

# Challenges and Prospects in the Adoption of Modern Agricultural Inputs in Gimbo District, Kaffa Region, Southern Ethiopia

Teju Belete<sup>1</sup> Tamirat Wato<sup>2</sup>

1.College of Business and Economics, Department of Economics, Bonga University P.O. Box 334, Bonga, Ethiopia

2.College of Agriculture and Natural Resource, Department of Plant Science, Bonga University P.O. Box 334, Bonga, Ethiopia

## ABBREVIATIONS AND ACRONYMS

<b>DAP</b>	Di-Ammonium Phosphate
<b>DAs</b>	Development Agents
<b>FDRE</b>	Federal Democratic Republic of Ethiopia
<b>GDP</b>	Gross Domestic Product
<b>GR</b>	Green Revolution
<b>GWARD</b>	Gimbo District Agricultural and Rural Development
<b>HHs</b>	House Holds
<b>HYVS</b>	High Yield Variety Seeds
<b>MAI</b>	Modern Agriculture Inputs
<b>NGO</b>	Non-government Organization
<b>SNNPR</b>	South Nation Nationalities and Peoples Region
<b>WB</b>	World Bank

## Abstract

The study was carried out to determine the challenges and prospects in the adoption of modern agricultural inputs in rural areas; in the case of Gimbo district. The data was collected from the farmer who lives in Gimbo District. The data for the study was collected from the sample of 100 farmers selected by simple random techniques from the three kebeles in Gimbo District. The adoption of agricultural input in the district is influenced by both demographic characteristics such as sex, age distribution, marital, family size, ox number, educational level and farm-land size and factors affecting adoption of modern agricultural inputs like extension contact, price of farm-inputs, price of farm-output, physical factors (level of infrastructural availability), agroecological factors such as (risk and uncertainty), credit availability and constrained, economical problem, family labor, information associated problem, availability distribution of inputs, the effectiveness of input, shortage of most needed inputs, accessibility of commodity market. The coordination between the farmers and extension service workers is necessary to achieve agricultural extensions strategies and to adopt different agricultural inputs such as fertilizers, pesticides, herbicides, improved seeds and so on.

**Keywords:** Technology Adoption and Innovation, Improved seed, Agriculture, Fertilizer, Pesticides, Herbicides, Farmers and Extension agents (Das)

**DOI:** 10.7176/PPAR/10-8-01

**Publication date:** August 31<sup>st</sup> 2020

## 1. INTRODUCTION

### 1.1. Background of the study

Agriculture is one of the key economic activities in developing countries like Ethiopia. The role of agriculture in economic development has been viewed as largely passive, supportive and secondary. It provides us with almost to fulfill all our basic needs Besides this agriculture provides the raw material for industrial products. About 50.8% of world populations are engaged in the agricultural sector. It is common knowledge that high yielding varieties of seeds, the use of chemical fertilizers and pesticides, irrigation and improved planting and weeding practices provide higher yields than conventional technologies (UNCTAD, 2010). In recent years Ethiopia has shown a sustained increase in the use of improved inputs notably seed varieties and chemical fertilizer, and farm credit (Gebreselassie, 2006; EEA, 2006; FDRE, 2010; Seife and Bosire, 2011).

Despite this, improved input use in Ethiopia is still lower than that of many other countries. For example, chemical fertilizer use in Ethiopia was only three kg per hectare while the corresponding figures for Kenya and India were seven and 107, respectively (WB, 2007). Productivity levels of major Ethiopian crops and animals are therefore low, and agricultural value-added per worker stands at a mere 56.6 percent of the sub-Saharan average. Agriculture is the livelihood of 85 percent of Ethiopians, contributes only 43 percent of gross domestic product, often leaving millions of Ethiopians food insecure (WB, 2010; Belay and Abebaw, 2004). Successive Ethiopian governments have promoted technology-led initiatives to enhance productivity, particularly in smallholder

agriculture (Gebreselassie, 2006; FDRE, 2010; Seife and Bosire, 2011).

Over the past two decades, the government has been reforming the research and extension systems and pursuing other relevant strategies such as irrigation, credit and allied services, to benefit farmers (Seife and Bosire, 2011). Moreover, as part of its current Growth and Transformation Plan, it has renewed its commitment to increase agricultural production and productivity through a combination of strategies, including by focusing on high productive areas, high-value crops, and farmers' increased use of improved inputs. It has also emphasized smallholder agriculture commercialization (FDRE, 2010; Seife and Bosire, 2011).

As a result, the agricultural primary role was to provide sufficient low-price food and manpower to expand industrial economic development (Nigate and Aklilu, 2005). According to the United Nation Development Program (UNDP, 2012), two-third of the people in developing countries are living in rural areas. Agriculture is the main source of subsistence and source of income for the majority of the rural people, many of them are small scale farmers whom their lands were as agricultural labor (Oxam Press, 2013).

Farmers in developing countries are depending on the farm income and they are characterized by low income and deficiency in the supply of grain. This is because of technological backwardness, rapid population growth and low productivity of livestock (FAO, 2011). Approximately 1.4 billion people in the world today live in extreme poverty level that-they survive on less than the United States dollar of 1.25 per day (World Bank database 2013). 842 million people or one out of eight people in the world do not have enough food to eat. 98% of the world's underfed people live in developing countries. Among those 223 million people lives in sub-Saharan Africa. 75% of the world's poorest people live in rural areas and depend on agriculture and related activities (FAO, 2011).

The agricultural sector has always been an important component of the Ethiopian economy accounts for 42% of gross domestic product (GDP), employs 80% of the Ethiopian labor force and supply 90% by value of all exports (MoA, 2002). 78% of Ethiopian people struggle with an income below 1 dollar per day. A predominant portion of Agricultural production takes place at the subsistence level (Wakuma, 2015). In all 99% of coffee production and 94% of other agricultural production comes from peasant farms (Samuel, 2005).

Appropriate investment to increase Ethiopian Agricultural productivity should focus on appropriate land saving techniques and increasing crop yield per unit of adoption of new farming techniques specifically related to production (Samuel. G, 2005). Ethiopia is one of the third largest users of inorganic fertilizer, has been striving for agricultural productivity. It was during the imperial period that the government started to adopt different technological inputs such as fertilizer, pesticide, and herbicides, aiming to enhance agricultural productivity and to ensure food self-sufficiency (Befekadu, 2014).

Chemical fertility is imported from abroad in the form of Di-ammonium phosphate (DAP) and UREA. Fertilizer import is mainly financed by funds obtained from donors and creditors. More than 90% of all fertilizers are used by smallholder farmers and the remaining 10% is used by private commercial farmers and the research centers. Of the total quantity of organic fertilizer used in the country, 94% was used for the production of major cereals (CSA, 2013). The effect of agro-climatic and socio-economic factors on their adoption of modern agricultural inputs must be assessed. However, the factors responsible for adoption variation are not well addressed. Therefore, the study aims to assess (investigate) the factors responsible for the adoption of modern agricultural innovations in Gimbo District.

