihood of organic fertilizer use in the Sahel region. The survey results of this study further revealed that about 73.6 and 3.8 percent of the adopter households perceived that their farms were medium and fertile respectively. On the other hand, about 74.8 percent and 3.3 percent of the non-adopters were believed that their farms were medium and fertile respectively.

Table 4.3: Results on Farm Fertility (N=204)

Farm fertility					Test statistics
adopters			non-adopter		
	Freq.	Perc. (%)	Freq.	Perc. (%)	0.17
Not fertile	12	22.6415094	33	21.8543	
Medium	39	73.5849057	113	74.83444	
Fertile	2	3.77358491	5	3.311258	
Total	53	100	151	100	

Source: own survey, 2020

4.1.3. Results on Group membership, Access to credit, Extension visits, and Distance to the nearest market

The results of the continuous institutional characteristics are presented in table 4.4. and table 4.5. The results show that overall 36.8 percent of the sampled respondents were members of farmers based associations while the remaining nearly 63.2 percent were not. The results further show that about 58.5 percent of the adopters were members of at least one farmer based organization whereas the percentage of non-adopter who belonged to at least one farmer group was 29.1 percent (table 4.4). Compared to non-adopters, most members of the farmers based organizations were adopters. Farmer based organizations are the potential sources of information. Unlike that of information media such as television and radio, the information obtained through membership in a given farmer group involves two way discussions which can be easily understood by the farmers. Due to this, availability of such organizations may increase frequency of discussion among the member farmers therefore enhancing communication for development (Berhe, 2014). Households belonging to farmers group such as associations and coo-peratives can easily access fertilizer technology (Martey *et al.*, 2013). As such, existence of farmers based organizations could possibly increase the adoption rate of organic fertilizer. The results further indicated that the average number of farmer organizations the respondents belonged to was less than 1 for both adopters and non-adopters of organic fertilizer.

Table 4.4. Results on Group Membership(N =204).

	Group membership		non-adopters		Total			
	adopters				Freq.	Perc. (%)	Freq.	Perc. (%)
	Freq.	Perc. (%)						
Yes	31	58.49057	44	29.13907	75	36.76471		
No	22	41.50943	107	70.86093	129	63.23529		
Total	53	100	151	100	204	100		

Source: own survey, 2020

Credit is an important source of finance in agricultural technology adoption. The major sources of credit in Ejere district include: Oromia credit and saving share-company (OCSSCO/WALQO) and farmers based associations such as *Idir*. It was found that about 19.61 percent of the sampled

respondents had accessed and used credit while about 80.39 percent of them did not access credit due to different reasons such as high interest rate. The results of credit access and use among the respondents were low. This may be related to the enforcements that financial institutions have been putting on farmers to payback the debt even if the crop failed such as in the year 2009 and 2010 E.C. Only 11.32 percent of the organic fertilizer adopters and 22.52 percent of the non-adopters of organic fertilizer used credit in the indicated season (Appendix 2). The results presented in Table 4.5 further showed that on average, organic fertilizer adopters had received average credit of 1603.77 ETB, while non-adopters had received 2854.31 ETB in the 2011 E.C. cropping season. The difference was significant at 5 percent probability level (appendix2).

Extension service refers to demonstrations, trainings, and advice delivered to the farmers mainly by development agents and other agricultural experts. It was measured in terms of the frequency of farmers meeting with extension workers during the previous agricultural season. The results indicated that the overall average frequency of extension contact was about 2.55 per season (Table 4.5). In comparison, it was found that the average frequency of extension contact was about 3.62 per season among the adopters of organic fertilizer while that of non-adopters was about 2.17 per season. The difference in the average extension contacts between the adopters and non-adopters of organic fertilizer was significant at 1 percent probability level (appendix2). The result shown that the adopters of organic fertilizer had better access to extension services on average compared to non-adopters justifying that the higher frequency of extension visits may have contributed toward adoption of organic fertilizer. Kassie *et al.* (2009) argued that farmers who have regular contact with agricultural experts are more likely to adopt agricultural technologies. Similarly, Ajewole (2010) claimed that the frequency of extension visits increased the possibility of commercial organic fertilizer adoption in Nigeria.

In relation to the distance to the nearest market place, overall average distance to the nearest market was 4.76 km (Table 4.5). The household that is closest to the nearest market was situated about 0.0015 km while the furthest household was situated about 20 km (Appendix 2). In comparison, the average distance was 3.84 km among the adopters of organic fertilizer and 5.08 km amongst non-adopters. This shows that the adopters were closer to the nearest market place compared to the non-adopters counteract. A farmer who is closer to the market place is likely be more informed about technologies compared to the one who is furthest from the market place

reflecting that the closer farmer could easily adopt organic fertilizer. According to IFPRI (2012), farmers who are on a shorter distance to the market are more likely to have access to agriculture-related information through different channels. This might have compelled the farmers who are close to the market place to engage in adoption of organic fertilizer. On the other hand, Martey *et al.* (2013) posited that distance to the nearest market place is one of the limiting factors of agricultural input use as it determines the transaction costs associated to its use.

Table 4.5: Results on Access to Credit, Extension Visits, and Distance to the Nearest Market (N=204)

Characteristics	Adopters		Non- Adopters		Overall mean	Test statistics
	Mean	SD	Mean	SD		
Access to credit (amount in ETB)	1603.774	4691.808	2854.305	6010.71	2529.412	- 6.32**
Extension (number of extension visit)	3.622642	2.505582	2.172185	1.253058	2.54902	20.43**
Distance to the nearest market (km)	3.843613	3.73352	5.07649	3.815	4.756184	-17.77**

Source: own survey, 2020.

Note, ** denotes significance at 5% probability level and SD indicates standard deviation.

Information can be accessed through different media such as radio and television where the flow of information through such type of media is mostly unidirectional (two way communications are less available). However, it is the fastest and cheapest mode of communication (Truc *et al.*, 2012). The results indicated that about 73.5 percent of the sampled household had access to information through radio and television while about 26.5 percent did not. Households who had access to information through television, radio or any other social media were considered to have access to information media. Among the adopters of organic fertilizer, about 83 percent had access to information through these information media, while the proportion of the farmers who do have access to information through radio and television was about 70.2 percent among the

non-adopters of organic fertilizer. According to Opara (2010), communication; in this case through information media such as radio and television, is at the heart of any change process across the society. As such higher proportion of households who have had information through radio and television were found to be adopters of organic fertilizer. Thus, improvement in access to information could have a positive effect on the decision to adopt organic fertilizer as well as the farmers' perception of organic fertilizer adoption. The results in Table 4.6 further posited that the relationship between access to information and organic fertilizer adoption was significant at 1 percent probability level.

