CHAPTER 1

INTRODUCTION

1.1 Background

Economic indicators on the distribution of output, employment, and foreign exchange earnings clearly unveil that agriculture is the dominant sector in the Ethiopian Economy. The agricultural sector accounts for 43% of the Gross Domestic Product (GDP) and nearly 78% of the export earnings (National Bank of Ethiopia [NBE], 2005). The livelihood of about 85% of the total population in Ethiopia entirely depends on the agricultural sector. Moreover, agriculture provides raw materials for domestic industries and the large agrarian population is meant for larger market for domestic industrial products. Especially, the role of agriculture in securing the food needs of the fast growing population is of paramount importance. Agriculture is generally the mainstay of the Ethiopian economy and the overall economic growth is highly influenced by the performance of the agricultural sector.

However, in spite of its great significance in the Ethiopian economy, the performance of agriculture has been below expectations particularly since the late 1960s. The agricultural sector grew at an average rate of 1.2% per annum between 1965 and 1980 while the average rate of population growth during the same period was estimated to be 2.7% per annum (World Bank, 1990: 180, 228). The growth rate of agricultural production was further deteriorated and reached to the level of 0.3% per annum during the period 1980-1991. Contrary to the declining trend in the growth of agricultural production, the population growth has accelerated to 3.1% per annum during the same period (World Bank, 1993: 240 & 288). Agricultural production could not keep pace with the unprecedented population growth. The food production per capita was consequently declining by 1.4% per annum during the period between 1979 and 1991 (Ibid: 244). As a result, Ethiopia has become a food deficit country and the rate of food self-sufficiency, measured by the extent of food demand met by domestic production, has declined to 58% in 1991/92 (Demeke, 1996: 243). The widening gap between the production and demand of food has forced the country to increase the level of food imports. For instance, the volume of cereal imports increased from 77 thousand metric tons in 1970 to 1047 thousand metric tons in 1992 (FAOSTAT, 2006a).

The poor performance of agriculture has been manifested by the widespread poverty and food insecurity problems especially in the rural areas. According to the World Bank (2005: 258), 44% of Ethiopia's population is living below the poverty line. It is also indicated that the incidence of poverty is much higher in the rural (45%) than in the urban areas (37%). Furthermore, some nutrition and health indicators reveal the prevalence of high level of food insecurity problem in the country. On average, 46% of the population was estimated to be undernourished during the period 2001-2003 (FAOSTAT, 2006c). Moreover, the high incidence of child malnutrition, estimated at about 52%, and infant mortality rate of 112 (0-1

year) (per 1000 live births) reveal the magnitude of the food insecurity problem in the country. A notable feature of poverty and food insecurity problems in Ethiopia is that they are closely related with the large proportion of agrarian population and the poor performance of the agricultural sector.

Various factors are commonly cited as the root causes of the weak agricultural growth performance over the last four decades. The major factors include recurrent drought, inappropriate economic policies, low-levels of agricultural technology, fast growing population, land fragmentation, and underdeveloped rural infrastructure. The command economic policy during the 1970s and 1980s had brought about a detrimental impact on Ethiopian agriculture (Abdurezak and Tadesse, 1995: 112 &113). However, though the performance of agriculture is influenced by policy changes, drought still remains to be the biggest threat to agricultural production in many parts of Ethiopia. The growth of agricultural production is highly dictated by weather conditions particularly on the timely and adequacy of rainfall distribution. Moreover, the application of improved agricultural technologies is very limited. The low level of agricultural technology is characterized by the limited use of improved crop varieties, fertilizers, and irrigation systems. For instance, the average national fertilizer consumption is estimated at 15 kg per hectare of arable land and irrigation is applied only on 1.8% of the cultivated land (FAO, 2005: 168).