## **1.2. Statement of the problem**

Sustainable development is unachievable without prioritizing the progress of agricultural productivity. Population growth is fast in developing countries like Ethiopia, Nigeria, and Egypt. From this, the Ethiopian population is increasing at a rate of 2.9% per annum (EEA, 2010). The ultimate goal of any rural agricultural strategy or program is to improve the welfare of rural households. This goal is to achieve among other things by increasing productivity at the farm level and by raising farmer's income and by improving their welfare. Although the total consumption of modern agricultural inputs has shown an increasing trend, farmers in Ethiopia are still using very little, due to various institutional, economic and physical factors. Increasing the number of cooperatives, the right quality and quality supply of fertilizer at the right time with the right distribution and factors cost supply are decision factors to improve agricultural input use. The government should emphasize to avoid the challenges that are beyond the capacity of the cooperatives in credit to boost agricultural product and production. Generally, future increases in agricultural production and productivity cowed achieve through intensification of improved agricultural technology (Abebe, 2011).

over the past four decades, numerous modern technology packages have been introduced to Ethiopia. While some studies in the past have attempted to access the factors behind the adoption behavior of farmers, the adoption and diffusion of these technologies has not been satisfactorily and comprehensively assessed even at the national and regional levels. So, we believe that there are little or not enough empirical and conceptual studies regarding the adoption of improved agricultural modern inputs at Gimbo district. The previous studies are done in different areas of Ethiopia on the determinant of fertilizer adoption and also identified some variable factors that determine chemical fertilizer adoption. But also, this research different from the other researcher by study area. Therefore,

this study is aiming to assess (investigate) the effect of those factors on the adoption of modern agricultural inputs to the smallholding farmers in Gimbo district.

### **1.3. The objective of the study**

#### **1.3.1. General objectives**

The general objective of this study is to assess the challenges and prospects in the adoption of modern agricultural inputs in Gimbo District.

#### **1.3.2. Specific objectives**

The specific objectives of this study:

- To address the extent of the adoption of modern agricultural innovation inputs in the study area.
- To identify the determinant of fertilizer adoption in the study area.
- To identify the determinant of HYV adoption in the study area.
- To come up with some possible recommendations for policy in the study area.

#### **1.3.3. Research question/Hypothesis of the study**

- What are the differences between before using modern agricultural inputs and after using describe in terms of quality and quantity of agricultural productivity?
- Which input do you think that has the highest contribution to crop productivity?
- What are the significance and problems of using modern agricultural inputs to agricultural productivity?

### **1.4. Significance of the study**

Conducting this study will have several advantages for the District and other students. To provide further information to individuals and other interested groups on the topic, for the further study used to provide helpful feedback from farmers and to access the effectiveness of technology transfer and improve the flow of information between research and extension.

### **1.5. Scope of the study**

This study was limited to one administration district, three kebeles, and respondents. The study covers one district of Gimbo district of kaffa region. It focused on challenges and prospects in the adoption of modern agricultural inputs and also analyzed the constraints that affect the adoption of modern agricultural inputs in the study area. This study limited by different factors such as time, resource and availability of data.

### **1.6. Limitation of the study**

The study was limited by different factors such as time constraints, resource constraint and no availability of current data. Only one district due to time and resource constraints like budget constraints, non-availability of current data and in some of the government bureau, workers do not allow using data available in the office, lack of computer. These and other factors might limit this paper not to be done easily and most of the respondents are unwilling to answer the questioners.

### **1.7. Organization of the paper**

The study organized into four chapters. Accordingly, the first chapters deal with the introductory part of the study which contains background, statement of the problem, objective of the study, the hypothesis of the study, the significance of the study and organization of the study. The second chapter focuses on the review of related literature. The third chapter contains methodology, data source target population, sample size, and sampling techniques, data collection, and data analysis method were presented, the fourth chapter includes data analysis and discussion and the chapter five includes conclusion and recommendation.

## **2. LITERATURE REVIEW**

### **2.1. THEORETICAL LITERATURE REVIEW**

#### **2.1.1. Definition of Technology, Adoption, Innovation, Productivity, and Their Measurement**

The vast majority of the world's poorest people live in rural areas and engaged in agriculture, and therefore activities designed to address the vulnerability of these rural poor are often led to improving agricultural practices through increasing productivity, efficiency and ultimately their income. Governments, NGOs, aid agencies and extension workers have long known that the success of any project depends, in part whether farmers adopt their offered technologies or whether those farmers adopt the technologies in an ideal combination and for the prescribed length of time needed to produce designed results.

Researchers have conducted surveys and analyses for many decades' around the world in an attempt to understand the adoption decisions of individual farmers and the diffusion patterns among communities. By understanding how farmers and communities decide whether to adopt a technology, aid professionals and can refine their agricultural technology outreach projects to address the conscious and subconscious concerns for

targeted communities, and increase the probability that farmers will be willing and able to participate in project activities (FAO, 2011).

### **2.1.2. Technology Adoption**

Technology is the assembly of techniques, skills, methods, and processes used in the manufacture/production of goods or services or the achievement of objectives, such as scientific investigation. *It* is assumed to mean a new, scientifically-derived, often complex input supplied to farmers by organizations with deep technical expertise. Neill and Lee point out that the majority of existing literature on agricultural technology adoption is focused on Green Revolution (GR) technologies such as irrigation, fertilizer use, and the adoption patterns of high-yield variety seeds (HYVS).

Due to the development process of HYVS and the inputs required to make them productive, studies examining HYVS adoption look at very advanced forms of technology; HYV seeds are often the product of intensive laboratory research. And when they are targeted to farmers, they are bundled with other technology inputs such as chemical fertilizers, pesticides, and extensive irrigation because these are necessary for the HYV seeds to perform as designed. Because of so many studies of agricultural technology adoption and diffusion focus on HYVS, their findings are concentrated on a “high-tech” definition of agricultural technology.

### **2.1.3. Adoption and Its Measurement**

Adoption studies have often explained technology acceptance or rejection of socio-demographic profiles of end-users. Adoption refers to the decision to use or not to use new technology, method, practice, etc. by a firm, farmer or consumer. Rogers (1983), defined adoption behavior as the process by which technology is communicated through certain channels of over time among the members of a social system. In the context of this study, adoption refers to the decision of an individual farmer to use or not to use modern agricultural technology at a point in time. According to Colman and Young (1989), adoption always pre-suppose that the innovation exists and studies of adoption analyze the reason or determinants of whether and when adoption takes place.

The measurement of adoption of a given technology depends on whether the technology is divisible or not. If technology is divisible, its adoption can be measured at the individual level in a given period by the share of the farm area under the new technology or by the per hectare quantity of input used about the resource recommendation (Feder *et al.*, 1985). In this study, the focus is only on technologies of divisible nature, especially fertilizer, HYVS and Chemicals (Colman and Young, 1989).

### **2.1.4. Innovation**

Innovation is the process of translating an idea or invention into good or service that creates values or for which customers will pay. Innovation is the basis of technological changes. An agricultural innovation system is about people, the knowledge, technology, infrastructure and cultures they have created or learned who they work with, and what new ideas they are experimenting with (IMWIC, 2016). The approach characterizes a major change in the way that the production of knowledge is observed and hence supported.

For a technological change to occur a technology is assumed to be generated from some sources within or outside the concerned or agricultural sector or adopted by the users. The domain tradition and expectation in developing countries are that technologies are generated by formal national or international research and development organizations (FAO, 2011). According to Schumters (2001), innovation may consist of the following elements.

- A. the introduction of new knowledge or product
- B. the introduction of a new method of production
- C. the opening up of new market and
- D. the conquest of a new source of supply of raw material or semi-finished goods

## **2.2. Limitation and Challenges of Agricultural Extension in Ethiopia**

Her below are some limitations and challenges that were worth considering while looking at the performance of the national extension system in Ethiopia.