Table 4.6: Results of the Households' Access to Information Media (radio and television) (N=204)

Access to information media							Test statistics
adopters		non-adopters		Total		χ^2 -value	
	Freq.	Perc. (%)	Freq.	Perc. (%)	Freq.	Perc. (%)	18.555 ***
No	44	83.0188679	106	70.19868	150	73.52941176	
Yes	9	16.9811321	45	29.80132	54	26.47058824	
Total	53	100	151	100	204	100	

Source: own survey, 2020

4.2. Organic Fertilizer Adoption

The role of agricultural technologies in increasing overall farm income has been well documented. Organic fertilizer is one of the agricultural technologies which have been believed to reduce direct production costs, improve environmental benefits, and increase crop yields (Kassie *et al.*, 2009). Despite these advantages, the rate of adoption of organic fertilizer among the farmers remains low in some places such as Ejere district. Out of the total sampled farmers in the Ejere district, about 26 percent were adopters while 74 percent were not. This is presented in Figure 4.3. The major factors contributing to the low organic fertilizer adoption are discussed in section 4.3 below.

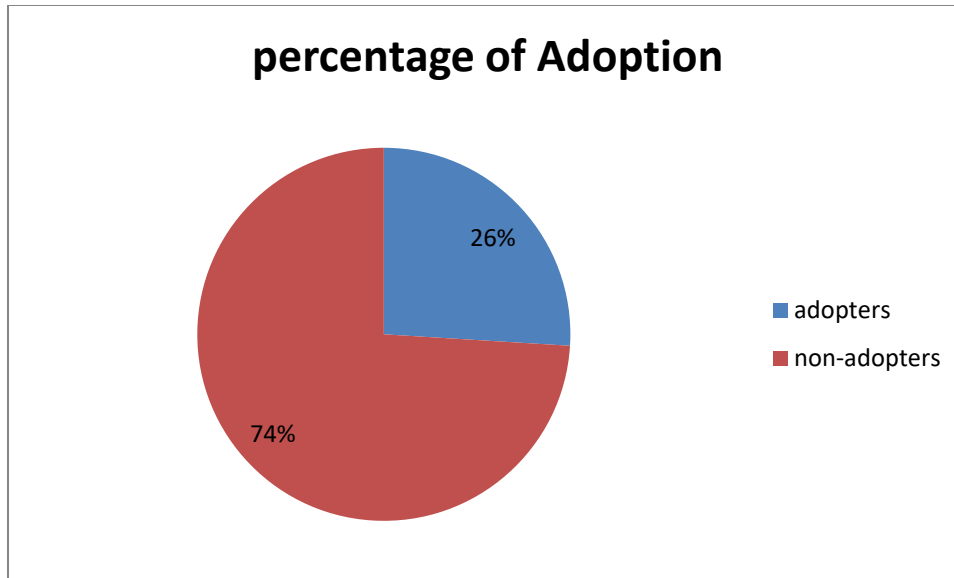


Figure 4.3: Rate of adoption of organic fertilizer

Source: EWNRAO (2020)

4.3.Constraints to Adoption of Organic Fertilizer

The major constraint to adoption of organic fertilizer was found to be low livestock holding. This was reported by about 55 percent of the organic fertilizer non-adopters. They reported that they do not own enough livestock which may provide them manure. This shows the importance of livestock holding in organic fertilizer adoption where the low livestock ownership could be the cause of low adoption rate of organic fertilizer.

Lack of adequate labour was the second major constraint to adoption of organic fertilizer. Organic fertilizer adoption is relatively labour intensive requiring more labour both for its preparation and application on the farm compared to chemical fertilizer. Thus, lack of adequate labour for its preparation could decrease its adoption rate. Due to this, about 21.9 percent of the respondents reported that they do not participate in adoption of organic fertilizer.

Inadequate knowledge related to organic fertilizer adoption in terms of compost preparation was another constraint to adoption of organic fertilizer. This was reported by about 9.3 percent of the non-adopter households. Kassie *et al.* (2009) noted that the preparation of organic fertilizer is knowledge intensive. This implies that low skills related to adoption of organic fertilizer could

limit adoption of organic fertilizer as farmers may face difficulty in preparing this fertilizer, specially, composting which has been commonly used in the study area.

High transaction costs associated with adoption of organic fertilizer was also one of the reasons reported as constraints of organic fertilizer adoption. This was primarily for those farmers who lack livestock and tend to find this fertilizer from other sources. For such farmers, high transaction costs coupled with their low capacity to provide finance could limit adoption of this fertilizer. Accordingly, high transaction cost was reported by about 7 percent of the households while lack of capital in terms of financing costs associated with organic fertilizer adoption. The summary results are presented in Table4.7 below.

Table 4.7: Constraints to Adoption of Organic Fertilizer (N=151; Non-adopters of organic fertilizer)

Description	Freq.	Percent.	Cum.
High Transaction cost	10	6.62252	6.62252
Lack of Livestock	83	54.9669	61.5894
Low skill	14	9.27152	70.8609
Lack of Capital	11	7.28477	78.1457
Inadequate labour	33	21.8543	100
Total	151	100	

Source: own survey, 2020

4.4. Transaction Costs Associated with Organic Fertilizer Adoption

In this section results on the transaction costs associated with adoption of organic fertilizer has been represented. This includes costs of searching for information, bargaining, policing and enforcement, and quality ensuring costs. Time taken to complete each activity before any transaction is made was calculated in terms of the best alternative forgone.

Greater part of the respondents reported that the cost of searching for information was the most common type of transaction cost in adoption of organic fertilizer in Ejere district. The average transaction cost in relation to searching for information was found to be 124.53 ETB. This was mainly associated with travel costs whereby some farmers use money for transport to search for information instead of other cheaper means such as telephone calls. Another cost related to organic fertilizer adoption was bargaining costs. Regarding bargaining, the average cost incurred

for bargaining was found to be 53.33 ETB. Compared to search for information, costs incurred as a result of bargaining during the transaction was found to be lower in the study area. In this case, it was found that telephone was the most commonly used communication media among the farmers leading them to incur relatively lower transaction costs. Martey *et al.* (2013) noted that high transaction costs in terms of transporting inputs normally limit the extent of the agricultural technology adoption such as chemical fertilizer. It can also put limitations on adoption of organic fertilizer

Looking at transportation, the average transaction cost was found to be 68.23 ETB per hectare. The other sources of transaction costs such as policing and enforcement costs were not reported among the farmers implying less availability of organic fertilizer transaction through the contracts. During transportation, horses and camels are used as pack animals by some farmers. On the other hand, majority of the farmers use horse pulled carts to transport organic fertilizer to their farmstead. Some farmers who own the horse but lack the cart use the donkey as pack animal to transport the organic fertilizer to their farm. Since the quantity of organic fertilizer to be transported is large (nearly 73 quintal per hectare on average) most farmers prefer use of cart. A number of farmers own both the cart and horse while those farmers who do not own normally hire from those who already own. Further, the maximum transaction cost reported was 375 ETB while 5 ETB was the minimum. The summary results are presented in Table4.8.