Besides, the basic structure of the agricultural sector itself has contributed to its slender production and productivity growth. Ethiopia's agriculture is dominated by subsistence smallholder farming which accounts for 95% of the agricultural production (African Development Fund [ADF], 2002: 4). The smallholder agriculture is primarily characterized by a mixed farming system that involves both crop and livestock production and mostly concentrated on the highlands of the country. Close to 80% of the total population is engaged in the mixed faming system in the highland areas that cover 45% of the total area of the country (FAO/AGL, 2005). Crop production is basically rainfed and at subsistence level. In the highland mixed farming system, agricultural production is generally based on traditional farming practices where the use of improved agricultural technologies and natural resource management are very limited. As a result, agricultural productivity is very low. For instance, the average cereals yield is estimated to be 1367 kg/ha while that of pulses is 1000 kg/ha (CSA, 2002a: 31). In addition, the high population pressure in the highland areas has been leading to a declining landholding size and land fragmentation problems. It is estimated that, on average, 63% of the smallholder farmers cultivate on a landholding less than 1 hectare (CSA, 2003a: 82).

Improving agricultural growth is critical to Ethiopia's ability to reduce poverty and ensure food security in the face of fast growing population given the following basic facts. First, poverty and food insecurity are largely concentrated in the rural areas where the rural poor account for 70% of the Ethiopian poverty (ADF, 2002: 12); second, agriculture provides the

main source of employment where 82% of the labor force is engaged in agriculture (FAO, 2002: 20); and third, agriculture represents the larger share of the economy. Therefore, the success of development strategies aiming at achieving the objectives of poverty reduction and food security in particular and economic development in general depends on a sustainable agricultural growth.

Although the smallholder farmers were not given a priority, different agricultural development projects had been implemented to transform the Ethiopian agriculture since the advent of the comprehensive projects, which were launched, in the late 1960s. Currently, agriculture has been given a high priority and a new development strategy known as the Agricultural Development-Led Industrialization (ADLI)[1] was adopted in 1993. In this strategy, agriculture is considered as an engine of overall economic growth. The strategy particularly gives a high priority for improving the productivity of the smallholder subsistence farming that dominates the agricultural sector. In this regard, it has been recognized that the success of ADLI depends on the uptake of improved agricultural technologies by a large proportion of smallholder farmers in order to raise farm productivity and income. To meet this end, a new agricultural extension program, known as the Participatory Demonstration and Training Extension System (PADETES) was formulated and launched in 1994/95 cropping season.

The PADETES is based on a package extension approach which has been adapted from the experience of Sasakawa-Global 2000 (SG 2000)[2] project. At first, in 1993, the SG 2000 project initiated the popularization of improved production technologies for the most important food crops namely maize, wheat, tef, and sorghum using a half hectare demonstration plots in areas with reliable moisture. The technology packages included improved varieties along with fertilizer and other recommended agronomic practices. In the period 1993-1995, SG 2000 project carried out 5000 half-hectare on-farm demonstration plots of maize, wheat, sorghum and tef. Impressive results were obtained and yields on demonstration plots using the recommended packages surpassed the traditional farming methods by more than 200% and 100% for maize and wheat, respectively (Gebre, 1996: 191& 192). Consequently, the government was convinced to adopt the same approach for popularizing the use of improved agricultural technologies to smallholder farmers. The number of farmer-managed demonstration plots increased from 35,000 in 1995 to nearly 4 million in 1999 (FAO, 2001: 100 & 101). Currently, the PADETES has become a regular

[1] The strategy recognizes the significant contributions of agriculture to overall economic growth in terms of surplus generation, market creation for domestic products, supply of raw materials, and foreign exchange earnings.

[2] SG 2000 Project is a non-governmental organization which was initiated in Ethiopia in 1993 to assist the country in improving its food production growth through intensive agricultural extension programs. It has also aimed at creating a functional linkage between the agricultural research and extension system in country. The centerpiece of the extension approach of SG 2000 is the farmer-managed Extension Management Training Plot (EMTP), which is a half hectare demonstration plot, applying a package of improved production technologies specifically improved seeds, fertilizer, herbicides, and other recommended agronomic practices.

extension program covering all regions of the country and including more additional technology packages such as improved livestock production technologies, post-harvest technologies, and soil and water conservation.