- Lack of clarity: as Tesfaye (2003), remarked the Ethiopian extension system operates without a concentrate extension policy.
- Gaps in decentralization and linkages: power is being developed to districts to plan and implement extension service.
- Unidirectional information flow: extension has been based on the linear model of knowledge utilization.
- Number and quality of extension personnel until recently the number of DAs and their quality until the recent is very low.
- Assuming that awareness alone always leads to adoption (Belay, 2003).
- Difficulties in assessing the performance and impact of agricultural extension systems are poor or unknown (MOA, 2010).

Mostly Farmers do not adopt technologies as a package, but rather adopt a single component or a few suitable techniques (Sibanda *et al*, 2018). The principal reasons given for the sequential adoption of a package of

technologies are profitability, riskiness, uncertainty, lumpiness of investment and institutional constraints. For example, Ryan and Subrahmanyam (1975) argue that this type of choice is a rational choice for farmers with limited cash. Only a few numbers of farmers adopt new technology in the early stage of the diffusion process. At this stage, only a few farmers will have full information about the potential advantage of the technology and even if they get full information about the potential advantage of the technology, fear of the possible risk associated with the new technology will make the adoption speed low.

But after a subsequent period, potential adopters will acquire full information about the potential advantage of the technology, and the degree of riskiness related to it becomes clear so that adoption becomes rapid. The adoption increases gradually and begins to level off, ultimately reaching an upper ceiling. Mansfield (1961), Griliches (1957), Gutkind and Zilberman (1985) and Bera and Kelley (1990), Legesse (1998) attributed the S-shaped diffusion curve to the spread of information as well as to economic factors. The adoption rate of a given technology mainly depends on its profitability, the amount of investment required to adopt it, the degree of uncertainty associated with it and its availability.

According to Rogers (1983), Rogers and Shoemaker (1971) and Mosher (1979), Legesse (1998), all farmers do not adopt a given technology at the same time, rather they adopt in order time sequence. Based on the time when farmers first begin using new technology, they identified and described five possible adopter categories in any social system: innovators, early adopters, early majority, late majority, and laggards (Legesse, 1998).

According to Ellis (1993), Legesse (1998), two kinds of innovation can enhance the productivity of farmers. The first is a process innovation that changes the amount, combination, quality, or types of inputs required to produce the same kind of output. Most innovations in agriculture are process innovation where the output produced remained unchanged. But sometimes, such a process innovation may change the test and size of agricultural outputs. The second type of innovation is a product innovation where the nature of the output changes and it is usually considered more prevalent in the industry than agriculture. But still, the product innovation in the industrial sector like tractors and fertilizers can be used as an input in the agricultural sector.

However, the concept of induced innovation is not as such acceptable in fewer developing countries like Ethiopia where the market doesn't work well and typically technologies transferred from developed countries to developing countries where there is less room for endogenous technological change (Ellis, 1993; Legesse, 1998). Moreover, in most of the less developing countries, agricultural innovations are imposed on farmers from above rather than conforming to the idea of choice between markets driven alternatives (Burmester, 1987).

According to Estehiwot (2018), productivity can be measured in two ways; partial productivity and total productivity. Partial productivity measures the productivity of each input in the production process, like the productivity of fertilizers, HYVS, pesticides and so on, whereas total productivity measures productivity about all inputs (Estehiwot, 2018). The agricultural productivity of a given farm household depends on various factors in the literature. Ellis (1993) argued that small farms in terms of land size are more productive than large farms and his recommendation that agricultural development strategy based on the promotion of small rather than large farms can serve both growth and income distribution objectives are based on this argument.

Overall, there is little irrigation available and inputs are scarce in Sub Saharan African. Thus, the problem is not so much of developing HYVS that need a lot of care, but of growing varieties that can adapt to a difficult environment and eventually develop resistance to several diseases. Concerning fertilizer, mainly used to improve the fertility of the soil which is degraded because of over-production are of two types; organic and inorganic. The organic one is mainly animal dung and green manure which are available to the farmer at his/her disposal. But the inorganic fertilizers are the purchased chemical fertilizers like DAP and Urea. Just like HYVS fertilizers are also divisible technologies. But when we see its application in most developing countries, because of many constraints, it is below the recommended rate with sub-optimal use which let alone improve soil fertility, it will not maintain the previous fertility which results in a decrease in productivity of the soil.

Further, countries should not stick to the blanket recommendation of fertilizer application; rather have to develop their rate depending on their own socioeconomic and agro-ecological environments (Nigussie and Mulat, 2003; Feder *et al.*, 1985). In the economic models of adoption behavior, the farmer's choice between alternative technologies depends on different socio-economic and agro-climatic factors. According to Rahm and Huffman (1984) and Legesse (1998), farmers' adoption decisions are assumed to be based on the objective of utility maximization. Lastly, insecticides and pesticides are chemicals used to protect production from pests and insects which could damage yield because of disease and low productivity.

## **2.3. Theoretical Framework**

### **2.3.1. The Diffusion Model Theory**

The diffusion of better husbandry practice, crop and livestock varieties has been a major source of productivity. Growth in agriculture in US crop exploration and introduction became a major activity of the US department of agriculture. The effective diffusion of identified technology was provided by the research of rural sociologists on the diffusion process (Udemezue and Osegbue, 2018). Methods were developed emphasizing the relationship

between diffusion rates and the personality characteristics and educational accomplishment of farm operators until late 1930s and 1940s a significant portion of total effort was devoted to the testing and refinement of farmer innovation and the testing and adoption of exotic crop varieties and animal species.

### **2.3.2. The High Pay Off Input Model Theory**

The key to transferring a traditional agriculture sector into a productive source of economic growth is an investment to make modern high pay off inputs available to farmers in poor countries. There are three types of relatively high productivity investment for agricultural development

- In the capacity of an agricultural experiment station to produce and market new technical knowledge.
- In the capacity of the agricultural sector to develop, produce and market new technical inputs and

In the capacity of farmers to use modern agricultural factors effectively. The unique implication of the model for agricultural development policy is emphasizing on the process of development and propagation of new inputs or techniques through public investment in scientific research and development.

## **2.4. Empirical Literature**

Studies on the adoption process of modern agricultural innovation focusing on the entire family and farm HHs are quite recent. Factors determining technology adoption and productivity differ from one sector to the other and from one region to the other in the same sector.

Especially, dealing with agricultural technologies where the sector has its peculiar characteristics like the seasonality of production and its high dependence on the varieties of nature makes it different from the other sectors. Moreover, there is a significant difference in terms of the characteristics of agriculture in developing and developed countries. In developing countries, the agricultural sector is characterized by its high dependence on natural phenomenon, highly constrained by a shortage of resources and undertaken by less educated farmers.

As a result, the empirical literature part covered in this paper emphasizes only on adoption and productivity studies undertaken in developing countries' agricultural sectors. This part has two parts, the first deals with different adoption and productivity studies in developing countries and the second concentrate on adoption and productivity studies in Ethiopia.