Table 4.8: Transactions Costs Related to Organic Fertilizer Adoption ($N=151$; Adopters of Organic Fertilizer)

```
. sum bargainingcost searchforinformationcost transportationcost totaltransactioncosts
```

Variable	Obs	Mean	Std. Dev.	Min	Max
bargaining~t	53	47.81132	22.01665	5	90
searchfori~t	53	60.66038	37.43607	13	138
transporta~t	53	8.943396	7.947944	1	35
totaltrans~s	53	117.4151	53.4856	29	231

Source: own computation, 2020

4.5. Econometric Analysis of Factors Influencing Adoption and Use Intensity of Organic Fertilizer

4.5.1. Results of Multicollinearity, Outliers and Statistical Specification Tests

During regression models it was assumed that perfect collinearity does not exist among the explanatory variables. If it exists, however, it leads to a problem of multicollinearity. Multicollinearity indicates existence of exact linear relationship among the explanatory variables. The higher the degree of multicollinearity, the more difficult the problem is. In this study, using variable inflation factor (VIF), the average VIF was found to be 4.53 which was less than 10 showing that multicollinearity was not a serious problem among the continuous explanatory variables (Appendix 4). Availability of heteroscedasticity was tested using Breusch-Pagan test (Cook-Weisberg test for heteroskedasticity). On the test result, probability greater than was given by 0.0000 implying that the model had no problem of heteroscedasticity. Finally, using Ramsey regression specification-error test for omitted variables (ovtest), the survey results revealed that the model had no problem of omitted variables. Therefore, it was concluded that the model was the most robust and complete.

4.5.2. Factors Affecting Adoption and Use Intensity of Organic Fertilizer

In order to find out the major factors affecting adoption and use intensity of organic fertilizer, Cragg's double hurdle model was employed. The χ^2 value given by 51.62 and the corresponding likelihood ratio statistic ($p < 0.000$) suggests that the null hypothesis of all the coefficients of the explanatory variables being simultaneously zero should be rejected. This shows that the explanatory variables included in the model are capable of explaining the farmers' probability of participating in adoption of organic fertilizer and the extent of organic fertilizer use. Marginal effects were estimated to predict the actual magnitude of the effect of the explanatory variables on the adoption decision of organic fertilizer while the coefficients were used in the second hurdle to explain the extent of organic fertilizer adoption. The estimated coefficients in the probabilistic models such as probit do not have direct interpretation rather they are just values which maximize likelihood function.

First hurdle: Factors Affecting Adoption Decision

The first stage of the double hurdle model deals with the adoption decision of organic fertilizer. Farmers were assigned 1 if they are adopters of organic fertilizer and 0 otherwise. The results of the Cragg's double hurdle model presented in Table 4.9 revealed that the marital status, age, the number of livestock units, extension services, access to information media, farm income, farm experience and membership in local farmers based associations had significant effect on household's adoption decision.

As expected, being single of household head was negatively and significantly related to the adoption decision of organic fertilizer at 5%. This result is reasonable, since marriage increases farmer's concern for household welfare thus increasing farmer's participation in agricultural technology adoption (Bonabana-Wabbi, 2002). Martey *et al.* (2013)).

Age of the household head negatively influenced adoption of organic fertilizer. This variable was statistically significant at 1%. An increase in age by one year decreases the probability of adoption of organic fertilizer by 2.6%. Perhaps this is because older farmers tend to invest several years in a particular practice hence may not want to risk themselves by trying out completely other methods of farming (Khanna, 2001). Young household heads are more interested in trying out new agricultural technologies because of their risk taking character than old household heads who are risk averse. These results are consistent with those of Furrh *et al.* (2007) on adoption of organic dried fig agriculture system, Menale *et al.* (2009) on adoption of OA techniques and Chukwuji *et al.* (2006) on adoption and intensity of use of fertilizer by smallholder farmers. However, Nchinda *et al.* (2010) indicated a positive relationship between age of the household head and adoption and use intensity of improved yam seed technology. In addition, Maddison (2006) argued that as farmers get older they tend to intensify adoption of new agricultural technologies in their farming business as a result of more years of farming experience.

Results on the number of livestock owned indicate that an increase in the number of livestock by one animal increased the likelihood of adopting organic fertilizer by about 3.1percent. The results were statistically significant at 1 percent probability level. The availability of more animal manure as the number of livestock unit increases possibly justifies the positive correlation between livestock ownership and organic fertilizer adoption. Animal manure is the potential source of organic fertilizer. It is the main ingredient during composting. Thus, households who own large

number of livestock's are likely to get more manure and therefore adopt organic fertilizer. The finding was consistent with Tefera *et al.* (2013). They explained that the households with more livestock holding are likely to adopt organic fertilizer due to their better capacity to have animal manure. Akpan *et al.* (2012) also noted that domestic animals constitute a good source of organic manure serving as a good substitute for chemical fertilizer.

Regarding to extension services, the results revealed that one additional meeting with extension workers increased the likelihood of organic fertilizer adoption by about 3.7 percent. Thus, extension service was found to have positive effect on adoption of organic fertilizer. One of the most important role of extension service is to raise farmer's awareness about agricultural productivity through providing them important information related to adoption of agricultural technologies. According to Kassie *et al.* (2009), in most cases, extension workers establish demonstration plots where farmers get hands-on learning and can experiment with new farm technologies which enhance adoption of new technologies. The results of the study therefore confirm that better information dissemination through extension workers could enhance adoption of organic fertilizer by improving knowledge about the advantage of new technology. Thus, for a given household, the more the frequency of meeting extension workers, the higher the likelihood of organic fertilizer adoption. The results were statistically significant at 5 percent probability level. The finding was in line with Kassie *et al.* (2009). They argued that farmers who have regular contact with agricultural experts are more motivated to participate in agricultural technology adoption due to intensive information they may get from the experts. This result is also similar with the result of Tura *et al.* (2017), Ali, Awuni, and Danso-Abbeam (2018) in their respective studies. Extension exposes farmers to a wide range of ideas which may give them the opportunity to have better access to information on new innovations, advice on inputs and their use and management of technologies (Menale *et al.*, 2009) and this may positively influence them towards adopting new innovations. These results tally with those of Mazvimavi and Twomlow (2009) on adoption of conservation farming. However, a study by Ayuya *et al.* (2011) on adoption of clean development mechanism projects contrasts this result because agricultural extension services were more focused on intensifying crop and livestock production on tree planting.

The result of this study indicated that access to information through media increased possibility of adopting organic fertilizer by about 11.5 percent revealing its positive influence on the adoption of organic fertilizer. Farmers who have had access to information through television, radio or any other social media were considered to have access to information media. Enhanced access to information could likely allow farmers to seek out for agricultural technologies which may increase their farm productivity. This is mainly because access to information could enable one to have more knowledge and awareness about different technologies. For example, in adoption of organic fertilizer, farmers can have information such as how to prepare, apply on the farms and so on with better access to information. Thus, such a farmer can possibly intensify adoption of this technology compared to other groups of farmers who have no access to information through these media. Access to information through information media had statistically significant effect on adoption of organic fertilizer at 10 percent probability level. Several recent studies on agricultural technology adoption in Ethiopia did not include this variable in their analysis (Berhe, 2014; Terefe *et al.*, 2013).

As hypothesized, being a member to one additional local farmers based association increased the possibility of organic fertilizer adoption by about 14 percent. The results show that membership to farmer groups influenced decision to adopt organic fertilizer positively and significantly at 1 percent probability level. The positive effect might be due to increase in possibility of meeting with other farmers as one becomes a member of different farmer groups and be informed about the new technology. Farmers based organizations in rural areas make possibility of information transfer easier among the farmers through increasing frequency of discussion among the members (Berhe, 2014). Thus, households whose memberships belong to farmer groups such as associations and cooperatives can easily access fertilizer technology (Martey *et al.*, 2013). This possibly may level up adoption rate of organic fertilizer among the farmers.