A number of improved agricultural technologies have been developed and released by the Ethiopian National Agricultural Research System over the last 50 years. Yet, the majority of the technologies generated so far have mainly been focused on crops particularly cereals and pulses[3]. This is perhaps attributed to the largest share of these crops in Ethiopian agriculture. Cereals are the major crops, which account for nearly 80% and 77% of the total annual cultivated land and production, respectively (CSA, 2002a: 57). Furthermore, about 68% of the total calorie consumption of the Ethiopian population is derived from cereals (FAOSTAT, 2006b). Pulses are next to cereals, which cover 13% of the total cultivated land and contribute to 10% of the total crop production (CSA, 2002a: 57). The most commonly grown cereal crops are *tef*, wheat, maize, sorghum, barley, and millet while the major pulses include chickpea, lentil, faba bean, field pea, and haricot beans.

One of the most important impacts of the new extension system is the massive diffusion of improved agricultural technologies especially a package of improved crop varieties, fertilizer and other recommended agronomic practices to smallholder farmers in most parts of the country. The improvement in credit provision for input procurement and technical backstopping by the research and extension services have resulted in a significant progress in the use of improved agricultural technologies in the smallholder sector. For instance, the number of farmers covered by the extension package program increased from 500,000 in 1996/97 to 2.9 million farmers in 1998/99 cropping season (ADF, 2002: 52). Economic statistics reveal that the performance of agriculture has been improved after the implementation of the new extension program. The growth rate of agricultural production was estimated, on average, at 2.8% per annum during the period between 1995/96 and 1998/99 (NBE, 2000)[4]. In general, the wider use of improved agricultural technologies in the smallholder sector is expected to bring about considerable growth in food production and ultimately ensure food security. Hence, the study focuses on analyzing the impact of technological change on farm productivity and food security at the household level.

1.2 Problem Statement

In Ethiopia, agricultural production is mainly characterized by smallholder farming where production is nearly at subsistence level and farm productivity is very low. Yet, there is a rapidly growing population, which has consequently led to the increasing gap between food

[3] During the period between 1960 and 1990, a total of 340 agricultural technologies were generated of which 229 (about 67%) were on field crops while the number of improved technologies for livestock, horticulture, and natural resource were 39, 44, and 28, respectively (Mekonnen, 1995: 387).

[4] Yet, the positive trend in agricultural growth is partly attributed to favorable weather conditions. In the 1997/98 cropping season, a 7.6% fall in total agricultural production was occurred due to a bad weather (Demeke, 1999:5).

production and requirement especially during the last three decades. Agricultural production could be increased by bringing more land under cultivation and/or improving agricultural productivity. Currently, increasing agricultural production through area expansion is not a feasible approach particularly in the highland areas where much of the agricultural activities are situated. The apparent high population pressure in the highlands has been increasingly limiting the frontier for further increases in the area under cultivation. Much of the arable land conducive for crop production has already been used and cultivation has been encroached into marginal and fragile lands that are susceptible to erosion and land degradation. Hence, the feasible alternative approach for attaining sustainable agricultural growth is enhancing agricultural productivity by improving farm resource use efficiency based on the existing technologies and/or employing new agricultural technologies, i.e. changing the production frontier (technological change).

Over the years, various efforts have been made in research and development activities to improve the productivity of Ethiopian agriculture. The Ethiopian National Agricultural Research System (NARS) has generated and released a number of improved agricultural technologies in crops, livestock, and natural resource management over the last five decades. However, farm productivity, as indicated by the yield of major crops, has remained very low due mainly to the limited adoption of improved agricultural technologies by smallholder farmers. The adoption of improved agricultural technologies is an important means to increase the productivity of smallholder agriculture and thereby increasing food production and alleviating food insecurity problem; and improving economic growth as well. To this effect, different productivity-enhancing technologies mainly technology packages in crop production have been disseminated to the smallholder farmers since the implementation of the new extension system in 1994. The high yield performance of the improved technologies compared to the local farm practices have been demonstrated to farmers using farmer-managed demonstration plots. In addition, the necessary supporting services such as input credit and technical advice have been improved to enhance the uptake of improved technologies by smallholder farmers.