### **2.4.1. Adoption and Productivity Studies in Developing Countries**

Most of the adoption studies in developing countries are undertaken in Asia and Latin American countries where the Green Revolution took place and was successful. Kamilson (2004), studies on agriculture service and input use in Nigeria. He concludes that adopting inputs were the difference and unabsorbed heterogeneity of state and local government level. Different authors have emphasized different factors as a significant determinant of adoption decisions. Perrin and Weinkelman (1976) and de Groote *et al.*, (2003) summarized adoption studies on wheat and maize in six countries, namely Kenya, Colombia, El-Salvador, Mexico, Tunisia, and Turkey and reported that the difference in adoption rates in these countries are explained by difference in information, agro-climatic and physical environments, availability of inputs, the difference in market opportunities for the crops, and the difference in farm size and farmers' risk aversion characteristics.

For the detailed analysis of the factors determining agricultural technology adoption, this part of the literature is classified into household head's characteristics, farm characteristics, institutional and agro-climatic factors and the characteristics of the technology. Concerning the household head's characteristics, the two most important variables considered in most literature are education and age. Most of the adoption studies undertaken in developing countries, using the Probit model show that education level of the household head has a positive and significant effect on the adoption decision of modern agricultural technologies (Jha *et al.*, 1990; Strauss *et al.*, 1991; Lin, 1991; Akinola and young, 1985). But other researchers like Shakya and Flinn (1985) and Pitt and Sumodiningrat (1991), using the same Probit model found the impact of education on technology adoption to be non-significant. It could be argued that the role of education on technology adoption may not be an important factor in the case where there is effective extension service and the technologies are simple like fertilizer and HYVS. But in the absence of effective extension service and complex technologies, education becomes an important factor in determining the farmer's decision.

Regarding the age of the household head, many researchers have stated contrasting results using the same Probit model. According to Jha *et al.* (1990), Akinola (1987) and Akinola and Young (1985) reported a negative relationship between technology adoption and the age of the household head. But Mahabub (1988); Zegeye (1989) and Legesse (1998) found a positive relationship between technology adoption and the household head's age. They argued that grownup farmers have more experience and skill and thus better knowledge of the use of different technologies than younger farmers. Coming to farm appearances, the two most mutual variables considered are family size (which is mostly used as a proxy to labor availability) and farm size. The impact of family size on the technology adoption decision of a farmer mostly subjected to the characteristics of the technology. If modern technologies are time and labor-saving like tractors, combine harvesters, pesticides and the like its impact will be negative, while if the technology is labor-intensive like fertilizer and HYVS, its impact will be encouraging and positive.

Akranove (2010), studies on agricultural productivity difference between Africa and Asia. He concludes that the substantial difference in agricultural productivity between Asian and African farmers was the difference in the use of modern inputs. Kamiljon, (2010), the evidence suggested that better access to infrastructures such as roads, irrigation and better access to modern inputs in Asian farmers, while Sub-Saharan African farmers without such access are not able to fully exploit the benefits of modern agricultural inputs. Here, whether farm size affects the adoption decision depends on the characteristics of the new technology. If the technology is divisible, it is scaling neutral and hence small farmers can adopt it as large farmers do. But in the case of lumpy technologies, there is a high probability for large farmers to adopt than small farmers do. But for Feder and O'Mara (1981), even if divisible technologies are neutral to scale, the record of adoption and diffusion experiences throughout the world show that adoption rates and the time patterns of adoption are related to farm size. The argument for this is the differences in information acquisition costs, which is higher for small farmers than large farmers which may discourage adopting the technology.

For Ruttan (1977), farm size plays a significant role at the early stage in the adoption process. Large farmers indeed adopt technology early because of the relative advantage they have, but as adoption progresses, their relative advantage will diminish and the small farmers will catch up. Hence at the latter stage of the adoption process, farm size will be a non-significant factor. In developing countries, where farmers have only limited capacity to finance investment in new technologies, the role of credit cannot be overestimated (Feder *et al.*, 1985; Bhalla, 1979). Almost all the literatures reviewed found a positive and very strong relationship between the availability of credit and the farmer's decision to adopt new technology in developing countries (Akinola, 1987; Pitt and Sumodiningrat, 1991; Shakya and Flinn, 1985) using the Probit model and (Green and Ng'ong'ola, 1993) using the logit model. The availability of infrastructures (like roads, transportation, irrigation, and the likes) and good agro-climatic conditions (like rainfall, soil fertility, salinity, and the likes) have also a positive impact on the adoption of modern technologies, while drought hurts the adoption decision. (Pitt and Sumodiningrat, 1991; Jansen *et al.*, 1990), using the Probit and logit model respectively.

Lastly, concerning the characteristics of technology, the farmer's preference, evaluation of the varieties characteristics and perception of specific traits like the test, yield, cooking quality and the like strongly affect the farmer's decision to adopt the new technology (Smale *et al.*, 1995 and Adesina and Zinnah, 1993), using the Tobit model and (Heisay *et al.*, 1993), using the multinomial logit.

#### **2.4.2. Adoption and Productivity Studies in Ethiopia**

A study by Tesfai (1975), using the Probit model in the Arsi zone reported that the probability of the adoption of improved varieties and fertilizer strongly increases with farm size and extension service. The availability of cash for a down payment, membership in local association and literacy also increases the probability of adoption but less strong than the above two factors. He further reported that tenants are less likely to adopt improved varieties and fertilizer as compared to owner cultivators.

Yohannes *et al.* (1991), using the logit model in Tegulet and Bulga area of North Shewa zone found that the adoption of modern technologies is positively affected by farm size, family size, education, farm and off-farm income, exposure to outside information and experience as represented by age. But debt and degree of risk aversion had a negative influence. According to Legesse (1992) using the Probit and Tobit models, access to credit, expected yield, cash availability for a down payment, participation in the farm organization as a leader and close exposure to technology had a positive impact on the probability of adopting HYVS, the intensity of fertilizer and herbicides.

According to Lelissa (1998), the most important determinants of fertilizer use and intensity in Ejere District of west Shewa zone are agro-climatic conditions, land tenure systems, credit, extension service, oxen ownership, age of the farmer, family size, farmers level of education, manure, the ratio of the price of crops to fertilizer cost, distance to the fertilizer distribution center and cropping pattern. Legesse (1998) studied adoption and diffusion of agricultural technologies in East and West Shewa zones using Probit and Tobit models and found that location, oxen ownership, distance to market, credit, gender and degree of risk aversion had a significant impact on the adoption decision of the new technologies. But education and the index of awareness did not affect the adoption decision. He also found that the impact of the increase in output price on the probability of adopting modern technology is very high.

Mulat and Bekele (2003), using the Cobb-Douglas production function model studied the determinant of high variety yields of major cereals in 18 sites of the four major regions in Ethiopia, namely Amhara, Tigray, Oromiya and Southern Nations and Nationalities Peoples (SNNP). They reported that DAP and Urea alone are not solutions for the productivity problems in Ethiopian agriculture and the contribution of extension to yield is not significant, holding other factors constant. According to this study, farmers' education is one of the explanatory variables with consistently significant and positive coefficient in determining productivity. The rate of fertilizer application, the quantity of labor used, use of herbicide and sex were found to be significant determinants of the productivity of teff and wheat but ownership of oxen was not significant. In the case of barely, the fertilizer coefficient was not significant but contact with extension, literacy, farm size, seed rate, and labor intensity positively affect productivity.