The result also showed that farm income positively and significantly affects the adoption decision of household head at 5 percent level of significant. This is because of that a household whose income depends on farm activities does not have enough capital to use chemical fertilizer in Kenya thus they opt to use manure to compensate outflow of nutrients (Makokha *et al.* (2001)).

Regarding the farm experience, an increase in farming experience by one year increased the likelihood of adoption by 2.5 percent. This result was plausible because farming experience

improves farmer's behavior of coping up with problems of soil infertility and reduces likelihood of chemical fertilizer adoption (Akpan *et al.* (2012) and lower the use of chemical fertilizer could possibly result in more use of organic fertilizer (Ketema (2011)).

Table 4.9: Results of Cragg's Double Hurdle Model (Probit Output) on Determinants of Decision of Adoption of Organic Fertilizer

Variable	Coef.	Std. Err.	Z	dy/dx
Gender	-.5863503	.5299289	-1.11	.0736476
Mstatus	-1.310036	.6355853	-2.06	.164545
Age	-.2058519	.0693252	-2.97	.0258557
Hhhdecn	-.0021519	.0538446	-0.04	.0002703
Hhsize	-.0250705	.1069245	-0.23	.0031489
Labour	-.212549	.1451206	-1.46	.0266969
Livestock	.2489321	.0506194	4.92	-.0312667
Farmsize	.4653962	.3631074	1.28	-.0584553
farmincome	.0000641	.0000261	2.46	-8.05e-06
Farmexp	.2015739	.0707537	2.85	-.0253184
soilfertility	-.0382858	.4294645	-0.09	.0048088
memberhip	1.12632	.3961417	2.84	-.1414696
crdtamount	-.0000879	.0000477	-1.84	.000011
extensionvisits	.297926	.1140537	2.61	-.0374205
disttonearmktkm	-.0751293	.0522925	-1.44	.0094365
acsstoinfomedia	.9168466	.4578309	2.00	-.115159
_cons	5.581345	2.606885	2.14	

Source: own computation, 2020

Second hurdle: Factors Affecting Use Intensity of Organic Fertilizer.

The greater part of households in Ejere district use some sources of organic fertilizer such as manure without measuring its amount. Because of this, it was not easy to know the exact amount (intensity) of organic fertilizer used by the farmers on their farms. However, households who use compost use m³ (cubic meter) measurement when preparing and *quintal* (a unit of weight equal to 100 kg) when transporting it to their farms. Thus, the application level of compost is better known by farmers compared to other types of organic fertilizer such as manure. Therefore, in this stage, using the compost as a proxy to evaluate intensity of organic fertilizer adoption, only respondents who reported positive and greater than or equal to the optimum use intensity of compost were included. The optimum adoption intensity was determined as the average level of compost usage per hectare in the study area. The results of the double hurdle model presented in Table 4.10 show

that the farm income, farm size, membership in farmer based organizations and frequency of organic fertilizer application had significant influence on use intensity of organic fertilizer.

As the results indicated, an increase in household farm income by 1 Birr decreased use intensity of organic fertilizer by about 0.002 quintal per hectare. This shows that the household income had negative effect on use intensity of organic fertilizer. Households' farm income had considerable effect on use intensity of organic fertilizer at 1 percent probability level. A household with high income may prefer to use chemical fertilizer compared to organic fertilizer which can be substitute for each other. The result coincided with finding of Ketema and Bauer (2011). If farmers can afford to buy chemical fertilizers, then the propensity of using labour intensive fertilizers such as manure decreases (Ketema and Bauer, 2011). Organic fertilizer preparation (for instance composting) is also time intensive requiring more time. Due to this, a household with better income may prefer to buy and use chemical fertilizer within short period of time. In addition, little cash holding households are likely to prefer more organic fertilizer as it is relatively cheaper compared to chemical fertilizer. According to Martey *et al.* (2013), investment of financial resources in interest earning assets which are associated with high income are likely to explain low fertilizer use with increase in income though the components of fertilizer was not captured.

In relation to farm size, the results indicate that an increase in farm size by a unit hectare increased use intensity of organic fertilizer by about 26.11 quintal per hectare. This result showed that Farm size is a significant determinant of organic fertilizer adoption at 1 percent probability level. The positive impact of farm size on use intensity of organic fertilizer can be justified in relation to better economies of scale associated to larger farm size. The farmers with larger farm size would also use organic fertilizer as it is less costly compared to inorganic fertilizer. These could have encouraged farmers to use organic fertilizer in the study area. The results were consistent with the findings of Kassie *et al.* (2009). They noted that ownership of the farm land increases assurance of future access to the returns of the investments thus increasing probability of using organic fertilizer such as compost.

Being member to one additional neighboring farmer based association increased use intensity of organic fertilizer by about 10.62 quintal per hectare. This shows that membership in farmers based organizations had positive effect on use intensity of organic fertilizer. The results were

significant at 10 percent probability level. Several reasons have been pointed out in the first hurdle of this model regarding positive correlation between a membership to farmers group and adoption decision of organic fertilizer. Furthermore, farmers based associations serve as a platform for accessing and dissemination of information and technology (Martey *et al.*, 2013) consequently enhancing communications for development (Berhe, 2014). These could possibly allow farmers to share ideas and experiences therefore likely intensifying per hectare use of organic fertilizer.

When we see the frequency of organic fertilizer application, the results showed that application of organic fertilizer in a given season decreased its reapplication in the following season by about 28.86 quintal per hectare. The negative relationship between the frequency of organic fertilizer application and intensity of organic fertilizer use could be mainly due to farmer's expectation of residual value of this fertilizer. In the study area, most farmers believe that the farm can stay fertile for a period of about four years once organic fertilizer is applied on it. Because of this, once they apply on their farms, the following season, they relatively apply fewer amounts. The results further indicated that the frequency of organic fertilizer use had significant effect on use intensity of organic fertilizer at 5 percent probability level. Frequency of application was found to have highest (nearly 30 quintal per hectare decrease every season) influence on use intensity of organic fertilizer. It also seems that the farmers in the study area were uncertain about the length of the time that compost maintains soil fertility. Thus, efforts to bring the exact time period of applying this fertilizer coupled with its right amount per hectare could be the best strategy to enhance use intensity of organic fertilizer. Several recent studies related to adoption of organic fertilizer did not include frequency of application in the analysis (Lavison, 2013; Tefera *et al.*, 2013; Ajewole, 2010).