Accordingly, a significant proportion of farmers adopted improved crop production technologies as indicated by adoption studies conducted in selected areas of the country. Some adoption studies carried out during the period 1996-1999 in different locations, i.e. Southeastern (Arsi and Bale), Central highlands (Ada, Lume, Gimbichu), Western and Northwestern pats of the country revealed that the adoption rates for improved wheat and maize varieties range from 32%–72% while it exceeds 58% for commercial fertilizer (Dose et al., 2003: 4). It was found that 74% of the farmers in Moretina Jiru District adopted improved wheat varieties that accounted for 53% of the total wheat area in 1994/95 cropping season (Negatu and Patrikh, 1999: 208). Similarly, a study conducted in four regional states of

Ethiopia showed that 19% and 60% of farmers adopted improved crop varieties and fertilizer, respectively in 1998/99 cropping season (Kassa, 2003: 79)[5].

In spite of the good yield performance achieved on demonstration plots and the observed impressive adoption rates, knowledge about the impact of technological change on farm production growth and food security at the household level is very limited. As a rule, the shift from local to improved production technologies results in increased farm production and productivity growth. All of the production growth, however, cannot be attributed to the improved technology alone. Therefore, in order to identify feasible options for maintaining further productivity growth using the improved technology and justify the need for new technology development, certain important issues should be taken into account: identifying the proportion of total production growth due to technical change, efficiency improvement, and intensification of factor inputs. Analyzing the contribution of technical change and efficiency improvement to total production growth is important for assessing the on-farm performance of the technology in improving productivity growth and identifying an exploitable potential for further productivity growth.

In the literature, there have been quite a number of adoption studies related to improved agricultural technologies in Ethiopia. Yet, since adoption is dynamic, it is imperative to update the information based on the current technologies being adopted by farmers. More specifically, information on technology adoption is vitally important to undertake impact studies.

1.3 Objectives of the study

The main objective of this study is to examine the impact of technological change on smallholders' farm productivity and household food security in the wheat-*tef* based farming systems of central highlands of Ethiopia. The specific objectives are:

1. to describe the farming systems in the study area;
2. to identify factors influencing intensity of technology adoption;
3. to analyze the impact of technological change on farm productivity; and
4. to examine the effect of technological change and other socio-economic factors on farm household food security.

1.4 Significance of the study

In general, agricultural research is undertaken to generate new technologies that will bring about productivity change at the farm level and thereby contribute to increased food production. However, the generation of new agricultural technologies alone is ultimately not a measure of research success. The new technologies must first be adopted by farmers to

[5] Namely, these four regional states are the Amhara National Regional State, the Oromia National Regional State, the Southern Nations, Nationalities and Peoples Regional State and the Tigray National Regional State. They covered the densely populated mixed-farming systems of the highlands of Ethiopia that account for about 90% of the total rural population (Kassa, 2003: 67).

achieve the objective of productivity growth. In this case, there is a need on the part of decision makers to have information on the contribution of research in improving the productivity of smallholder farmers. Hence, the information to be generated serves this purpose.

Impact studies are important not only for evaluating claims for continued funding of agricultural research but also for guiding future research in ways that will make a great contribution to increased food production and income of the farmers. Such studies will generate information on the performance of improved agricultural technologies and factors affecting technology adoption at farm level. This information is important for agricultural researchers to plan research activities that could generate better improved agricultural technologies based on farmers' conditions.

Development of agricultural technologies alone is not enough to bring about growth in agricultural production. There should be an enabling policy environment which creates the condition where farmers have access to improved technologies and able to increase their food production and productivity. The information generated could be used as an input in future policy formulation regarding agricultural technologies and smallholder agriculture.

In addition, this study contributes to the knowledge base of the limited number of impact studies conducted in Ethiopia and could be used as an input for further studies.