Lastly, a study by Assefa and Gezahegn (2004) on the adoption of improved technologies in Ethiopia, using probit and logit models reported that the age of the farmer and the distance of the farmer from the market center hurt the adoption decision of the farmer. On the other hand, household size, farm size and farmers' contact with extension agents had a strong and positive effect on the adoption of improved technologies in Ethiopia. They further reported that religion is also an important factor in the adoption decision. According to this study, both Muslim and Orthodox farmers are less likely to adopt new technologies as compared to farmers practicing other religions. But literacy, formal education, number of oxen owned and credit were found to be non-significant determinants in the adoption decision of the farmer.

## 2.5. Critical Evaluation

Most of the adoption studies in Ethiopia are not regional or countrywide, rather it has been undertaken in specific areas, especially in the areas where the package and the extension approach can be applied. Most of the study's accomplishment was taken before the last three and four decades ago. For this purpose, the relevance for the present generation was not significant because of the modern agricultural technology inputs are the requirement of modification which coincides with the time. And as explained above most literature was disused as a whole not studying detail especially in southern nations had no relevant study worked. The paper doesn't deal with all modern agricultural inputs; rather it is restricted to HYVS, fertilizers, and chemicals. HYVS are those seeds that have not only higher yield, but also resist disease, tolerate drought and have a shorter growing period. Such seeds have resulted in a substantial increase in output in many countries, but to realize their potential, they highly depend on complementary purchased inputs. The potential of HYVS is not affected by farm size, scale or Socio-economic status because they are infinitely divisible (Ellis,1993; Sintayoh, 2013). But location endowments like natural soil, water, irrigation, infrastructural disparities affect their potential. For example, Chambers *et al.* (1989) stated that HYVS are less successful in resource-poor and semi-arid environments like in Africa.

Moreover, there is no literature regarding the adoption of modern agricultural technology inputs in Gimbo District. For this reason, the researcher aims to fill the time-constrained and place concentration (most works were accomplished out of the researchers' field of operation). From the literature, some of the researches were done out of Africa. From this, I can conclude that African technology and the rest of the world are not comparable so that the technology available in the rest world is not the same for our country Ethiopia.

## 3. MATERIALS AND METHODOLOGY

### 3.1. Description of the study area

Gimbo is found in the kaffa Zone of Southern Nations, Nationalities, and People's Region which is located in Ethiopia - some 205 mi (or 330 km) South-West of Addis Ababa. This area has a tropical climatic condition. Based on the 2010 E.C statistical data on health, this Gimbo district has a total population of 120,000. The primary food crops include Enset and maize; other staple foods include wheat and barley. A major cash crop in this District is tea; there is a large tea plantation at Wushwush.

### 3.2. Types and Source of Data

Both the primary and secondary data sources would be used.

### 3.3. Method of Data Collection

For this study, the interview and questionnaire would be chosen.

### 3.4. Sampling Techniques and Size

This study is used the sample survey from the total number of households within the districts; I preferred and apply a simple random sampling method were each farm household is exposed to equal chance. The reason for selecting the three kebeles is that it is very difficult to consider all kebeles the researcher faced time and finance limitations. The selection of the three kebeles is reasonable because the total distributions of the farm households of the district are socioeconomically, culturally and institutionally similar.

The administration, technology diffusion procedures and plans of development by the district leaders are almost the same for all the 34 kebeles and so any household from any kebeles can be representative of the district. A multi-stage sampling technique was adopted in this study by adopting a simple random technique at each stage. Out of 34 kebeles, 3 kebeles were randomly selected, out of which 100 respondents were taken as a sample based on the procedures. According to Gimbo district agricultural and rural development office, the total household in the three kebeles is 8,138. and the precision level is 10 percent.

The sample size determination technique adopted was as of Yamani T. (1967)

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

Where n= sample size, N=total households of the target population in the case study, e= level of precision

$$n = \frac{120000}{1 + 120000(e^2)} \quad 99.92 \approx 100$$

The stratum also calculated as  $Ni = \frac{n}{N}$ , where  $Ni$  = the total number of observations in the kebele  $i$ .  $N$  = total numbers of household heads in the study area.  $n$  = the total number of sample sizes. So, by using the above sampling formula the proportional number of the respondent in each kebele is calculated as follows.

1. From Gojeb kebele  $(\frac{3701}{8138}) \times 100 = 46$
2. From Diri Kebele  $(\frac{2366}{8138}) \times 100 = 29$
3. From Zingaj kebele  $(\frac{2071}{8138}) \times 100 = 25$

### 3.5. Method of Data Analysis

For data analysis, the descriptive data analysis methods were used. The descriptive analysis includes orderly arranging the data in tabulation, frequency, percentage and table forms. Because the descriptive statistics method of data analysis is a more important and widely used method due to its nature of simplicity and clarity to analysis especially for the beginner is advisable.

## 4. DATA ANALYSIS AND DISCUSSION

### 4.1. Primary Data Analysis

This chapter deals with the analysis and discussion of challenges and prospects in the adoption of modern agricultural inputs in rural areas. The results and discussion mainly deal with the demographic characteristics of respondents, factors affecting the adoption of modern agricultural inputs for the farmer.

The total number of households that were selected for were one hundred from those forty-six were selected from Gojeb kebele, another 29 respondents were selected from the Diri kebele and 25 sample respondents from Zingaj kebele. The sample from each kebele is through proportional numbers who have numbers of people in each selected kebele.

**Table 1:** Sex of sample respondents

No	Sex	Gojeb Kebele		Diri kebeles		Zingaj Kebele		Total
1	Male	38	83%	20	69%	18	72%	76
2	Female	8	17%	9	31%	7	28%	24
3	Total	46	100%	29	100%	25	100%	100

Source: own survey, 2019

According to the data above in three kebeles, the majority (large proportion) of the respondents are males and remains a small proportion of sample respondents are females. From these reviews in all of these kebeles, females are low users.

**Table 2:** Age distribution of sample respondents

No	Age	Kebele One		Kebele Two		Kebele Three		Total
1	<30	8	17%	7	24%	2	8%	17
2	30-40	12	26%	4	14%	6	24%	22
3	40-50	20	44%	10	34%	12	48%	42
4	>50	6	13%	8	28%	5	20%	19
5	Total	46	100%	29	100%	25	100%	100

Source: own survey, 2019

According to the above table in three kebeles under aged 40-50 are the majority of the respondents. In addition to this, the smaller portion of respondents found at the age of less than 30.

**Table 3:** Education levels of sample respondents

No	Education level	Gojeb		Diri		Zingaj		Total
1	Illiterate	37	80%	21	73%	11	44%	69
2	1-4	2	5%	2	7%	6	24%	10
3	5-8	1	2%	1	3%	3	12%	5
4	8-10	1	2%	2	7%	1	4%	4
5	>10	5	11%	3	10%	4	16%	12
6	Total	46	100%	29	100%	25	100%	100

Source: own survey, 2019

According to the table above the majority of the respondents are illiterate. Which is 80% in Gojeb kebeles, 73% in Diri kebele and also around 44% of the respondents in Zingaj kebele are illiterate. Only 11% of the respondents are educated above the level of grade 10 in the Gojeb kebele and only 16% in the Zingaj kebele and 10% in Diri kebeles.