Table 4.10: Results of Cragg's Double Hurdle Model (Truncated output) on Factors Affecting Intensity of Organic Fertilizer Adoption

Variables	Coef.	Std. Err.	t – value
Age	-0.313	0.446	-0.70
Gender	3.180	9.573	0.33
Household size	-1.418	1.365	-1.04
Education of household head	0.114	0.893	0.13
Farm income	-0.002***	0.00	-3.57

Experience	-0.060	0.449	-0.13
Farm size	26.112***	6.269	4.17
Soil fertility	0.354	5.483	0.06
Livestock number	0.958	0.693	1.38
Credit amount	0.002	0.002	1.03
Extension contacts	1.527	1.023	1.49
Access to information media	3.213	7.847	0.41
Membership	10.621*	5.460	1.95
Distance to the nearest market	0.560	1.190	0.47
Marital status	1.618	8.225	0.20
Labour	-1.783	1.786	-1.00
Family's highest education	0.197	1.190	0.17
Application frequency	-28.858**	13.129	-2.20
Constant	122.638	43.019	2.85
/sigma Constant	30.65***	1.998	15.34
N	53		
Wald chi2 (18)	82.09		
Prob. > χ^2	0.000		

Source: own computation, 2020. Note, ***, ** and * indicate significance at 1%, 5% and 10% probability level respectively.

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

This section presents summary of the major findings in the study, conclusions drawn, and Policy implications.

5.1.Summary

This study aimed at identifying the major constraints of adoption and use intensity of organic fertilizer in Ejere district of Ethiopia. To select respondents for the study, fourteen kebeles were selected purposively based on the intensity of adoption of organic fertilizer and similarity in agro-climate environment. Accordingly, primary data was collected from 204 respondents of which 53 were adopters and 151 were non-adopters of organic fertilizer.

To examine determinants of adoption of organic fertilizer and income effect, the study assessed transaction costs associated with adoption of organic fertilizer, factors affecting adoption and use intensity of organic fertilizer. Descriptive statistics, probit model and Cragg's double hurdle were employed for analysis. During analysis, different software's such as Excel and Stata were used.

In relation to transaction costs, the results showed that the average transaction costs through bargaining, searching for information and transportations were 47.8, ETB, 60.7 ETB and 8.9 ETB respectively. Policing and enforcement costs were uncommon among the farmers. The age, marital status, livestock number, extension visits, access to information media, farm income, farm experience, and membership to farmers group had significantly influenced decision of adoption of organic fertilizer. The household age and being single negatively influenced organic fertilizer adoption while the remaining factors influenced adoption decision of organic fertilizer positively. This was revealed by the first hurdle empirical estimates under section 4.5.2. Regarding use intensity of organic fertilizer, households' farm income and the application frequency of organic fertilizer had negative influence on use intensity of organic fertilizer while farm size and membership to farmers group had positively influenced use intensity of organic fertilizer. This indicates that factors that affect adoption are not necessarily the same as those that influence intensity and those factors affecting both the adoption and use of organic fertilizer do not necessarily affect them in the same way and by the same magnitude. Therefore, it is important to consider both stages in evaluating strategies aimed at promoting the adoption and use of organic

fertilizer. Further, households who had adopted organic fertilizer earned better average per hectare farm income compared to the non-adopters. This implies that the adoption of organic fertilizer had positive impact on households' farm income in the study area therefore farmers should be encouraged to use organic fertilizer.

5.2. Conclusions

This study has investigated powerful factors which determine the probability of fertilizer adoption and intensity of fertilizer use in Ejere woreda, Oromia region, Ethiopia. A cross sectional at with a sample of 204 has been employed in the analysis.

Today, there is a general consensus that fertilizer is considered as one of the most important inputs for the achievement of increased agricultural production and productivity in Ethiopia, which is one of the Sub Saharan Africa countries. The result of the study has shown that the highest transaction costs related to adoption of organic fertilizer were information search costs followed by transportation cost and bargaining costs. Most of these costs were associated with means of communication and transportation where communication through phone calls resulted in lower transaction costs and traveling to search for information resulted in relatively higher transaction costs. Policing and enforcement costs were not reported, implying less availability of organic fertilizer transactions through contracts.

An increase in the household age discouraged adoption of organic fertilizer showing that Young household heads are more interested in trying out new agricultural technologies because of their risk taking character than old household heads who are risk averse. As domestic animals constitute a good source of organic manure serving as a good substitute for chemical fertilizer, households who owned large number of livestock are likely to get more manure and thus they are likely to adopt organic fertilizer. Better information dissemination about organic fertilizer through information media also enhanced adoption and use intensity of organic fertilizer by improving knowledge about the advantage of new technology. A household with lower income prefers to use organic fertilizer compared to chemical fertilizer. It was thus concluded that lower costs in relation to use of organic fertilizer on larger farm size encouraged farmers to use organic fertilizer intensively in the study area. In addition, an empirical estimate of the first hurdle of this study revealed that farm experience, number agricultural extension workers visit per season, farm

income and membership are positively relate to likelihood o adopting organic fertilizer. The positive effect of membership might be due to increase in possibility of meeting with other farmers as one becomes a member of different farmer groups and be informed about the new technology and that of income might be because of that a household whose income depends on farm activities does not have enough capital to use chemical fertilizer. The study found out that more experienced farmers seem to have better information and knowledge accumulated over time. This result is reasonable because farming experience improves farmer’s behavior of coping up with problems of soil infertility and reduces likelihood of chemical fertilizer adoption and lower the use of chemical fertilizer could possibly result in more use of organic fertilizer. It was also found that Extension contact had positive and significant effect on adoption decision of organic fertilizer. This implies that organic fertilizer adoption by the small-scale farmers in the study area would depend significantly on the information they get through the extension agents and the frequency of contact.

On the other hand, estimates of the second hurdle revealed that, the extent of use of organic fertilizer was determined positively by farm size and membership and negatively by arm income an application frequency.

5.3. Policy Implications

This study has the following useful implication for policy and future researchers in the area of factors affecting the adoption decisions and use intensity of organic fertilizer of small holder farmers in Ejere woreda in particular and in Ethiopian in general. The study drew attention to information that can guide policy towards influencing adoption and intensity of use of organic fertilizer which can have a potential benefit to soil fertility conditions, increased productivity and environmental sustainability. Therefore, the policy implication of this study is as follow.

As the above result showed, extension services were the main instrument in the promotion of organic fertilizer use. So, appropriate and adequate extension services have to be provided in line with current agricultural development policies of the country. This could be done by designing appropriate capacity-building program to train additional development agents to reduce the existing higher ratio of farmers to development agents as well as to provide refreshment training for development agents. Provision of training and technical advice on organic farming practices

through agricultural extension services and developing information networks among farmers is vital. This strategy will require both the government and NGOs concerned with agricultural production to hire more staff members and equip them with the necessary facilities to execute this role. In addition, there is need to organize for seminars and workshops regularly where farmers are invited and educated on the importance of organic farming systems as well as the technicalities involved in preparation of compost manure. Beyond assigning the extension workers to the respective *kebeles* in the district, attention should also be given to ensure that farmers get the expected services.

Access to information plays crucial role in enhancing technology adoption. Information can be obtained through membership to different organizations, from information media or through extension workers. Based on the results, being non-member to farmers group coupled with low access to extension services and information media could result in low adoption of organic fertilizer. To counter this, the policy makers should target at enabling farmers to have access to information media such as radio, and encouraging farmers' group formation and membership to such organizations.