1.5 Scope of the study

Impact assessment studies range widely in scope and depth of analysis from an effort to measure the adoption of improved technologies to research quantifying a wider array of impacts of improved technology on production, productivity, equity, poverty alleviation, food security, biodiversity, environment and a variety of social issues. Impact studies are widely applied to evaluate the effectiveness of agricultural research by estimating the rates of return to commodity research investments. Undertaking a more comprehensive economic impact assessment requires considerable financial resources and time that cannot be handled by such study. Therefore, given the budget and time constraints, this study was limited only to the adoption and impact of improved crop production technologies on farm productivity and food security at the household level. Other improved technologies in livestock, forestry, soil and water conservation, etc have not been covered in this study.

1.6 Organization of the Thesis

The thesis is organized into six chapters. Chapter 2 provides the highlight of some of the basic features and structure of Ethiopian agriculture. In this chapter, the importance of agriculture to the national economy is briefly presented. Further, it describes the land use and agro-ecological zones of the country. The crop and livestock production aspects along with a brief description of the natural resources are presented. The significance of the smallholder agriculture and the different agriculture supporting services such as research and extension,

and credit are also briefly described. Some issues related to land tenure are also mentioned. Chapter 3 presents the research methodology employed in the study. It provides the description of the basic conceptual frameworks that provide the basis for the specification of the empirical models. It also describes the research design and data sources. Chapter 4 describes the natural and socio-economic characteristics of the study areas.

Chapter 5 presents the results of the study. In this chapter, the description of the farming systems based on sample characteristics is presented. It further presents and discusses the Econometric model results. In the last chapter, summary, recommendations, and policy implications are drawn based on empirical results. Finally, some relevant issues which need further research are also outlined.

CHAPTER 2

BASIC FEATURES AND STRUCTURE OF THE AGRICULTURAL SECTOR IN ETHIOPIA

2.1 Significance of agriculture in the economy

In general, Ethiopia has an agrarian economy where agriculture contributes the lion's share of output, income and employment in the economy. Hence, the overall economic growth is highly associated with the performance of the agricultural sector. For instance, the high economic growth, estimated at 7.7%, in 2000/01 was achieved mainly due to the strong performance of the agricultural sector indicated by 11.5% growth rate (NBE, 2005). Here, the agricultural sector accounted for close to 65% of the economic growth achieved in the same year. This was closely associated with the bumper harvest achieved in the 2000/01 cropping season due mainly to good weather conditions. On the contrary, the sever drought in 2002/03 caused a fall in agricultural growth by nearly 13% and consequently real GDP growth declined by 4% (Ibid.).

Above all, the significance of agriculture in satisfying the food demand of the country's rapidly growing population entails a high priority. Ethiopia is one of the sub-Saharan African countries, which have a high population growth rate. The Ethiopian population grew on average 2.3% per annum during the period 1990-2003, and the total population size was estimated to have reached about 68.6 million in 2003 (World Bank, 2005: 256). This has an important implication on the sustainability of the natural resources base and the efforts to attain national food security given that nearly half of the current population is classified as undernourished with a daily consumption per head of 1,765 kcal, well below the required energy supply level of 2,600 per day (Dejene, 2003: 1). The smallholder agriculture has been satisfying, on average, 70% of the country's food requirement and the balance is covered with food imports (ADF, 2002: 21).

The commodity composition of Ethiopia's export is dominated by agricultural products indicating that the country heavily relies on agriculture for its foreign exchange earnings. The major agricultural export commodities include coffee, oilseeds, pulses, hides and skins, meat and meat products, fruits and vegetables, live animals and others. All these commodities accounted for 78% of the total export earnings in 2004/05 while coffee, the major export commodity, alone accounts for 41% of the total foreign exchange earnings (NBE, 2005). Currently, the share of coffee has been declining as compared to its share in the 1980s and early 1990s. For example, coffee accounted, on average, 76% of the total foreign exchange earnings during the period 1978 and 1980 (Woldu, 1995: 167). Despite its significance in the export sector, the dominance of coffee has some drawbacks such as the risk of instability of export earnings which is related to the coffee price fluctuation in the world market. Generally, Ethiopian export lacks diversity and highly depends on a limited number of agricultural