**Table 4:** Landowners of the sample respondents

No	Land Size	Gojeb		Diri		Zingaj		Total
1	Non Land Owner	9	20%	7	24%	6	24%	22
2	Below 1 Hectare	26	57%	12	42%	9	36%	47
3	1-2	7	15%	2	7%	5	20%	14
4	2-3	3	6%	5	17%	3	12%	11
5	>3	1	2%	3	10%	2	8%	6
6	Total	46	100%	29	100%	25	100%	100

Source: own survey, 2019

According to the table above, there are large sample respondents who have not a piece of land. The largest number of the respondents has below one hectare of land this accounts for 57% in Gojeb kebeles, 42% in Diri kebeles and 36% in Zingaj kebele. In addition to this, there are small numbers of respondents who have their own 2-3 hectares and there were very small respondents who have more than three-hectare land.

**Table 5:** Ox owner of the sample respondents

No	Ox in No	Gojeb		Diri		Zingaj		Total
1	Non Ox owner	7	15%	9	31%	5	20%	21
2	1	13	28%	11	38%	7	28%	31
3	2	11	24%	3	10%	4	16%	18
4	3	7	15%	2	7%	2	8%	11
5	4	3	7%	3	10%	4	16%	10
6	>4	5	11%	1	4%	3	12%	9
7	Total	46	100%	29	100%	25	100%	100

Source: own survey, 2019

According to the above table, the majority of the respondents were One ox owner, 28% in Gojeb kebeles, 38% in Diri kebeles and 28% in Zingaj kebele from the above table. Some slightly different respondents have 2 oxen and more than 2 oxen farmers and it is small in numbers.

**Table 6:** Input adoption behavior of sample respondents

No	Types of inputs used by sample respondents	Gojeb				Diri				Zingaj				Total percentages	
		User		Non-user		User		Non-user		User		Non-user		No user %age	Non-user %age
		No	%age	No	%age	No	%age	No	%age	No	%age	No	%age		
1	Fertilizer	42	91%	4	9%	22	76%	7	24%	18	72%	7	28%	80%	20%
2	HYV seeds	34	74%	12	26%	19	66%	10	34%	15	60%	10	40%	68%	32%
3	Pesticides	29	63%	17	37%	21	72%	8	28%	17	68%	8	32%	67%	33%
4	Practicing irrigation	4	9%	42	91%	2	7%	27	93%	6	24%	19	76%	12%	88%

Source: own survey, 2019

According to the above table majority, 80% of the sample respondents adopt fertilizer. In Gojeb kebele 91% of the respondents' uses fertilizer, in Diri kebele 76% of the sample respondents use fertilizer and in Zingaj kebeles 72% of the sample respondent adopt fertilizer. This indicates chemical fertilizer is the best modern agricultural inputs in this area adopted by the sample respondents. This is because without fertilizer it is little to produce agricultural products in these areas.

Next to fertilizer the next most widely used modern agricultural inputs in this area adopted by the sample respondents are high yielding variety seeds. This input adopted in the above kebeles nearly, in the same way, more than 60%. This rate of adoption is very important and plays a role model to the rest of modern agricultural inputs to be adopted in these areas.

Pesticides were also adopted. The rate of adoption of pesticides is significant. Pesticides adopted in Gojeb kebeles by 63% and it is adopted by 72% in Diri kebeles more than that of Zingaj kebeles by 68%. Practicing the irrigation scheme is one of the most important techniques but, that should not be practiced by farmers. According to the table above the irrigation scheme is practiced by a very small amount.

#### 4.2. Factors Affecting Farmers' Adoption Behavior

According to the data collected from the field survey, the most contribution to increasing production and productivity is the adoption of chemical fertilizers. At this time without chemical fertilizer adoption not only fails to increase production and productivity but also unable to grow. Organic fertilizer is the most important input for the production and productivity of crops. According to the data collected the comparability between input prices and output prices, these two things cannot be comparable because input prices such as fertilizer have a price of above 1400 birr for a quintal in the current time on the other hand most widely produced crop like barley and wheat have the prices of less than 600-700 and 720-750 respectively for a quintal.

**Table 7:** Prospects or opportunities in the Adoption of MAI

No	Prospects	Gojeb		Diri		Zingaj		Total respondents	%
1	Available distribution	42	91%	24	83%	19	76%	85	85
2	Available infrastructure	44	96%	27	93%	22	88%	93	93
3	Available credit	41	89%	25	86%	23	92%	89	89
4	Effectiveness of inputs	40	87%	23	79%	20	80%	83	83
5	Available inputs	45	98%	28	97%	23	92%	96	96
6	Family labor	43	94%	27	93%	24	96%	94	94
7	Accessibility commodity market	44	96%	26	90%	24	96%	94	94

Source: own survey, 2019

According to the table above, available distribution, better infrastructure, available credit, inputs effectiveness, available inputs, accessibility of commodity market and family labor are the opportunities or prospects to the adoption of modern agricultural inputs in the area by the farmers. According to the data available distribution of modern agricultural inputs in these areas has a significant role. That is from the sample respondent 85% of sample respondents' available distribution considered as the opportunity to adopt modern agricultural inputs in this area. The effectiveness of modern agricultural inputs in the area is another opportunity to adopt these MAI. There is better available credit service in all the kebeles. There are also available infrastructural facilities such as roads.

**Table 8:** Challenges in the Adoption of MAI

No	Challenges	Gojeb		Diri		Zingaj		Total respondents	%
1	Credit constraint	36	78%	22	76%	19	76%	77	77
2	Low output price	43	94%	24	83%	23	92%	90	90
3	High input price	38	83%	27	93%	23	92%	88	88
4	Infrastructural problem	2	4%	12	41%	7	28%	21	21
5	Shortage of most needed inputs	16	35%	17	59%	14	56%	47	47
6	Economical problem	32	70%	22	76%	19	76%	73	73
7	Information problem	42	92%	18	62%	23	92%	83	83
8	Lack of extension worker incentives	38	83%	21	72%	17	68%	76	76

Source: own survey, 2019

According to the table 8 above, the most difficult challenges in the Adoption of modern agricultural inputs in this area is the problem of lower output price that is 90 respondents from the total of 100 respondents that is more than 90% of the respondents' problem next to this there is high input price which is 88% of the respondents. The other most difficulty in the adoption of MAI in these areas is an information problem. This information asymmetry problem challenges 83%, 42 respondents from a total of 46 respondents in Gojeb kebeles. It also appears this problem and makes the hindrance to adopting MAI in the other kebeles. The table 8, indicated that credit constraint, low output price, high input price, infrastructural problem, shortage of important inputs, economical-problems, informational problems and lack of extension worker incentives and advice are the major problems to adopt modern agricultural inputs in the sample kebele of respondents. Therefore, these prospects or opportunities and challenges are the problems of the whole Gimbo district rural areas.

The effect of adopting agricultural inputs in quality and quantity would be explained as follow. Before adopting improved agricultural inputs and after adopting improved agricultural inputs there is an increase in production and productivity up to double and more increasing in production after adopting. In quality explained as, in terms of the output price, that is output price before and after the adoption has significant differences. That means after adoption the output price is increased. This is the impact of the adoption of modern agricultural inputs.

The role of extension workers for farmers to adopt modern agricultural inputs in Gimbo district is not appreciated or significance. According to the data collected from sample respondents on the role of extension workers to adopt MAI into their areas is very low. But their role should be significant where countries like Ethiopia and as a farmer of Gimbo district most of the population is not educated. This indicates that extension workers are one cause of the low adoption of modern agricultural inputs in Gimbo district.