Households with more livestock are more likely to adopt organic fertilizer. This shows that households with less or no livestock are less likely to adopt organic fertilizer. So, improving farmer access to credit facilities needs to be enhanced. This will help to eliminate liquidity constraints experienced in the purchase of organic manure from stockist or from other sources and in the purchase of livestock. The government and other development partners should encourage commercialization of the organic fertilizer. The fact that organic fertilizer processing factories have been limited in Ethiopia might be the major constraint for commercialization. However, governments and NGO's should focus on providing incentives to investors and entrepreneurs through credit and others. This could increase organic fertilizer processing plants and composting sites among others which also plays crucial role in reducing transaction costs associated with organic fertilizer adoption as farmers can get this fertilizer easily at lower costs.

The national government along with the regional government should do a big push investment on the educational sector, expanding of infrastructural facilities, creating market activities, and building institutions.

A deliberate effort to promote shops that stock dried organic manure. This could be achieved through encourage farmers to rear animals under intensive livestock management systems that support more livestock units per unit of land for provision of manure. In this regard, the stockist will be obliged to purchase organic manure from farmers with a surplus or from other regions of the country and sell to farmers who are demand or to other regions with shortage.

Generally, organic fertilizer has a potential to increase farmers farm income. As such, the smallholder farmers should be encouraged to adopt organic fertilizer so as to increase their farm income and improve their livelihood.

5.4. Further research

The main intention of the study was to assess the factors affecting adoption and intensity of use of organic fertilizer in smallholder crop production. The study proposed the following avenues for future research:

- I. To evaluate the impact of organic fertilizer usage on the income and welfare o agricultural household in study area.
- II. To investigate the farmers' perception towards the organic fertilizer in the study area.

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APPENDICES

Appendix 1: Questionnaire

Dear Respondents, I am MilkessaDejene Robi -an Msc student in Economics at Addis Ababa University. As a precondition of obtaining my Msc degree, I have supposed to conduct a research entitled on ‘Factors affecting the adoption of organic fertilizer and impact of organic fertilizer usage on small holder farmers’ income in Ejere Wereda, West Shoa zone, Oromia, Ethiopia.: Double Hurdle Model. This questionnaire is, therefore, designed to collect information from you regarding the adoption of the technology beginning from its introduction into the district and its effect on your income after adoption of it. Here are important points that you are expected to know while answering each and every questions:

- Apart from taking up your time, answering this questionnaire presents no risk whatsoever.
- All responses will be treated in strict confidentiality and will be used for academic research purposes only.
- Feel free to seek any clarification and ask any question regarding this research from the enumerator.
- Since your individual opinion is highly valuable, try to provide the correct answer for every question.
- The questionnaire should not take you more than about 15 to 20 minutes to answer the whole questions.
- There is no right or wrong answer; a quick response is generally the most useful.
- If you think that important points related to the technology are not included here, please have a say.

To The Enumerator

- ✓ Make it clear that you are a student/or collect for the student.
- ✓ Try to create a friendly environment with them.
- ✓ Ask the respondents and wait them for ready cooperation before starting the questionnaire.
- ✓ Impress on them the importance of the survey.
- ✓ Don’t ask for information the researcher doesn’t require and irrelevance to this research.
- ✓ Ask for approximates or estimates rather than exact answers—if the respondent has to leave.
- ✓ Ensure that the questions have been understandable by the respondents.

Section 1: General Information.

Farmers survey identification: _____

Name of data collector: _____

Date of interview/data collected _____

Checked by: _____

Date checked: _____

Name of peasant Association/kebele _____

Type of Agro-ecological zone of the peasant Association/ kebele: **(circle one)** 1. Dega 2. Woina Dega

SECTION 2: HOUSEHOLD CHARACTERISTICS

1. Current age of respondent _____ (in years).

2. Gender of respondent: **(circle one)**

Male	Female
1	0

3. Marital status of respondent: **(circle one)**

Single	Married	Divorced	Widowed(separated)	If any other specify
1	2	3	4	5

4. The level of education of respondent in years? (Years of schooling of). _____

5. Household family members' and parents' information:

S/No	Name of families (including parents)	Sex	Age in years	Education level Attended in years	Remark
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					

6. What is the level of your income per year from agriculture in ETB? _____

7. Do you have any other employment opportunity **in addition to farming**?

8. If question number 7 is yes, what type of employment opportunity is it? **(circling or answering more than one is possible)** 1= Government employment

2 = Non-agriculture private work, 3 = other, specify _____

9. What is the level of your income per year from employment opportunity you stated in question number 8 in ETB? _____

10. What is your total income per month/year in ETB irrespective of its sources? _____

11. For how long have you been practiced farming? _____

Section 3: Farm Characteristics

12. Do you own land? 1 = Yes 0 = No

13. If question 12 is yes, what is the size of your land in hectare? _____

14. If question 12 is no, to whom the land you currently plot belong? 1 = Family, 2 = rented (contracted), 3 = ½ (qixxee in local language), 4 = 1/3 (siso in local language), 5 = other if specify

15. What is the current size of your plot under crop production in hectare? _____

16. How do you rate your plots fertility? 1 = Not fertile, 2 = Medium, 3= Fertile

17. Currently, on what size of farm plot did you apply composting? Answer: _____hectare.

18. Which types of crops are you growing? _____, _____, _____, _____
19. Do you own livestock? 1= Yes 0 = No
20. If question 18 is yes, how many animals? Cattles_____, Sheep_____, Goats_____, and Others_____ do you own?

Section 4: Use of Organic Fertilizer

21. Do you use organic fertilizer? 1= Yes 0 = No
22. If question number 20 is yes, what is the main source of material that you have used as an **input** for the preparation of organic fertilizer? (**circling or answering more than one is possible**)

Livestock's waste material	Crop residue	Leaf of a Tree	Human waste Material	Others
1	2	3	4	5

23. If question 20 is no, what makes you not to use organic fertilizer?

- 1 = High transaction costs, 2 = Have no animals which may provide manure,
 3 = Low skill of know how to prepare and use, 4 = Shortage of finance,
 5 = Have no enough labor, 6 =distance between your and plot farm,
 7 = others, specify and list them_____.

24. If your choice for question 22 is 1 or 4, based on your choice, how much would you have been spend to get organic fertilizer for one hectare of your plot in ETB? _____

25. If question 20 is yes, answer the questions (a – d) in the following table.

- a. Which type of organic fertilizer do you use? 1= Manure, 2 = Compost 3 = other, specify_____

If your answer for the above question on (a) is compost, fill the following table on your plot productivity before and after the use of compost for the given crops. Your answer should only include those crops you have been producing from the listed crops. How many quintals of the following crops do you harvest per hectare in 2018/19? _____.

		Harvested/hect	Productivity/hect	Income/hect
When you use compost	Wheat			
	Maize			
	Teff			
	Beans			
	Others specify, _____			
When you don't use compost	Wheat			
	Maize			
	Teff			
	Beans			

	Others specify, _____			
--	--------------------------	--	--	--

- b. For how long have you been using organic fertilizer in years? _____
- c. What quantity of organic fertilizer do you apply on your farm per hectare per growing season in kg? _____
- d. How frequent do you apply organic fertilizer? 1 = every season, 2 = per two season, 3 = per three season, 4 = above three season.