## 5. CONCLUSION AND RECOMMENDATIONS

### 5.1. CONCLUSION

Ethiopia is one of the developing countries striving for economic development and food self-sufficiency by adopting different policies and strategies. It should be noted that poor agricultural policy, landlessness, lack of basic infrastructures, lack of extension service has all undermined the adoption of modern agricultural inputs. Besides, the agricultural sector of the country is well known for its being traditional and the use of backward technologies.

Since 1992 the development of Ethiopia revolves around productivity enhancement of small-scale farmer and industrialization based on the utilization of domestic raw material. Agricultural productivity enhancement required

the application of technological productive inputs. The coordination between the farmers and extension service workers is necessary to achieve agricultural extensions strategies and to adopt different agricultural inputs such as fertilizers, pesticides, herbicides, improved seeds and so on.

The study was based on the data obtained from randomly selected households through a questionnaire. From the result shows that family size, number of oxen land ownership rights security were found to be positive in determining the adoption of modern agricultural input decisions. The extension agent contact and service weakness affect negatively the adoption of agricultural inputs. Information asymmetry, high cost of farm inputs, economical problem, credit constraints, information associated problems, agro-ecological factors, shortage of inputs, infrastructural problems are negatively affecting the adoption of improved agricultural inputs. some areas, availability of distribution and some credit availability to extremely poor farmers in the area facilitate the adoption of improved agricultural inputs or positively affect the adoption of improved agricultural inputs. The adoption of modern agricultural inputs in the study area is expected to be fully but in reality, it is less in the adoption of modern agricultural inputs.

According to the data available distribution of modern agricultural inputs in these areas has a significant role. That is from the sample respondent 100 of sample respondents' available distribution considered as the opportunity to adopt modern agricultural inputs in this area.

## 5.2. RECOMMENDATIONS

Above all, to enhance the adoption of modern agricultural inputs and to empower farmers in, particular and the development of agriculture to the rural poor in general. The following key points should be taken in to account.

- ✓ Creating a conducive political and policy environment.
- ✓ Setting up a good agricultural system.
- ✓ Proper planning and management of resources.
- ✓ Focusing agricultural investment on the smallholders.
- ✓ Sustained government public investments in agricultural technology, and extension irrigation and market infrastructure.
- ✓ Taking into account the ideas, innovations, decisions of farmers not only for the sake of moral reasoning but because the knowledge base of innovative farmers is very powerful and realistic.
- ✓ Creating favorable linkages between farmers, governments, researchers and other agents of agriculture.
- ✓ Farmers (whether small of the large holders) should be linked to the market, and innovations should address the needs of both groups.
- ✓ Sustainable core funding is vital to support various types of research on agriculture.
- ✓ The government should try to Create a National Agricultural Research Forums.
- ✓ Involving the farmers in development, implementation, advocacy, monitoring, etc.
- ✓ Strengthening the relationships between farmers and extension agents by giving awareness and different training for both of the farm-households and extension agents.
- ✓ By minimizing the cost of inputs for the farmers as much as possible.
- ✓ Extending financial systems for the rural farmers to buy their agricultural inputs and government should work in collaboration with these institutions.
- ✓ Develop Insurance for the farmers by different agents at the time of crop failures.
- ✓ Giving incentives for the role model farmers to initiate the low productive farmers.

## 6. REFERENCES

- Adebiyi, S., & Okunlola, J.O. (2013). "Factors Affecting Adoption of Cocoa Farm Rehabilitation Techniques in the Oyo State of Nigeria". *World Journal of Agricultural Sciences*: 9(3): 258-265.
- Adesina, A., & Zinnah, M. (1993). "Technology characteristics, farmers' perceptions and adoption decisions: a Tobit model analysis in Sierra Leone". *Agricultural Economics*, 9
- Aikens, M.T., Havens, A.E., Flinn, W.L. (1975). "The adoption of innovations: the neglected role of institutional constraints. Mimeograph. Department of Rural Sociology. The Ohio State University. Columbus, Ohio
- Akinola, A. A. and T. Young. (1985). "An Application of the Tobit Model in the Analysis of Agricultural Innovation Adoption Process: A Study of the Use of Cocoa Spraying Chemicals among Nigerian Cocoa Farmers," *Oxford Agrarian Studies*, 37: 395-404.
- American Agricultural Economics Association (AAEA), Nashville, Tennessee, A., Mosher, T.A. (1979). An Introduction to Agricultural Extension. *Singapore University Press for the Agricultural Development Council*.
- Asfaw, A., and Assefa Admassie. (2004). The role of education on the adoption of chemical fertilizer under different socio-economic environments in Ethiopia. *Agricultural Economics*: 30(3): 215-28
- Befekadu D, 'Berhanu' N. And 'Getahun' T. (2002). "EEA annual report on Ethiopian economy "Addis Ababa, Ethiopia
- Bellanosa and Pava. (1987), Rubenstein, J.M. (2003). Definition of Agriculture

- Bera, A.K. and T.G. Kelley. (1990).” Adoption of High Yielding Rice Varieties in Bangladesh: An Econometric Analysis,” *Journal of Development Economics*, 33: 263-285.
- Bhalla, S. (1979). “Farm Size, Productivity and Technical Change in Indian Agriculture” in R. A. Berry and W. R. Cline (eds.).
- Bisrat A. (1980).” The Diffusion of Fertilizer in Ethiopia: Pattern, Determinants, and Implication,” *The Journal of Economics and Sustainable Development: Vol.8, No.19*
- Burmeister, L. L. (1987). “The South Korean Green Revolution: Induced or Directed\_ Chambers, R.D., A. Pacey and Thrupp L.A. (1989). Farmer First- Farmer Innovation
- Colman, D. and T. Young. (1989). Principles of Agricultural Economics: Market Prices in Less Developed Countries. Cambridge, Cambridge University Press.
- CSA (2001), (2003). Central Statistics Authority Statistical Abstract, Addis Ababa, Ethiopia.
- EEA. (2004). “Annual Report on the Ethiopian Economy,” Vol III, 2003/2004, The Ethiopian Economic Association (Addis Ababa, Ethiopia).
- ELlis, F. and Freeman, H. Ade, H. (2004). “Rural Livelihoods and Poverty Reduction Strategies in Four African Countries.” *Journal of Development Studies: 40(4):1-30*.
- Etsehiwot S. (2018). The Determinants of Agricultural Technology Adoption and Its’ Impact on Teff productivity. In the case of Amhara and Oromia National Regional State. Addis Ababa.
- FAO. (2002). Food and Agricultural Organization, Annual Report, Addis Ababa, Ethiopia FAO (World Bank, 2011), Agricultural knowledge and information system for rural development.
- Feder, G., R.E. Just, and D. Zilberman. (1985). “Adoption of Agricultural Innovations in Developing Countries: A Survey,” *Economic Development and Cultural Change*, 33: 255-299.
- Gemeda, A., Aboma, G. Verkuijl, H., & Mwangi, W. (2001). Farmers’ Maize Seed Systems. Western Oromia, Ethiopia. Mexico, D.F.: International Maize and Wheat Improvement Center (CIMMYT) and Ethiopian Agricultural Research Organization (EARO). p 32.
- Gezahegn A. (2004). “Adoptions of Improved Technologies in Ethiopia,” Ethiopian Development Research Institute, Research Report 3.
- Green, G. A. D., and D. H. Ng’ong’ ola. (1993). “Factors Affecting Fertilizer Adoption in Less Developed Countries: An Application of Multivariate Logistic Analysis in Malawi,” *Journal of Agricultural Economics*, 44:99-109.
- Griliches, Z. (1957). Hybrid Corn: An Exploration in the Economics of Technological Change. *Econo-metrica*, 25: 501-523.
- Gujarati, D. N. (1992). Essentials of Econometrics, Fourth Edition, New York: McGraw-hill Inc.
- Gutkind, E. and D. Zilberman. (1985). “An Economic Approach to the Diffusion Process,” *Indian Journal of Economics*, 65: 499-512.
- H. de Groote, Doss, C. R., W. Mwangi, and H. Verkuijl. (2003). *Adoption of Maize and Wheat Technologies in Eastern Africa: A Synthesis of the Findings of 22 Case Studies*. CIMMYT Economics Working Paper 03-06. Mexico, D.F.: CIMMYT.
- Hayami, Y. and V. W. Ruttan. (1984). “The Green Revolution: Inducement and Distribution,” *The Pakistan Development Review*4
- Heisay, *et al.*, (1993). “Varietals Change in Post-Green Revolution Agriculture: Empirical Evidence for Wheat in Pakistan,” *Journal of Agricultural Economics*, 44:428-442. Innovation,” *Economic Development and Cultural Change*, 35: 767-790.
- IMWIC (International Maize and Wheat Improvement Center). (2016). Agricultural Innovation Systems (AIS) in Maize.
- Jansen, H. G. P., T. S. Walker, and R. Barker. (1990). “Adoption Ceilings and Modern Coarse Cereal Cultivars in India,” *American Journal of Agricultural Economics*: 72: 653-663.
- Kamiljon T. Akramov. (2010). Decentralization, agricultural services and determinants of input use in Nigeria.
- Kandji, S.T., Verchot, L., & Mackensen, J. (2006). “Impacts and Adaptation Strategies in the Agricultural Sector Impacts and Adaptation Strategies in the Agricultural Sector.” World Agroforestry Centre (ICRAF) and the United Nations Environment Programme (UNEP).
- Legesse D. (1992). “Analysis of Factors Influencing Adoption and the Impact of Wheat and Maize Technologies. Arsi Negele Area of Ethiopia,” M.Sc. Thesis, Haramaya University of Agriculture, Haramaya, Ethiopia.
- Legesse D. (1998). Adoption and Diffusion of Agricultural Technologies: A Case of East and West Shewa Zones, Ethiopia, Ph.D. Thesis, University of Manchester School of Economics Studies, UK.
- Lelissa Ch. (1998). “The Determinants of Adoption, Intensity, and Profitability of Fertilizer Use: The Case of Ejere District, West Shewa Zone, M.Sc. Thesis, Addis Ababa University.
- Lin, J. Y. (1991).” Education and Innovation Adoption in Agriculture: Evidence from Hybrid Rice in China,” *American Journal of Agricultural Economics*, 73: 713-723.
- Lugandu, S. (2013). “Factors Influencing the Adoption of Conservation Agriculture by Smallholder Farmers in

- Karatu and Kongwa Districts of Tanzania” Presented at REPOA’s 18<sup>th</sup> annual research workshop held at the Kunduchi Beach Hotel, Dar es Salaam, Tanzania.
- M. Sibanda, N. L. Ntshangase, and B. Muroyiwa. (2018). Farmers’ Perceptions and Factors Influencing the Adoption of No-Till Conservation Agriculture by Small-Scale Farmers in Zashuke, KwaZulu-Natal Province. *Sustainability* 2018, 10, 555; DOI:10.3390/su10020555
- Mahabub, H. (1988).” Nature and Impact of the Green Revolution in Bangladesh,” International Food Policy Research Institute in Collaboration with The Bangladesh Institute of Development Studies, Research Report 67, Washington D.
- Morris, M., Doss, C. (1999) and Schumters. (2001). “How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana”: Paper Presented at the Annual Meeting.
- Mulat and Bekele. (2003). “The determinant of the yield of major cereals in Ethiopia, namely Amhara, Tigray, Oromiya and Southern Nations and Nationalities Peoples (SNNP).
- Mulat D. and Bekele H. (2003). “The Determinants of Yield of Major Cereals: The Contribution. *Journal of Economics and Sustainable Development*: Vol.8, No.19,
- Mulat *et al.*, (2003). “Technological Progress in Ethiopian Agriculture”: Proceedings of the National Workshop or Technological Progress in Ethiopian Agriculture, Addis Ababa.
- Nigussie T. (2001). “The Productivity and Profitability of Wheat and Teff Technologies in Selected Villages of Ethiopia” M. Sc. Thesis, Addis Ababa University.
- Perrin, R. and D. Winkelmann. (1976). “Impediment to Technical Progress on Small versus Large Farms,” *American Journal of Agricultural Economics*, 58: 888-894.
- Pitt, M. M., and G. Sumodiningrat. (1991). “Risk, Schooling and the Choice of Seed Technology in Developing Countries: A Meta Profit Function Approach,” *International Economic Review*, 32: 457-473.
- Rahm, M. R., and W. E. Huffman. (1984). “The Adoption of Reduced Tillage: The Role of Human Capital and Other Variables,” *American Journal of Agricultural Economics*, 66: 405-413.
- Rogers, E.M. (1983). “Diffusion of Innovations”, New York: The Free Press.
- Ruttan, V. W. (1977). “The Green Revolution: Seven Generalizations,” *International Development Review*, 19: 16-23.
- Ryan, J.G. and K.V. Subrahmanyam. (1975). “Package of Practice Approach in Adoption of High Yielding Varieties: An Appraisal,” *Economic and Political Weekly*.
- Samuel G. (2010). “Techniques for increasing agricultural productivity in developing countries.
- Seife A. and Caroline Bosire. (2011). Farmers use of improved agricultural inputs and practices. A review and synthesis of research in Ethiopia. *Canadian International Development Agency*.
- Singh, (1986). Xiasong. (1998). The diffusion Model Theory. Department of agriculture in the USA.
- Sintayoh Getachew Aklilu. (2013). The Role of Seed Producer and Marketing Cooperatives on Wheat Crop Production and Its Implication to Food Security (The Case of Endamokhoni Wereda, Tigray, Ethiopia).
- Strauss, J., M. Barbosa, S. Teixeira, D. Thomas, and R. G. Junior. (1991). “Role of Education and Extension in the Adoption of Technology: A Study of Upland Rice and Soya bean Farmers in Central West Brazil,” *Agricultural Economics*, 5:341-359.
- Tesfai T. (1975). “Application of Multivariate Probit Analysis to Adoption Model of New Agricultural Practices,” *Ethiopian Journal of Development Research*, 2:43-56.
- Tewodaj, M., *et al.*, (2009). “Agricultural Extension in Ethiopia through a Gender and Governance Lens”. Ethiopia Strategy Support Program 2 (ESSP2) Discussion Paper No. ESSP2 007.
- Udemezue JC, Osegbue EG. (2018). Theories and Models of Agricultural Development. *Ann Rev Research*; 1(5): 555574. DOI: 10.19080/ARR.2018.01.555574
- Wakuma K. (2015). Ethiopia: Role of Agriculture in Poverty Reduction in Ethiopia. *The Ethiopian Herald*.
- Yamani T. (1967). The sample size determination
- Yohannes K., K. Gunjal and G. Coffin. (1991). Adoption of New Technologies in Ethiopian.