SECTION 4: INSTITUTIONAL FACTORS

26. Do you have access to credit? 1=yes 0= no
27. If question 25 is yes, how much did you get last season in ETB? _____.
28. Who is/are the sources of credit? _____
29. Have you been participated in any training related to composting? 1=Yes 0= No
30. If question 28 is yes, how many times did you participate in training per year? _____
31. If question 28 is yes, what was the agenda of the training? *Possible to choose more than one answer!*

How to prepare composting	1
How to use composting	2
The importance of composting	3

32. If question 28 is yes' how did you feel about the importance of the training?

Very important	A little bit good	Unimportant at all	I don't know
1	2	3	4

33. Do you have extension services? 1=Yes 0 = No
34. If question 32 is yes, how many times did you meet extension workers last season? _____ - _____
35. If question 32 is yes, what was his/her main contribution for you a as an extension workers on composting? More than one answer is possible.

S/he tells us the importance of composting	1
S/he tells us how to prepare composting	2
S/he tells us how to use composting	3
S/he tells us from what it can be prepared	4
S/he has no contribution in all this cases	5

36. Have you visited any field demonstration about composting? 1 =yeas 0 = No
37. If question 35 is yes, put how many times you visited it per year? _____
38. Do you have access to TV, radio or any other social media? 1= yes 2= no
39. Are there any farmers' organizations/ peasant Association in your village? 1= yes 0= no
40. If question 38 is yes, how many organizations are available? _____
41. Based on question 38, are you a member of that organization/s 1= yes 0= no
42. If question 40 is yes, to how many organizations are you a member in? _____

43. Based on question 34, how frequent do you meet with other organization/s members per month?

44. What is the transport mode do you use to the nearest market? 1= on foot,
2= Camel/horse, 3 = bus/car, 4 = other specify

45. How far is your village from the nearest market in km? _____

46. How many hours does it take to you to reach the nearest market from your village? _____

47. How long it takes you **on foot** from your home to the plot you have applied /could apply composting? _____minutes/hours.

48. How do you feel your accessibility to water in your village in terms of **distance** you walk?

Very close	Close	Far	Very far	Other, specify
1	2	3	4	5

Section 5: Transaction Costs

49. Do you produce your own organic fertilizer? 1 = Yes, 0 = No

50. If question 38 is no, from where do you get it? 1 = Market, 2 = From government,

3 = Farmer based association, 4 = other, specify _____

51. If question 49 is a market, can you get organic fertilizer from the nearest market?

1= Yes 0= No

52. Are there any other sources to buy organic fertilizer? (other than markets) 1=Yes, 0 = No

53. If question 51 is yes, how far are these sources from your village in km? _____

54. How long does it take to identify the sources of organic fertilizer in days? _____

55. When you search for the sources of organic fertilizer, what do you use? (more than one option is possible) 1= Phone call, 2 = SMS, 3 = Internet, 4 = Transportation, 5=others,

56. Based on question 54, how much does it cost in ETB when you use;

57. a. Phone call _____ c. SMS _____ b. Transport _____ d. Others specify sources and the amount of costs in ETB _____.

58. How long does it usually take from searching for to getting the organic fertilizer in days? _.

59. Do you bargain when buying organic fertilizer? 1 = Yes 0 = No

60. If question 58 is yes, what is the cost of bargaining in ETB and how long does it take in time? Time: _____ Cost: _____(Cost per hectare _____.)

61. In trying to get this fertilizer do you forgo any benefit? 1 = Yes 0 = No

62. If question 60 is yes, what is the amount of the benefit you forgo in ETB? _____

63. If question 60 is yes and the total amount of the benefit is unknown, list the benefits you would have lost. _____, _____, _____, _____

SECTION 6: FARM PRODUCTIVITY FOR SELECTED CROPS (This Section Is To Be Filled Only By Non-Adopters of Organic Fertilizer).

64. Fill the following table based on your plot productivity. Your answer should only include those crops you have been producing from the listed crops. How many quintals of the following crops do you harvest per hectare in 2018/19?

Crops	Harvested/hect	Productivity/hectare	Income/hectare
Wheat			
Maize			
Teff			
Beans			
Others specify, _____			

Appendix 2: Descriptive Statistics for Age, Education, Household Size, Labour, Livestock Holding, Farm Size, Experience and Credit

Age

adopters			non-adopters		
Range	Freq	Perc. (%)	range	Freq	Perc. (%)
22-30	7	13.20754717	22-30	21	13.90728
31-40	16	30.18867925	31-40	48	31.78808
41-50	19	35.8490566	41-50	45	29.80132
51-60	7	13.20754717	51-60	20	13.24503
>60	4	7.547169811	>60	17	11.25828
Total	53	100		151	100

Household head education				
adopters			non-adopter	
	Freq.	Perc. (%)	Freq.	Perc. (%)
Illitertate	6	11.32075472	13	8.609272
Primary	29	54.71698113	100	66.22517
High school	14	26.41509434	35	23.17881
College	3	5.660377358	3	1.986755
Uversity	1	1.886792453	0	0
Total	53	100	151	100

Household size

adopters			non-adopter	
Range	Freq.	Perc. (%)	Freq.	Perc. (%)
1-5	14	26.41509434	52	34.43709
6-10	32	60.37735849	73	48.34437

>=11	7	13.20754717	26	17.21854
Total	53	100	151	100

Labour

adopters			non-adopter	
Range	Freq.	Perc. (%)	Freq.	Perc. (%)
1-5	42	79.24528302	123	81.45695
6-10	10	18.86792453	25	16.55629
>=11	1	1.886792453	3	1.986755
Total	53	100	151	100

Livestock holding

	adopters		non-adopters	
	Freq.	Perc. (%)	Freq.	Perc. (%)
No	2	3.773584906	54	35.76159
Yes	51	96.22641509	97	64.23841
Total	53	100	151	100

Farm size

Farm size				
adopters			non-adopter	
Range	Freq.	Perc. (%)	Freq.	Perc. (%)
0-0.75	30	56.60377358	107	70.86093
1-1.75	19	35.8490566	40	26.49007
2-3	4	7.547169811	4	2.649007
Total	53	100	151	100

Farm Experience (years)

Farm Experience (years)				
adopters			non-adopter	
Range	Freq.	Perc. (%)	Freq.	Perc. (%)
1-10	8	15.09433962	25	16.55629
11-20	16	30.18867925	45	29.80132
21-30	18	33.96226415	42	27.81457
31-40	7	13.20754717	28	18.54305
41-50	4	7.547169811	11	7.284768
Total	53	100	151	100

Access to credit

	adopters		non-adopters	Total		
	Freq.	Perc. (%)	Freq.	Perc. (%)	Freq.	Perc. (%)
No	47	88.6792453	117	77.48344	164	80.39215686
Yes	6	11.3207547	34	22.51656	40	19.60784314
Total	53	100	151	100	204	100

. ttest extensionvisits, by(adoption)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	151	2.172185	.1019724	1.253058	1.970698	2.373673
1	53	3.622642	.3441681	2.505582	2.932018	4.313265
combined	204	2.54902	.1247532	1.781832	2.303041	2.794998
diff		-1.450456	.2663004		-1.975541	-.9253709

diff = mean(0) - mean(1) t = -5.4467
 Ho: diff = 0 degrees of freedom = 202

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
 Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

. ttest crdtamount, by(adoption)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	151	2854.305	489.1446	6010.71	1887.801	3820.808
1	53	1603.774	644.4694	4691.808	310.5511	2896.996
combined	204	2529.412	399.982	5712.886	1740.76	3318.064
diff		1250.531	910.1153		-544.0137	3045.076

diff = mean(0) - mean(1) t = 1.3740
 Ho: diff = 0 degrees of freedom = 202

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
 Pr(T < t) = 0.9145 Pr(|T| > |t|) = 0.1710 Pr(T > t) = 0.0855

```
. ttest farincome, by(adoption)
```

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
0	151	10897.54	622.4447	7648.729	9667.645	12127.43
1	53	15441.7	1136.216	8271.779	13161.71	17721.68
combined	204	12078.13	563.3684	8046.51	10967.32	13188.93
diff		-4544.162	1247.541		-7004.034	-2084.289

```
diff = mean(0) - mean(1)                                t = -3.6425
Ho: diff = 0                                           degrees of freedom = 202
```

```
Ha: diff < 0                                           Ha: diff != 0                                           Ha: diff > 0
Pr(T < t) = 0.0002                                     Pr(|T| > |t|) = 0.0003                                   Pr(T > t) = 0.9998
```

Appendix 3: probit output

```
. mprobit adoption gender mstatus age hhhdecn hysize labour livestock farmsize farincome farmexp
> soilfertility memberhip crdtamount extensionvisits disttonearmktkm acsstoinfomedia
```

```
Iteration 0: log likelihood = -65.940005
Iteration 1: log likelihood = -65.727119
Iteration 2: log likelihood = -65.726701
Iteration 3: log likelihood = -65.726701
```

```
Multinomial probit regression                               Number of obs = 204
Wald chi2(16) = 51.62
Log likelihood = -65.726701                               Prob > chi2 = 0.0000
```

adoption	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
0	(base outcome)					
1						
gender	-.5863503	.5299289	-1.11	0.269	-1.624992	.4522913
mstatus	-1.310036	.6355853	-2.06	0.039	-2.555761	-.0643123
age	-.2058519	.0693252	-2.97	0.003	-.3417267	-.0699771
hhhdecn	-.0021519	.0538446	-0.04	0.968	-.1076853	.1033815
hysize	-.0250705	.1069245	-0.23	0.815	-.2346387	.1844977
labour	-.212549	.1451206	-1.46	0.143	-.4969802	.0718822
livestock	.2489321	.0506194	4.92	0.000	.1497199	.3481442
farmsize	.4653962	.3631074	1.28	0.200	-.2462812	1.177074
farincome	.0000641	.0000261	2.46	0.014	.000013	.0001152
farmexp	.2015739	.0707537	2.85	0.004	.0628992	.3402486
soilfertility	-.0382858	.4294645	-0.09	0.929	-.8800207	.8034492
memberhip	1.12632	.3961417	2.84	0.004	.3498968	1.902744
crdtamount	-.0000879	.0000477	-1.84	0.065	-.0001815	5.59e-06
extensionvisits	.297926	.1140537	2.61	0.009	.0743848	.5214671
disttonearmktkm	-.0751293	.0522925	-1.44	0.151	-.1776207	.0273621
acsstoinfomedia	.9168466	.4578309	2.00	0.045	-1.814179	-.0195146
_cons	5.581345	2.606885	2.14	0.032	.471945	10.69075

```
. margins, dydx( gender mstatus age hhhdecn hhsizelabour livestock farmsize farmincome farmexp soilfertility membership crdtamount extensionvisits disttonearmktkm acsstoinfomedia)
> ilfertility membership crdtamount extensionvisits disttonearmktkm acsstoinfomedia)
```

```
Average marginal effects      Number of obs   =      204
Model VCE      : OIM
```

```
Expression      : Pr(adoption==0), predict()
dy/dx w.r.t.   : gender mstatus age hhhdecn hhsizelabour livestock farmsize farmincome farmexp
                 soilfertility membership crdtamount extensionvisits disttonearmktkm
                 acsstoinfomedia
```

	Delta-method				[95% Conf. Interval]	
	dy/dx	Std. Err.	z	P> z		
gender	.0736476	.0659283	1.12	0.264	-.0555695	.2028646
mstatus	.164545	.0771779	2.13	0.033	.0132791	.3158109
age	.0258557	.0080021	3.23	0.001	.0101718	.0415395
hhhdecn	.0002703	.0067645	0.04	0.968	-.0129879	.0135285
hhsizelabour	.0031489	.0134096	0.23	0.814	-.0231334	.0294313
labour	.0266969	.0180253	1.48	0.139	-.0086321	.0620259
livestock	-.0312667	.0050478	-6.19	0.000	-.0411603	-.0213731
farmsize	-.0584553	.0452276	-1.29	0.196	-.1470997	.0301891
farmincome	-8.05e-06	3.09e-06	-2.60	0.009	-.0000141	-1.99e-06
farmexp	-.0253184	.0082344	-3.07	0.002	-.0414574	-.0091793
soilfertility	.0048088	.0539431	0.09	0.929	-.1009178	.1105354
membership	-.1414696	.046634	-3.03	0.002	-.2328705	-.0500687
crdtamount	.000011	5.85e-06	1.89	0.059	-4.28e-07	.0000225
extensionvisits	-.0374205	.0136822	-2.73	0.006	-.0642371	-.0106039
disttonearmktkm	.0094365	.0064727	1.46	0.145	-.0032497	.0221227
acsstoinfomedia	.115159	.0561033	2.05	0.040	.0051985	.2251194

Appendix 4: Results of VIF for Multicollinearity, heteroskedasticity and omission Test

```
. vif
```

Variable	VIF	1/VIF
farmexp	24.85	0.040238
age	23.76	0.042096
hhsizelabour	4.72	0.211825
labour	4.52	0.221008
farmsize	1.68	0.596372
farmincome	1.51	0.662097
livestock	1.39	0.721650
extensionvisits	1.23	0.815242
hhhdecn	1.16	0.860052
crdtamount	1.13	0.885015
membership	1.12	0.892852
soilfertility	1.11	0.904519
disttonearmktkm	1.10	0.912476
gender	1.07	0.938532
mstatus	1.06	0.944495
acsstoinfomedia	1.04	0.965308
Mean VIF	4.53	

Hottest
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
Ho: Constant variance
Variables: fitted values of adoption
chi2(1) = 17.92
Prob > chi2 = 0.0000

Ovtest	
Ramsey	RESET test using powers of the fitted Values of Adoption
Ho: model has no omitted variables	
F(3, 184) = 5.01	
Prob > F = 0.0023	

DECLARATION

I, the undersigned, declare that this thesis is my original work and has never been presented for a degree or masters in any other university, and all the sources of materials used for the thesis have been duly acknowledged.

The examiners' comments have been dully incorporated

Declared by:

Name: Milkessa Dejene Robi

Signature: _____

Date: _____

Confirmed by Advisor:

Name: Atnafu Gebremeskel (PHD)

Signature: _____

Date: _____

Place and Date of Submission: Addis Ababa University, October 2020